Environmental Economic Assessment for Ngā Awa Northland Catchments (DOC Contract No. 4827)

A study to evaluate the economic contribution of the restoration of rivers to the Northland Regional Economy

A Report Prepared for the
New Zealand Department of Conservation

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Executive Summary

The New Zealand Department of Conservation (DOC)'s Ngā Awa programme aims to support the catchment-scale restoration of three river catchments in the Northland Region: the Doubtless Bay, Waihou and Waipoua River Catchments. The restoration of these catchments would increase the Northland Region's climate change resilience. The restoration of these catchments also has the potential to align with many of the Tai Tokerau Northland Economic Action Plan goals.

The DOC Tai Tokerau - Northland team are looking for win-win opportunities in the Northland Region for land use changes in relation to the Ngā Awa river restoration program. One of the many things to consider in terms of land use changes is the 'total economic value' (TEV) of different practices, which includes ecosystem service values. The preliminary TEV results in this investigation, using data from previous international studies, illustrates that river catchments are one of the most valuable land types, second only to wetlands. Horticultural land use can also have a high TEV, depending on the assumptions of the valuation. The results also reveal that certain agricultural land uses are of a markedly lower value than others. For example, cattle and sheep grazing is of a much lower value than horticultural crops. Water usage of different crops is not taken into account into the TEV and New Zealand-specific data is lacking in this area.

Other information is presented on population and land use trends in the 3 catchments, as well as GDP earnings and employment by different business types. Tourism makes up almost 7% of Northland's economy, supports a significant proportion of employment and GDP in the Doubtless Bay and Waipoua river catchments, and both domestic and international tourism have been increasing in recent years. Climate change predictions and the New Zealand Emissions Trading Scheme are discussed in relation to economic opportunities and river restoration.

This initial investigation indicates that there are several win-win opportunities emerging. These include the river restoration project itself, which supports many ecosystem services, the establishment of native tōtara stands in riparian river corridors and on steep land under the NZETS, the establishment of new recreation opportunities, including walking and cycling trails, and manuka and kanuka oil and honey production.

Introduction

The New Zealand Te Papa Atawhai Department of Conservation (DOC)'s Ngā Awa programme aims to support the catchment-scale restoration of 14 rivers around New Zealand, with a view to increasing their ecological integrity and climate change resilience. Ngā Awa is supported by a research strategy that has identified four key knowledge gaps: 1. how to address climate change resilience in river restoration; 2. using riverine geomorphology to support enduring restoration (i.e., working 'with' the river); 3. understanding socio-economic drivers in our catchments; and 4. monitoring strategies & techniques for river catchments. This report is focused on the third research theme, and, in particular, on economic drivers influencing the three Ngā Awa catchments in Northland, namely Doubtless Bay, the Waihou River and the Waipoua River.

Economic factors strongly influence activities in each catchment, for example, land use (e.g., dairy vs. dry stock vs. forestry vs. horticulture), water storage and abstraction, and managed retreat ahead of climate change. The Ngā Awa team would like to identify and rank 'win-win' opportunities that support both economic success and river restoration initiatives – particularly river restoration and economic decisions that take into account climate change. Environmental economic values are important to consider for projects related to improving river processes and conditions, improving freshwater biodiversity, protecting threatened species, and increasing climate change resilience. This information can assist in all aspects of the planning and development process.

Focus for this investigation was placed on Northland's current economic initiatives (e.g., those expressed in the recently updated Tai Tokerau Northland Economic Action Plan), and applying market and non-market values in relation to freshwater health, river restoration and climate change plans supporting Ngā Awa's emerging river restoration initiatives in the region. This report is intended to support decision-making and strategic development by the River Restoration Coordinators, mana whenua, other iwi entities and other catchment stakeholders.

This project involved several steps, but was primarily a desktop exercise utilizing currently available information. Firstly, a search of the currently available economic initiatives, climate change management, and valuation information for Northland was conducted, focusing on information relevant to the three Ngā Awa catchments. Next, contact was made with local

Northland representatives to acquire additional information related to the Ngā Awa River Restoration Programme. Consideration was made of the current economic situation and land use changes indicated over the next ten years (e.g., avocado plantations, 'carbon credit farming' via forestry). Particular attention was paid to initiatives that may be influenced by climate change expected in the region (i.e., susceptibility to drought). Missing information was extrapolated from Statistics New Zealand data and other relevant resources. The data was collated and a summary of the valuation information was extrapolated from the collected resources. This report considers the market and non-market values of the current situation and ranks the economic initiatives signalled for the region with respect to their alignment with 'catchment-scale' river restoration that takes climate change into account.

Ngā Awa Catchments in Northland

The Northland Region is the northernmost region in New Zealand. It has a subtropical climate with mild wet winters and warm humid summers. Frosts rarely occur in the region, except for the occasional frost in the lowland areas around Dargaville. This region also has the highest average annual temperature throughout the country. Tāne Mahuta, New Zealand's largest tree, is located in the Waipoua Forest in this region, while the city of Whangarei is the main population centre (Northland Regional Council (NRC), 2021b).

The Northland Region consists of an area of 1,328,600 hectares. The three Ngā Awa catchments in Northland under investigation include the Doubtless Bay Catchment, the Waihou River Catchment and the Waipoua River Catchment. In a size comparison (Table 1), the Doubtless Bay Catchment covers approximately 4% of the Northland Region's area, while the Waihou and Waipoua River Catchments are approximately 2% and 1% of the area, respectively (Manaaki Whenua Landcare Research, 2020; NRC, 2021b).

Table 1. Ngā Awa Catchment Size

	Hectares	Compared to Northland Region
Doubtless Bay Catchment	51,614	3.88%
Waihou River Catchment	29,639	2.23%
Waipoua River Catchment	11,286	0.85%

Source: Manaaki Whenua Landcare Research (2020) and author calculations.

Doubtless Bay Catchment

The Doubtless Bay catchment area is located in the Far North, east of Kaitāia, and includes the Awapoko (Te Aurere), Oruaiti and Oruru subcatchments (Figure 1). It is one of Northland's most important recreational areas. Consequently, Doubtless Bay is sometimes called New Zealand's Beach Paradise. Mangonui is the biggest town in the catchment.

Recreation activities in the Doubtless Bay area include:

- going to beaches;
- fishing (and fishing charters);
- kiwi and glow worm adventure tours;
- sky diving;
- stand up paddle boarding, surfing and kayaking;
- visiting art galleries;
- dune surfing;
- visiting the whaling museum;
- visiting the gumdiggers park and kauri gum digging site;
- lawn bowling;
- wine tasting;
- visiting boutique shops, restaurants and cafes;
- purchasing local arts and crafts;
- spas;
- sailing;
- dolphin watching;
- snorkelling;
- diving; and
- walking (Doubtless Bay Promotion, 2021).

Figure 1. Map of the Doubtless Bay Catchment (Northland).

The Doubtless Bay Catchment map includes the Awapoko (Te Aurere), Oruaiti and Oruru subcatchments, showing the main land cover types (e.g., crops (orange-brown), exotic forestry (green), indigenous forest (khaki green), scrub and shrubland (brown) and waterways. The purple line indicates the catchment boundaries. Source: West (2021a).

There are three main rivers in the Doubtless Bay catchment: Awapoko (Te Aurere), Oruaiti and Taipā. Of these, only the Oruaiti River is being monitored for quality purposes. Water monitoring results have revealed that the Oruaiti River has many water quality issues. These include high levels of *E. coli* bacteria, dissolved reactive phosphorous (DRP) and turbidity, all exceeding the National Guidelines. It is also known that high levels of sediment are coming from woody vegetation areas (15%), pasture (62%) and streambank erosion (23%) (NRC, 2013; NRC, 2017).

The Oruaiti River's water quality is similar to that of other river sites in the Northland Region. These poor water quality conditions are typically seen in lowland rivers that are impacted by intensive land use activities. As the soils in this area are primarily red volcanic soils composed of very fine textured clay sediment, it is important that careful land management practices are imposed to avoid any further water quality deterioration (NRC, 2013; NRC, 2017).

To obtain and maintain high levels of ecological health, it is important for the Doubtless Bay area rivers to support diverse habitats and flow regimes, and good quality riparian vegetation (NRC, 2013).

Current issues in the Doubtless Bay area rivers include:

- hill-slope erosion from pasture;
- stream bank erosion;
- sediment deposition;
- impacts on native aquatic plant growth and fish habitat due to reduced water clarity;
- livestock have access to water bodies;
- damage to in-stream and riparian vegetation;
- damage to streambed habitat;
- exotic species (e.g., trout, alligator weed);
- predation of native fish;
- competition for space/smothering;
- reduced habitat quality for native species;
- nutrient toxicity (causes reduced habitat quality for aquatic species);
- effluent discharges;
- nutrient enrichment;
- frequent algal blooms;
- extraction of water from rivers;
- risk to fish habitat due to reduced flows;
- reduced flow variation (flushing flows);
- impacts on mahinga kai species (e.g., commercial harvest, habitat modification); and
- limited public awareness of cultural values and sites of significance to tangata whenua.

More information on the primary land uses and land cover types will be detailed in the following sections (i.e., Understanding Socio-economic Drivers in Northland, Land Uses).

Waihou River Catchment

The Waihou River in Northland, which is not to be confused with the Waihou River near Putāruru in the Waikato Region, enters an arm of the Hokianga Harbour (Figure 2). It is a popular river to fish for trout. The Waihou River Catchment was once a sawmilling district. Farming has replaced timber milling in this location (Hokianga Tourism Association, 2021).

Common recreation activities in this area include:

- fishing;
- hunting;
- walking; and
- swimming.

The Waihou River has 2 main subcatchments. The northern Waipapa subcatchment extends into Puketi forest with some exotic forestry in the headwaters, while the Whakanekeneke subcatchment extends southeast into a mainly lowland farming area with some forestry and areas of Public Conservation Land (Hokianga Tourism Association, 2021).

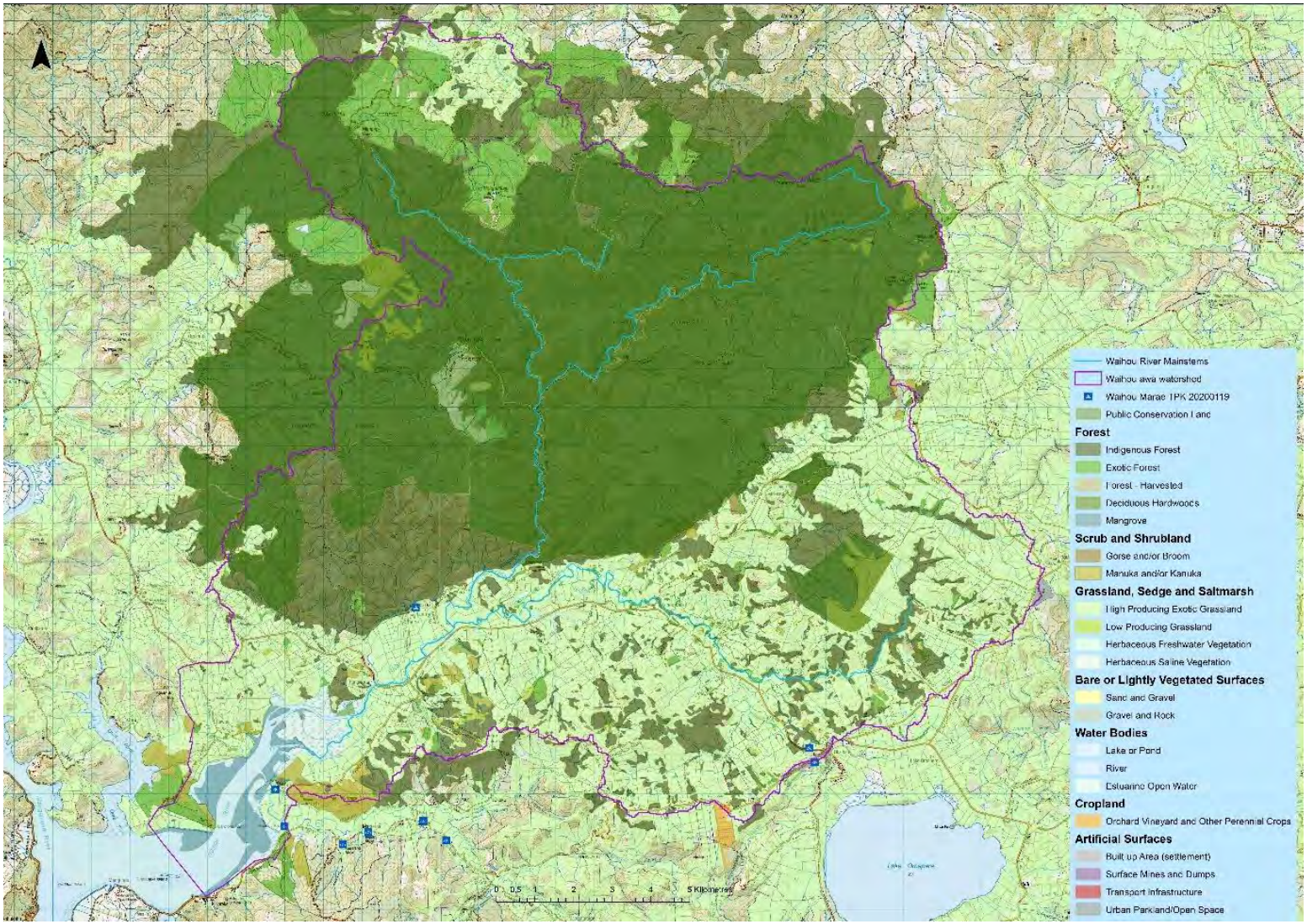

Figure 2. Map of the Waihou River Catchment.
Map of the Waihou River Catchment showing different land cover types. The purple line indicates the extent of the catchment boundaries. Source: West (2021b).

Waipoua River Catchment

North of Dargaville is Northland's Waipoua River (as opposed to the Wellington Region's Waipoua River) (Figure 3). The Waipoua River Catchment begins in and flows through the Waipoua Forest, which is the location of the famous kauri tree called Tāne Mahuta. As of 15 March 2021, Tāne Mahuta was the largest documented kauri tree in New Zealand. This tree is well over 1,000 years old and possibly as old as 3,000 years (LAWA, 2021; DOC, 2021).

The Waipoua River catchment is predominantly indigenous forest. The Waipoua Forest and its neighbours, the Mataraua and Waima Forests, comprise the largest native forest tract in Northland. The Waipoua catchment is in a more pristine condition than the other two locations in this investigation. Surprisingly, although most recent water quality testing values reported by NRC (LAWA, 2021) fall within recommended guidelines, the microbial water quality values for freshwater bathing in this catchment are below the acceptable limits in the lower catchment. The contamination source is thought to be farming in the headwaters with stock still not fenced out of some waterways – although this is being addressed (LAWA, 2021).

The headwaters of the Waipoua River contain a small area of farmland, most of which is drystock farming with some dairy. At the lowland end of the catchment just above the estuary, a ford was installed for vehicles (particularly large logging trucks) to cross. The ford is, however, a significant fish barrier for fish migrating inland. Consequently, fish ramps were installed, but at present, not all fish can get past the ford using the ramps. Therefore, a change in the ramps or the structure itself may be required so more native fish species can access the river catchment. The river passes through a pine plantation, native kauri forest, a regenerating forest and farmland (DOC, 2021).

Common recreation activities in this area includes:

- fishing;
- hunting;
- camping;
- walking; and
- swimming.

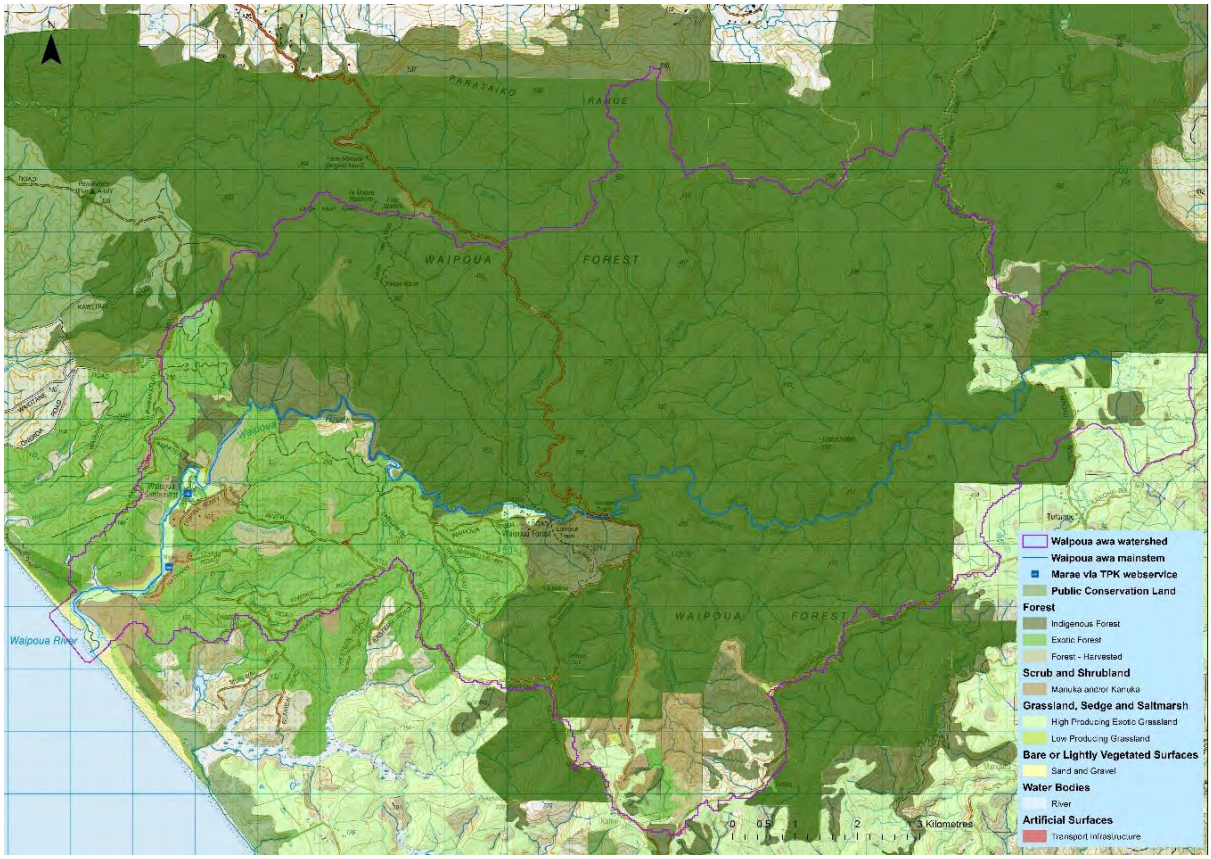

Figure 3. Map of the Waipoua River Catchment.
Map of the Waipoua River Catchment indicating the main land cover types and water bodies. The purple line indicates the extent of the catchment. Source: West (2021c).

Statistical Area for Each Catchment

Data from Statistics NZ is not broken down by catchments. Therefore, some data for individual catchments was not available. The data is broken down by Statistical Areas (SA2) (Table 2), which encompass and roughly represent the river catchment boundaries, but may be slightly larger than the catchments themselves. The Waipoua River Catchment is located in the Waipoua Forest SA2 and the Waihou River Catchment is located in the Omahuta Forest – Horeke SA2. The Doubtless Bay Catchment is part of three SA2s: Oruru-Parapara, Taemaro-Oruaiti, and Taumarumaru (Table 2). When possible, data will be presented by catchment. However, when it is not possible, data will be presented by the SA2 area. For ease of understanding, a plus sign (i.e., +) will be used after the catchment name when the SA2 statistical area is used (i.e., Waihou River Catchment+) as opposed to only the catchment (i.e., Waihou River Catchment) (Jones, 2021a).

Table 2. Statistical Area (SA2) for Each Catchment

Catchment	SA2
Waipoua River Catchment	Waipoua Forest
Waihou River Catchment	Omahuta Forest-Horeke
Doubtless Bay Catchment	Oruru-Parapara
	Taemaro-Oruaiti
	Taumarumaru

Source: Jones (2021a).

Northland Population

In 1996, the resident population of New Zealand was 3,732,000 (Figure 4), while that of the Northland Region was 140,700 (Figure 5). In 2020, the population increased to 5,084,300 for New Zealand and 194,600 for the Northland Region. The data reveals that the population of the Northland Region has been increasing at a higher rate than the New Zealand population overall (Statistics New Zealand, 2021). As this report focusses on the current situation, as well as ten years in the future, population estimates were conducted. In 2031, it is estimated that the New Zealand population will be 6,287,684 and the Northland Region population will be 252,877.[1]

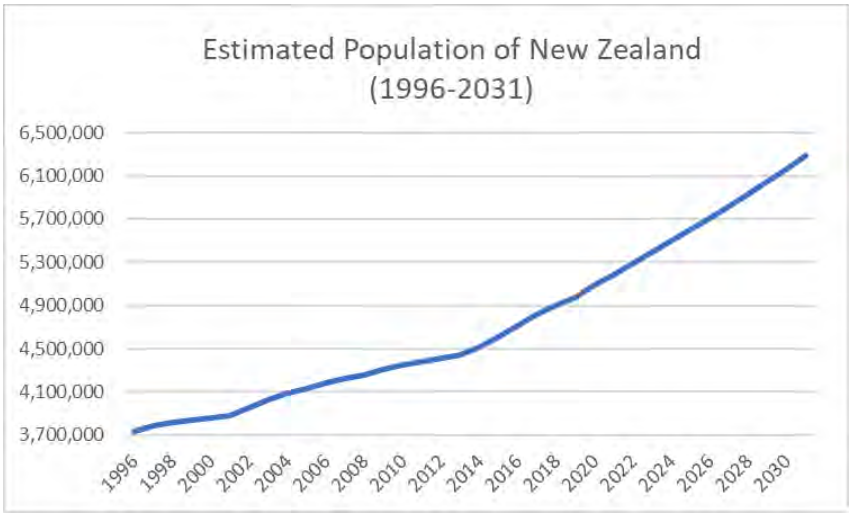

Figure 4. Estimated Population of New Zealand (1996-2031)
Source: Statistics NZ (2021a) and author estimation.

[1] Future population estimations were based on the past 7 years of data. It is important to note that Covid-19 will affect population trends, primarily in relation to migration. This has been acknowledged by assuming a slight decrease in the growth trend.

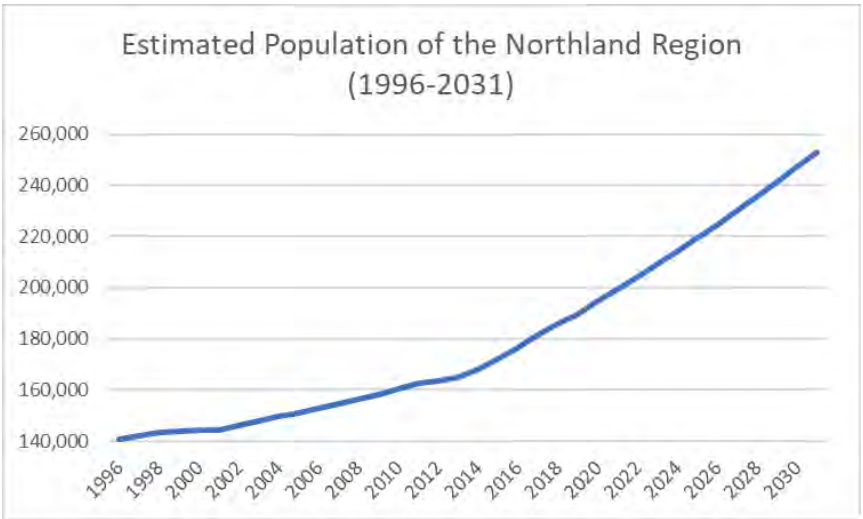

Figure 5. Estimated Population of the Northland Region (1996-2031)
Source: Statistics NZ (2021a) and author estimation.

The population of New Zealand has continued to increase since 1996. The same is true for both the Northland Region and the Doubtless Bay Catchment+ (Figure 6). In 1996, the catchment area had approximately 2,770 people. In 2020, the number increased to 4,400.

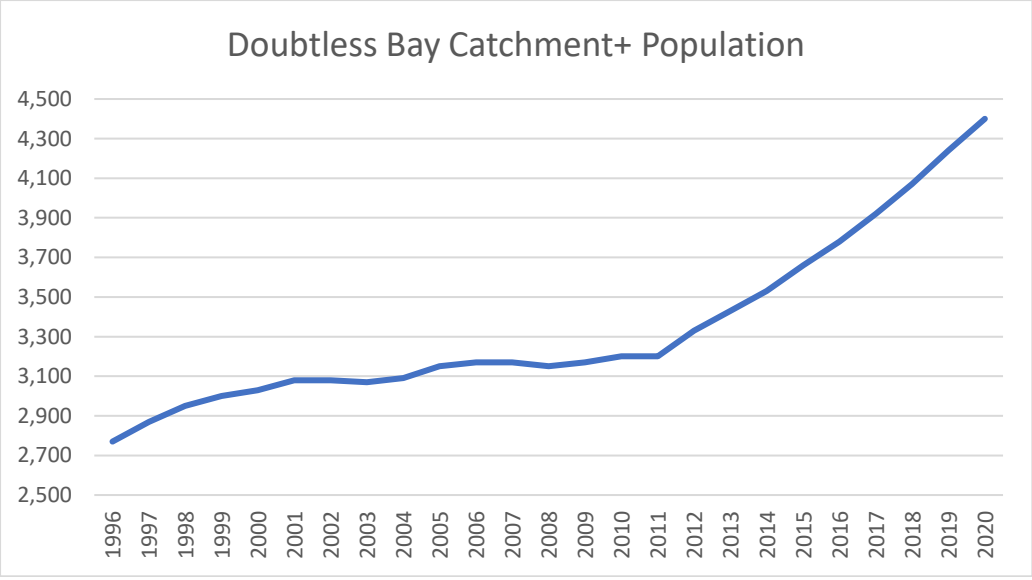

Figure 6. Doubtless Bay Catchment+ Population
Source: Jones (2021b) and author calculations.

The Waihou Catchment+ has experienced a different population trend to Doubtless Bay and the Northland Region, in general. As we can see from Figure 7, the Waihou Catchment was at a population of 1,160 in 1996. This number decreased until 2013, where it reached 950 people. Since then, it has been increasing and is now at 1,130. However, this is still less than the population in 1996.

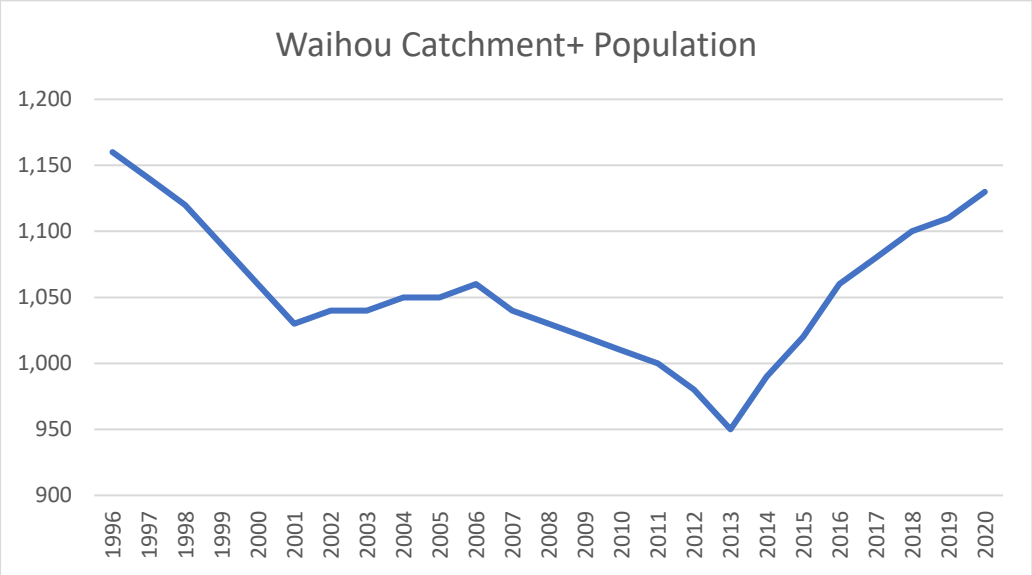

Figure 7. Waihou Catchment+ Population
Source: Jones (2021b) and author calculations.

The Waipoua Catchment has also seen a population fluctuation. In 1996, the population was 1,300 people (Figure 8). The population peaked in 2000, with 1,370 people. This number dropped to 1,130 in 2010 and remained there throughout 2011, 2012, and 2013. The population began increasing in 2014 and in 2020 reached 1,280. The 2020 population is below the peak of 1,370 in 2000.

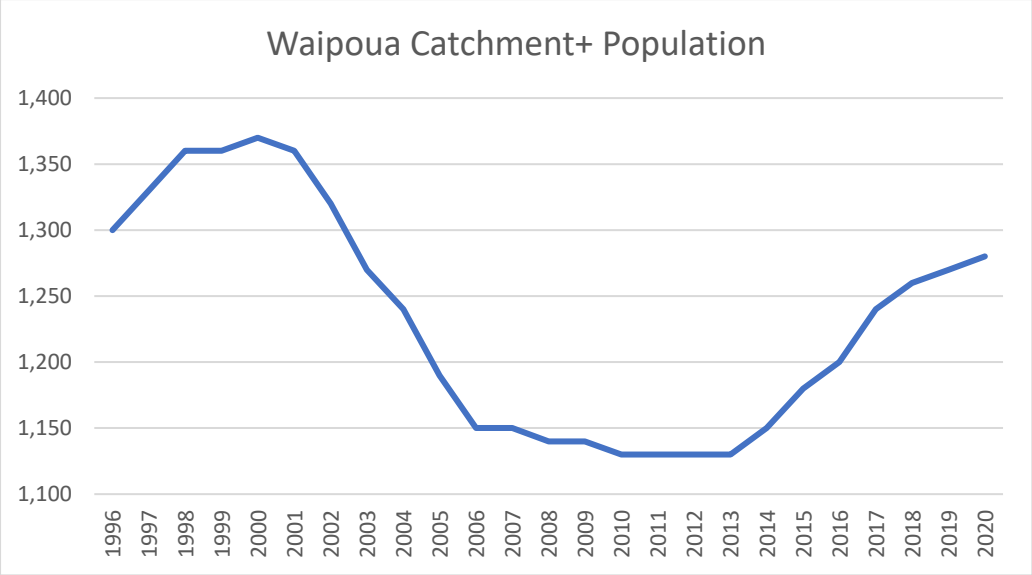

Figure 8. Waipoua Catchment+ Population
Source: Jones (2021b) and author calculations.

Population increases must be considered in future planning, as larger populations require a larger amount of resources. They also require more government services. If these increases are not accounted for, quality of life may decline.

Gross Domestic Product (GDP)

New Zealand is divided into 16 local government regions. Of these, GDP is greatest in Auckland (38%), Canterbury (12%) and Wellington (12%) (Figure 9). In 2019, Northland contributed to approximately 3% of New Zealand's GDP. This may sound like a small number, but it amounts to approximately $7.86 billion (Statistics NZ, 2021).

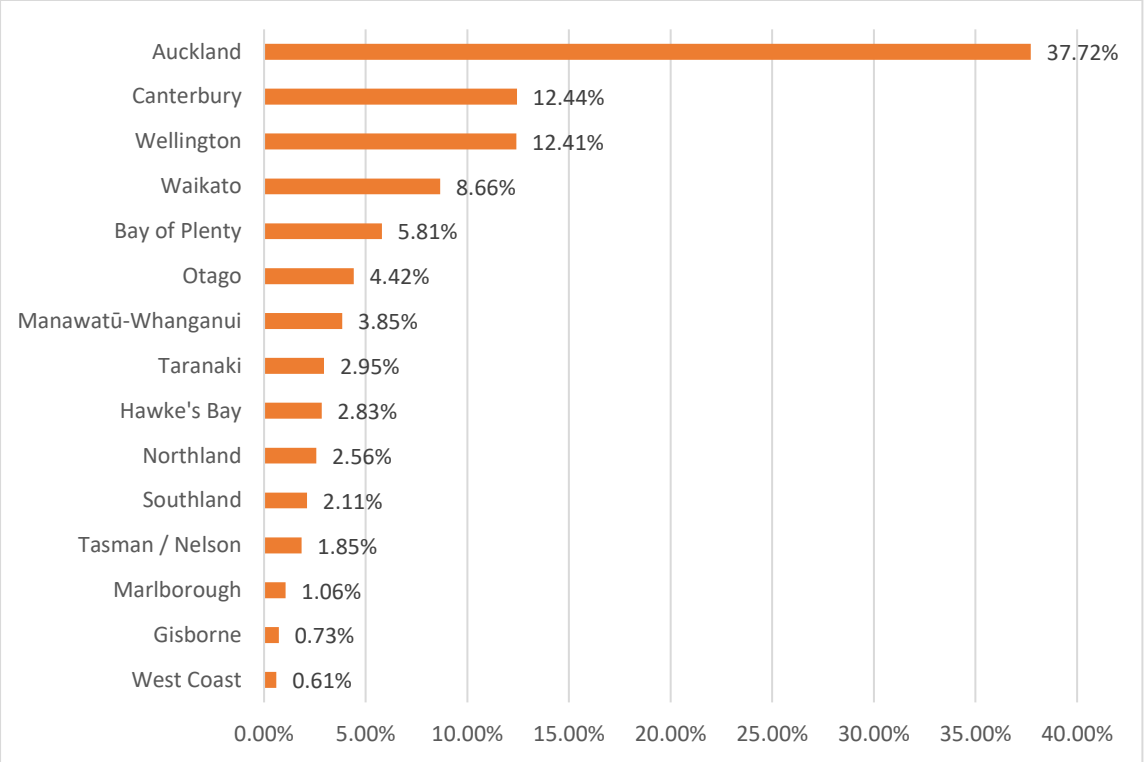

Figure 9. NZ GDP Percentage by Region (2019)
Source: Statistics NZ (2021).

Northland's most important industry is manufacturing (15.7% of Northland's GDP). Northland's manufacturing industry includes wood and paper manufacturing (Figure 10), as well as oil production at Marsden Point, the country's only oil refinery. The second most important area of industry (according to the Statistics NZ categorization) is 'agriculture, forestry and fishing' (10.4%), of which a large majority is dairy cattle farming. Crops of interest include avocadoes, kumara, kiwifruit, citrus fruit and olives. Tourism makes up almost 7% of Northland's economy (Statistics NZ, 2021).

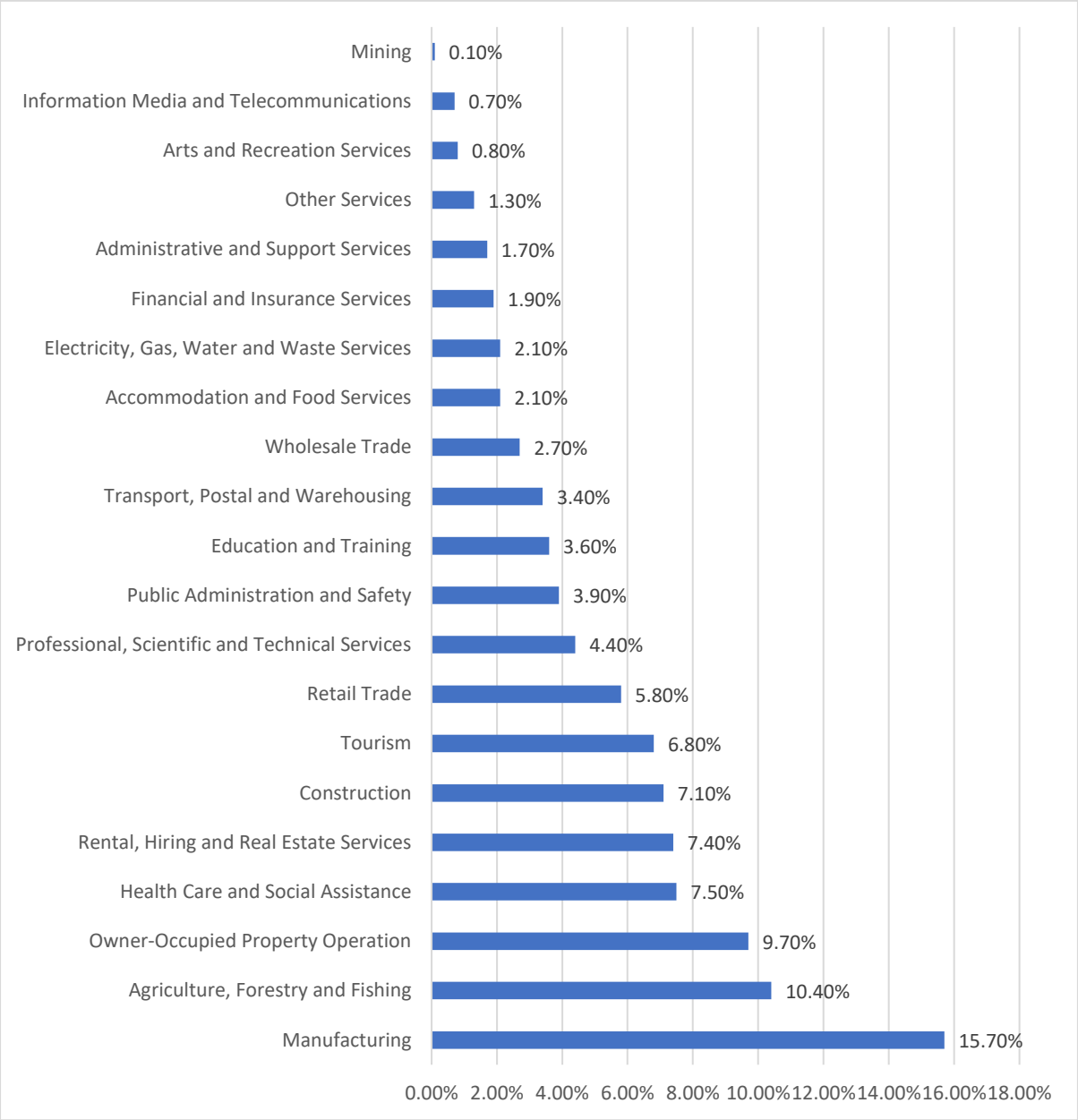

Figure 10. Northland GDP Percentage by Industry (2020)
Source: Statistics NZ (2021).

In 2020, GDP for the Doubtless Bay Catchment+ (Table 3) was $88.96 million, while GDP was $13.35 million for the Waihou Catchment+ and $11.32 million for the Waipoua Catchment+.

Table 3. Ngā Awa Extended Catchment GDP (2020)

Location	GDP ($ Million)
Waipoua Catchment+	11.32
Waihou Catchment+	13.35
Doubtless Bay Catchment+	88.96

Source: Jones (2021b) and author calculations.

GDP in the catchments was provided by data collected for 'business units'. Business units are individual businesses or enterprises (e.g., farm, retail outlet) that generate income. According to the number of business units by SA2 catchment area, we find that Doubtless Bay+ has the largest number of business units (495). This was followed by Waihou+ (135) and Waipoua+ (111) (Figure 11).

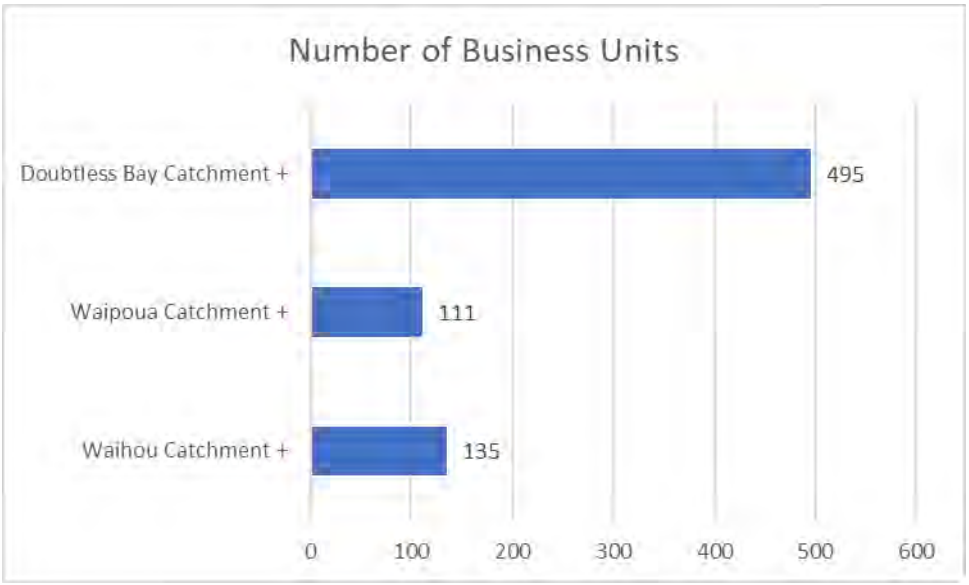

Figure 11. Number of Business Units by Catchment SA2 Area
Source: Jones (2021b) and author calculations.

Doubtless Bay Catchment

In reviewing the 2020 GDP for the Doubtless Bay Catchment, we find that property operators and real estate services provided the largest amount of GDP to the catchment ($17.74m) (Figure 12). This was followed by road transport ($8.43m) and construction services ($8.39m). Some of the areas of interest to river restoration include accommodation and food services for tourism purposes ($5.17m), dairy cattle farming ($2.94m), sheep, beef cattle and grain farming ($2.23m), fishing and aquaculture ($1.81m), agriculture, forestry and fishing support services and hunting ($0.73m), and poultry, deer and other livestock farming ($0.51) (Jones, 2021b).

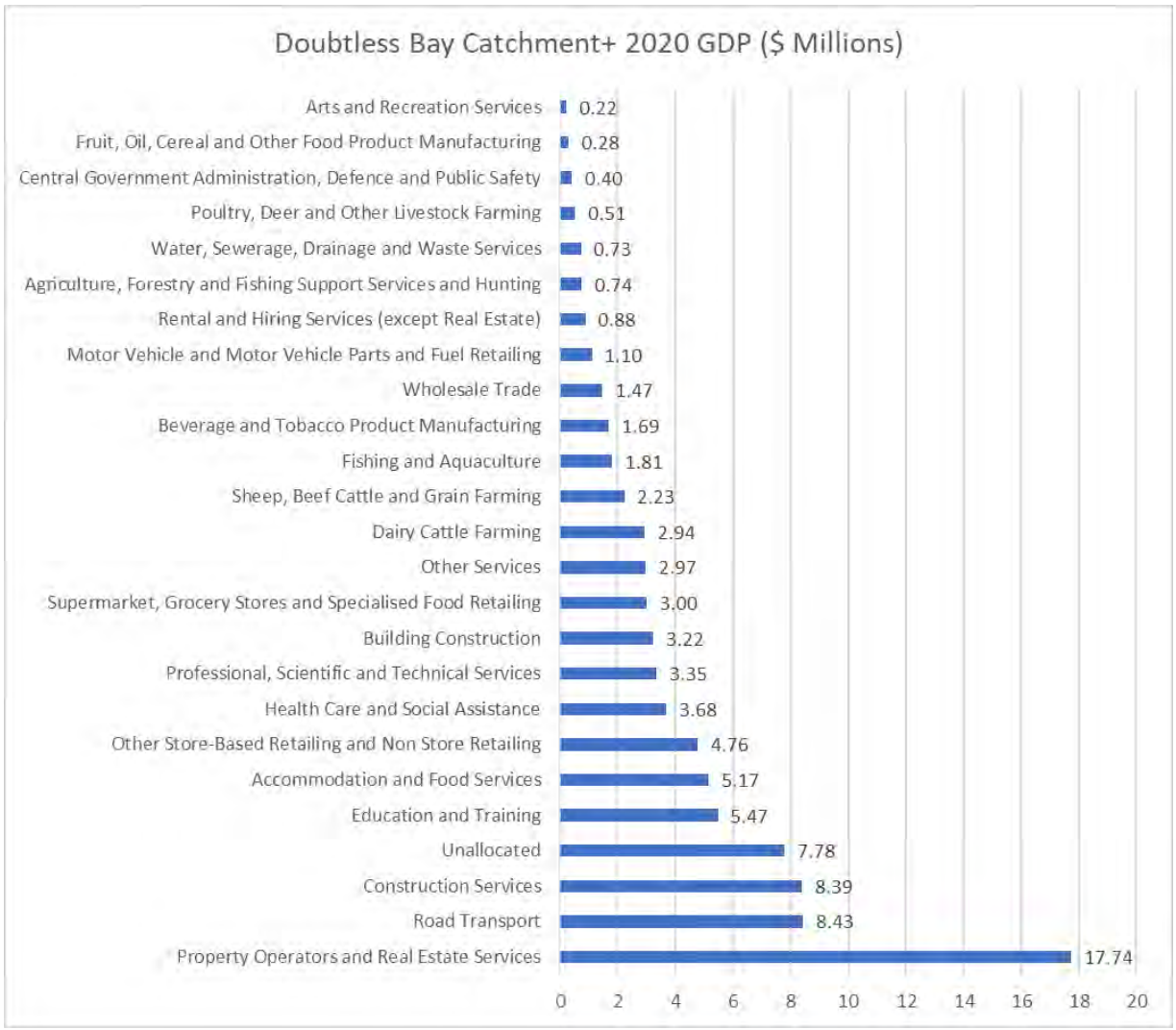

Figure 12. Doubtless Bay Catchment+ GDP
Source: Jones (2021b) and author calculations.

Employment data in the Doubtless Bay area illustrates that construction services employs the largest number of people, despite it providing the 3rd largest amount of GDP to the region. Property operators and real estate services provides the most GDP to the region, while it is the 9th largest employer (Figure 13). Accommodation and food services is the 2nd largest employer. Sheep, beef cattle and grain farming is the 12th largest employer, dairy cattle farming is the 13th and fishing and aquaculture is the 14th.

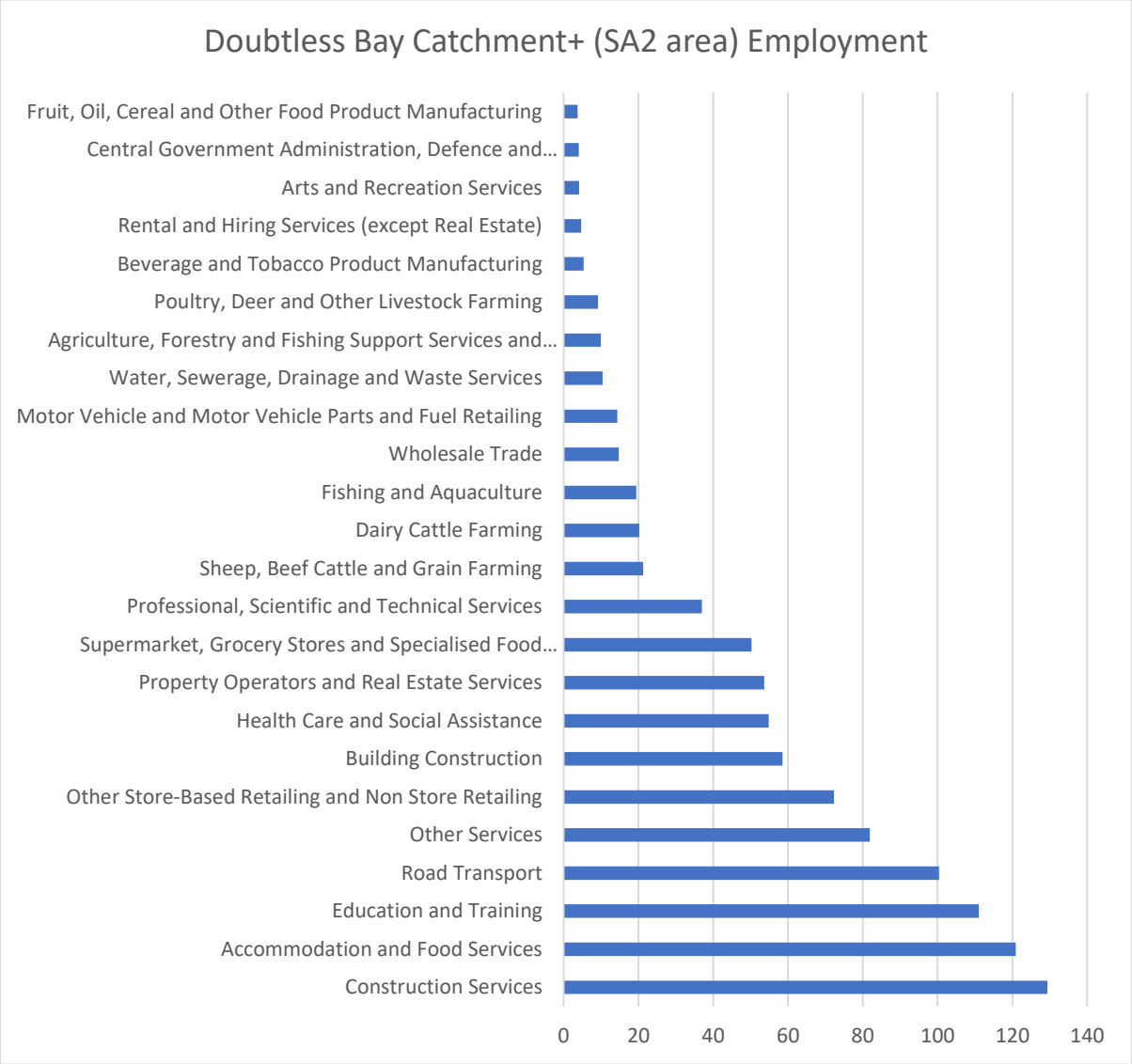

Figure 13. Doubtless Bay Catchment+ Employment (Number of People)
Source: Jones (2021b) and author calculations.

Waihou Catchment

The Waihou Catchment+ provides a different mix of GDP, when compared to the Doubtless Bay Catchment+. Here, there are only 7 categories. We find dairy cattle farming to provide the most GDP ($5.15m) (Figure 14). Other areas of interest to river restoration initiatives include sheep, beef cattle and grain farming ($2.23m) and agriculture, forestry and fishing support services and hunting ($0.37m).

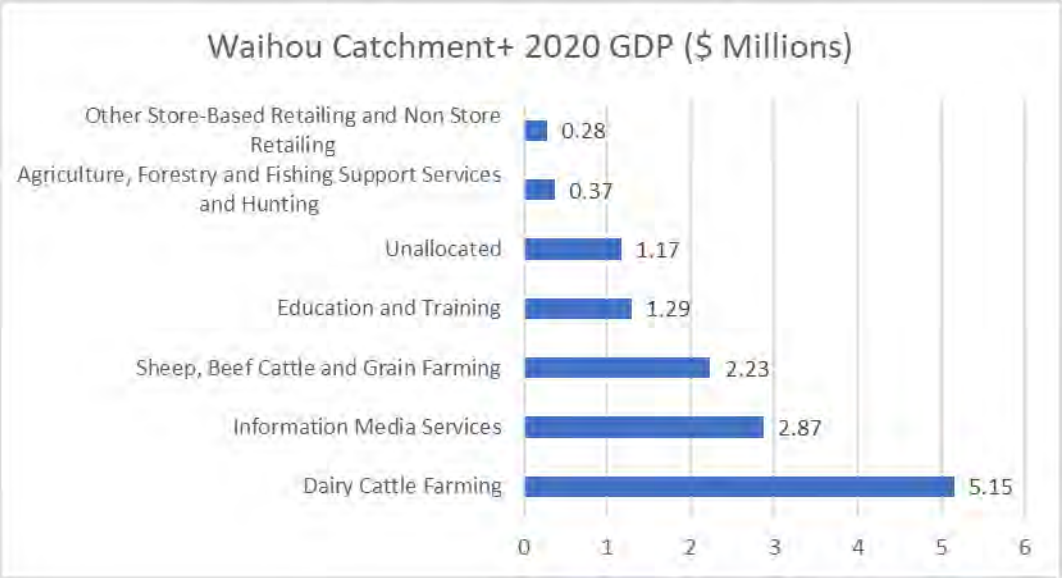

Figure 14. Waihou Catchment+ GDP
Source: Jones (2021b) and author calculations.

In the Waihou Catchment+, dairy cattle farming provides the largest GDP, but is the second largest employer. Sheep, beef cattle and grain farming provide the 3rd largest GDP and is the 4th largest employer (Figure 15). Agriculture, forestry and fishing support services and hunting is the 5th largest employer in the catchment+.

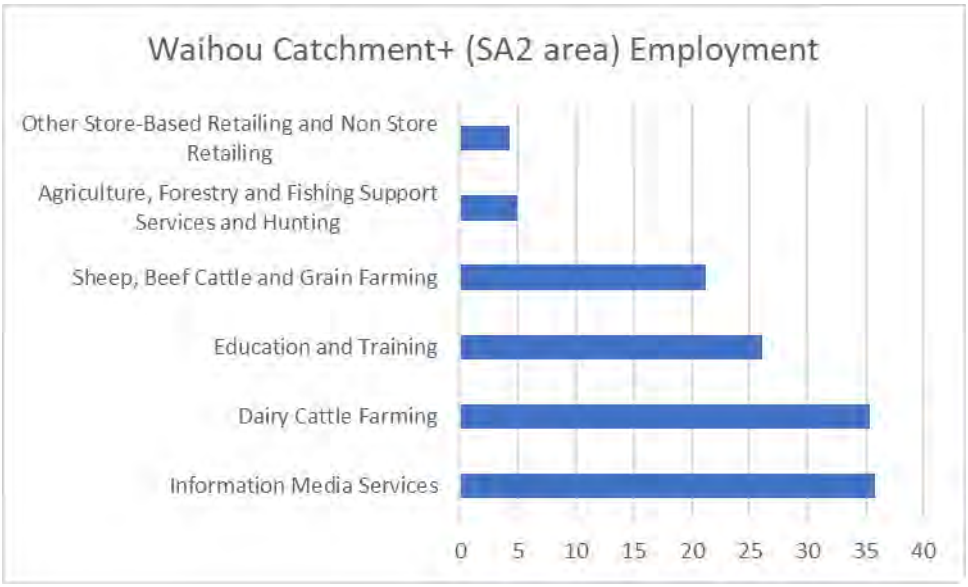

Figure 15. Waihou Catchment+ Employment (Number of People)
Source: Jones (2021b) and author calculations.

Waipoua Catchment

In the Waipoua Catchment, the most GDP is brought in by tourism-related activities: accommodation and food services ($4.47m) (Figure 16). Sheep, beef cattle, and grain farming account for $1.49m of GDP and are also important to river restoration activities.

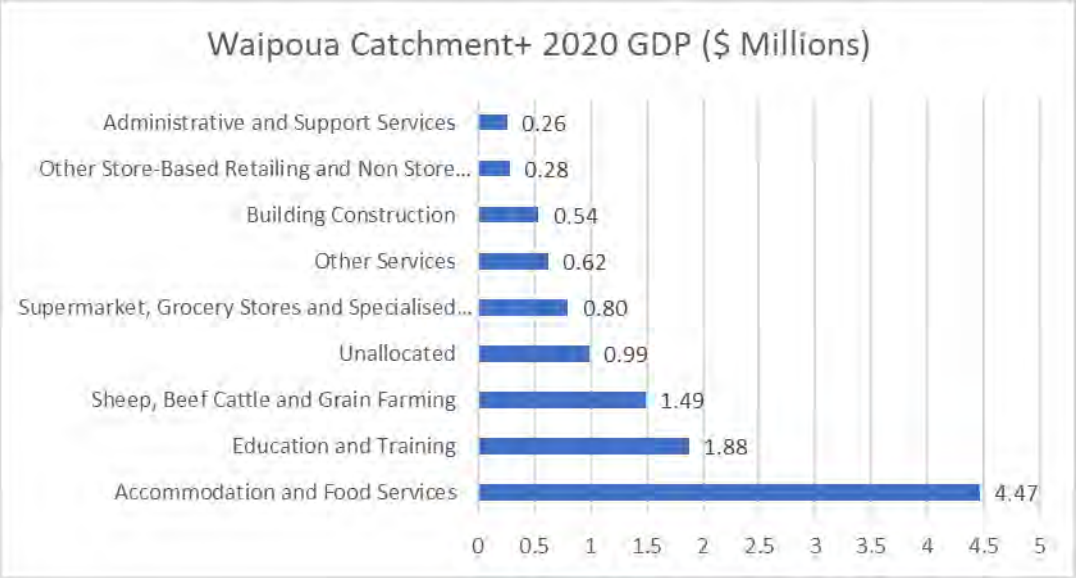

Figure 16. Waipoua Catchment GDP
Source: Jones (2021b) and author calculations.

In terms of employment in the Waipoua Catchment+, accommodation and food services are the largest employers. Sheep, beef cattle and grain farming provide the fourth largest area of employment (Figure 17).

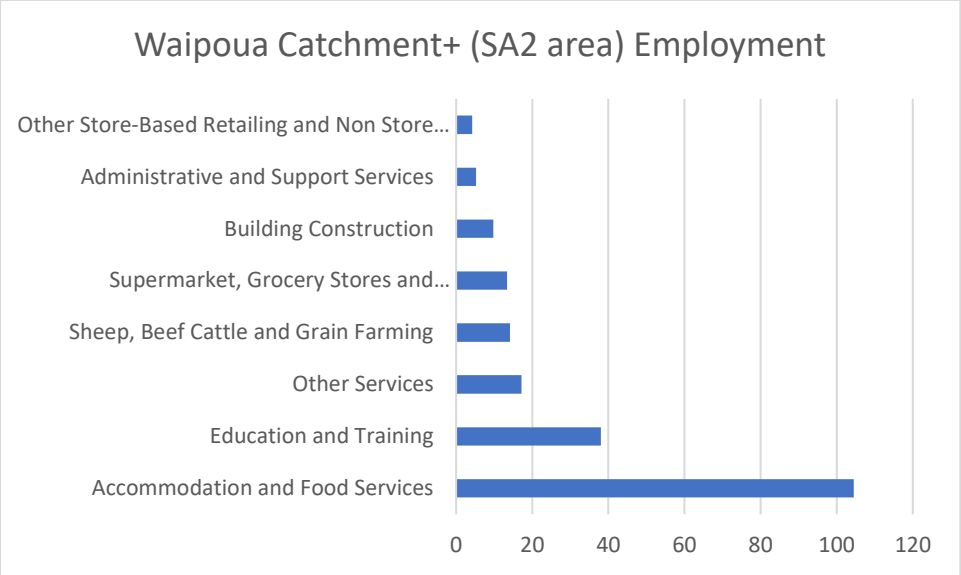

Figure 17. Waipoua Catchment+ Employment (Number of People)
Source: Jones (2021b) and author calculations.

Land Use

Doubtless Bay Catchment Land Use

The Doubtless Bay Catchment covers an area of 51,614 hectares. Five land types comprise over 91% of the Doubtless Bay Catchment: high producing exotic grassland (44%)[2], indigenous forest (18%), manuka and/or kanuka (16%), exotic forest (9%) and broadleaved indigenous hardwoods (4%) (Figure 18). Human settlement only comprises 0.5% of the area.

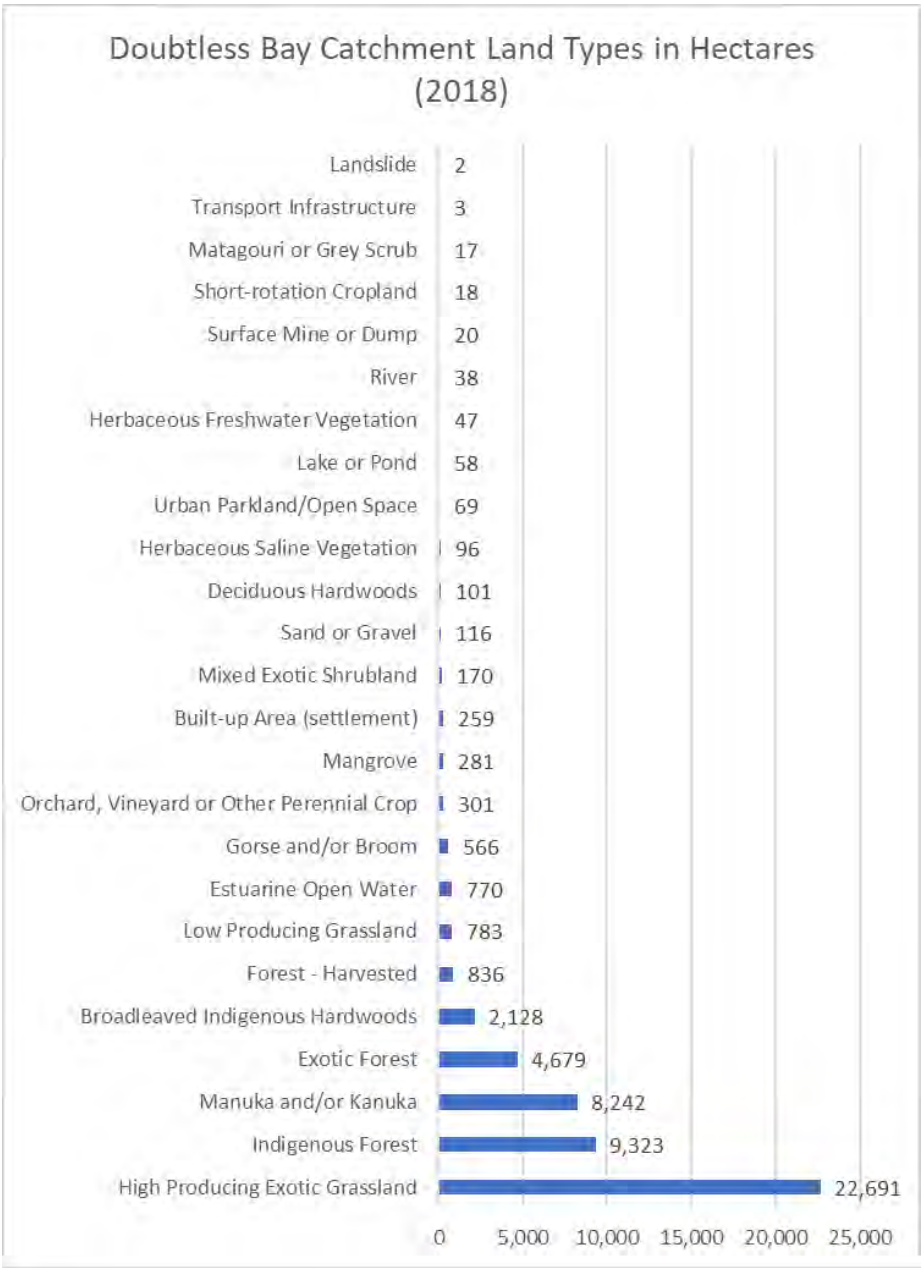

Figure 18. Doubtless Bay Catchment Land Types in Hectares (2018)
Source: Manaaki Whenua Landcare Research (2020).

[2] Usually pasture for either dry stock farming (e.g., sheep and beef) or dairy cattle farming.

In broad terms, land use in the Doubtless Bay Catchment has changed only slightly over the last 22 years. Of the largest land cover types, we find that the area of high producing exotic grassland and indigenous forest has decreased slightly from 23,530 hectares to 22,691 hectares for high producing exotic grassland and 9,634 hectares to 9,323 hectares for indigenous forest. The area of exotic forest increased slightly from 4,001 hectares to 4,679 hectares (Figure 19).

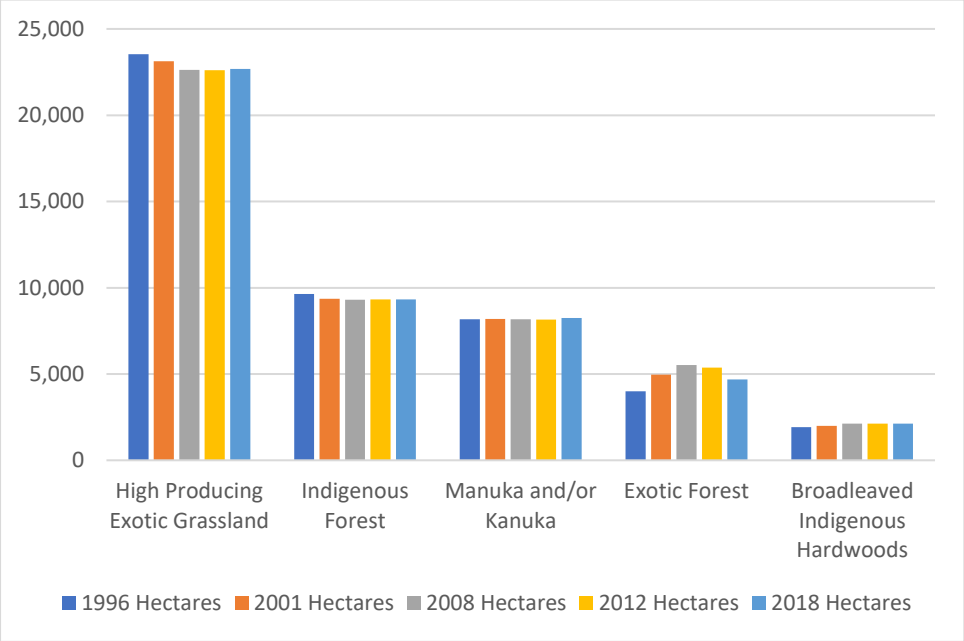

Figure 19. Doubtless Bay Catchment by Land Type (Part 1)
Source: Manaaki Whenua Landcare Research (2020).

The area of harvestable forest has fluctuated over the years, with a significant increase between 1996 and 2018 from 836 hectares to 1,283 hectares. The area of low producing grassland has decreased from 1,283 hectares to 783 hectares. The area of gorse and/or broom has also decreased (669 hectares to 566 hectares) (Figure 20). The settlement area increased from 191 hectares (1996) to 259 hectares (2018), as did the area of orchards, vineyards or other perennial crops (41 hectares to 301 hectares).

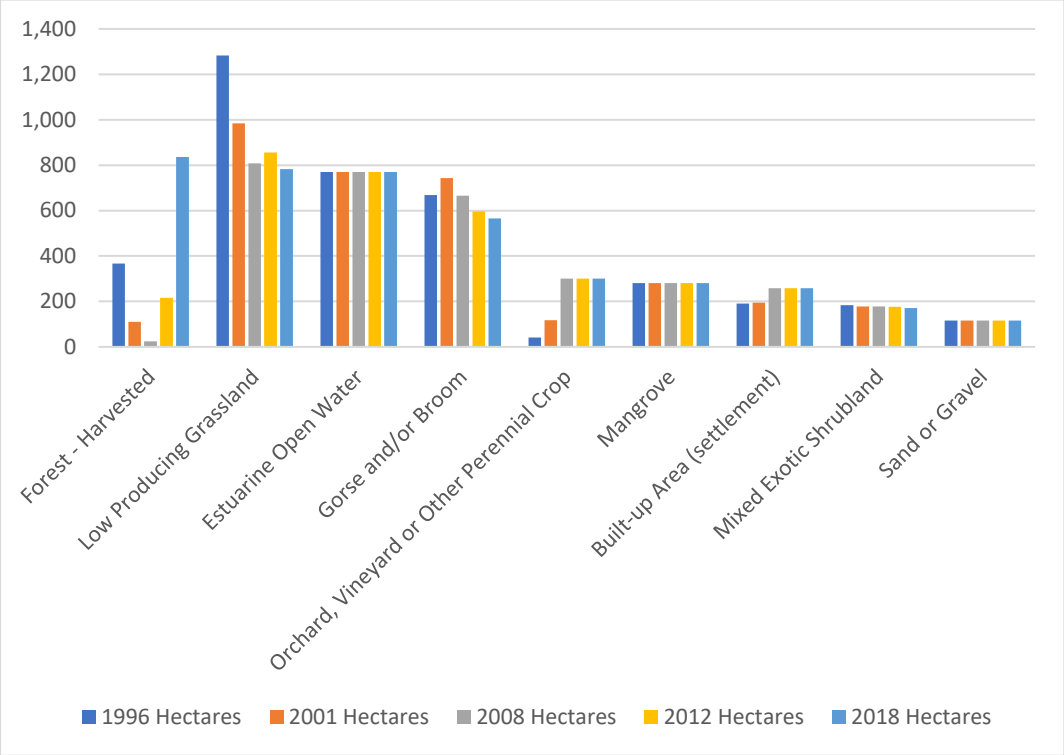

Figure 20. Doubtless Bay Catchment by Land Type (Part 2)
Source: Manaaki Whenua Landcare Research (2020).

The area of the Doubtless Bay Catchment's hardwoods has increased slightly since 1996, from 94 hectares to 101 hectares, as has the area of short-rotation cropland (6 hectares to 18 hectares). The area of urban parkland or open space has decreased from 73 hectares to 69 hectares (Figure 21). Most other land types have had a relatively consistent area between 1996 and 2018.

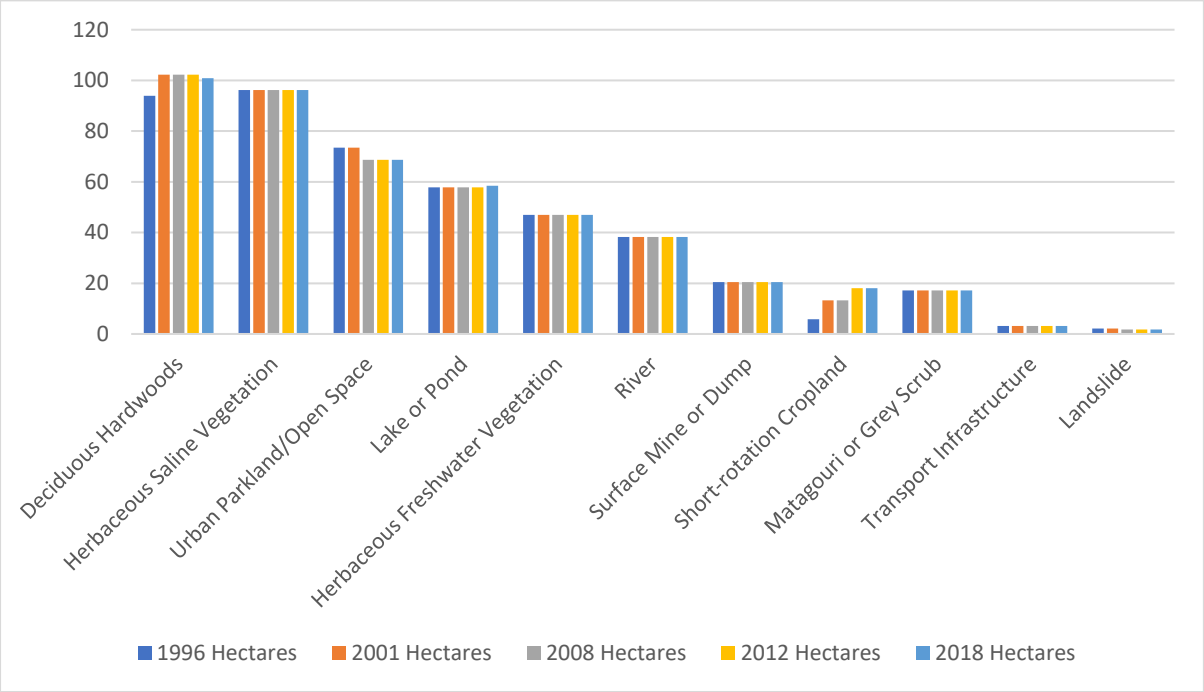

Figure 21. Doubtless Bay Catchment by Land Type (Part 3)
Source: Manaaki Whenua Landcare Research (2020).

Waihou River Catchment Land Use

The Waihou River Catchment covers an area of 29,639 hectares. Three land types comprise over 92% of the Waihou River Catchment: indigenous forest (57%), high producing exotic grassland (31%), and exotic forest (16%) (Figure 22).

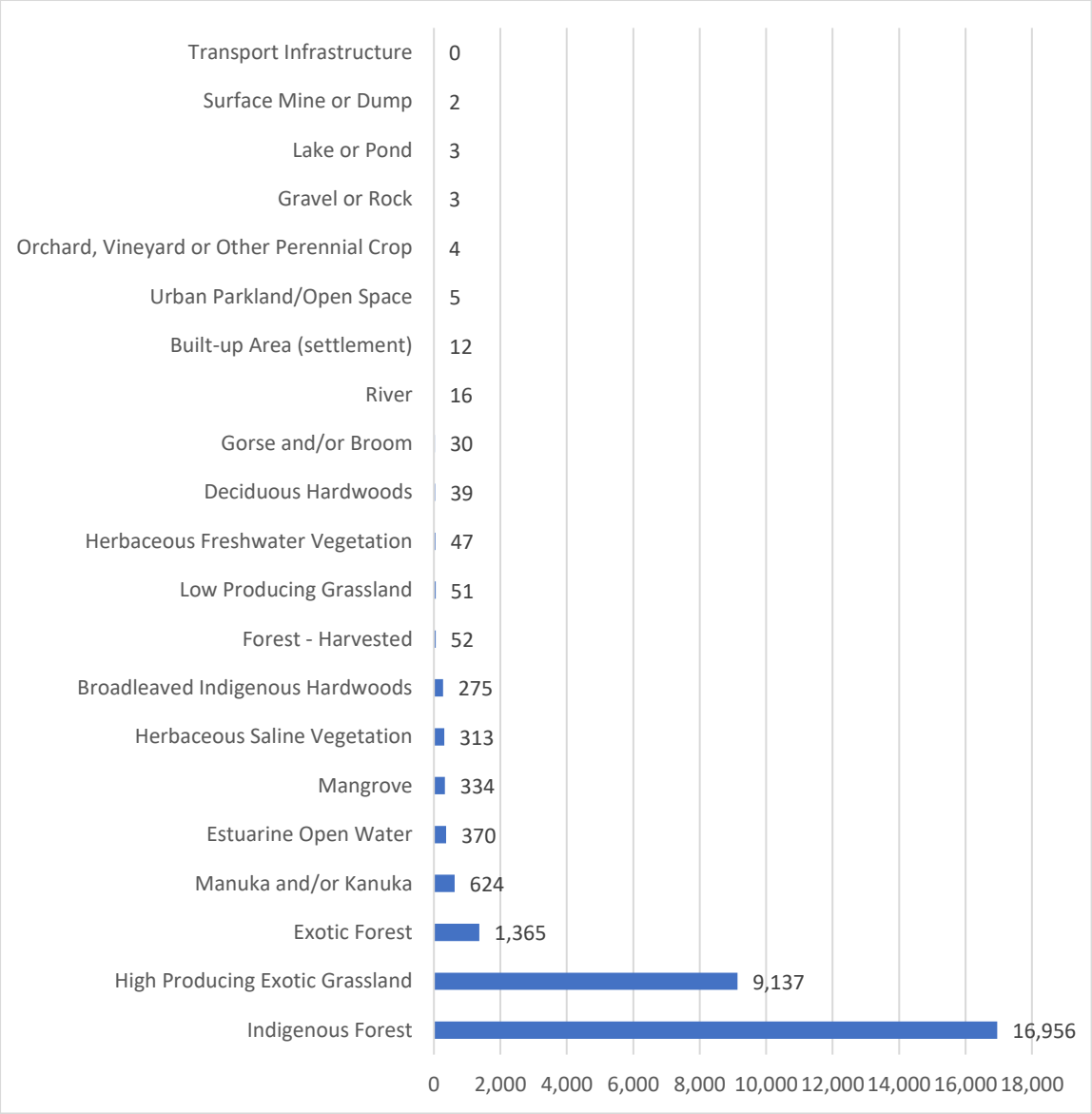

Figure 22. Waihou River Catchment Land Types in Hectares (2018)
Source: Manaaki Whenua Landcare Research (2020).

Land use in the Waihou River Catchment has changed minimally since 1996. Of the largest land cover types, we find minimal changes in the acreage of indigenous forest (17,036 hectares in 1996 to 16,956 in 2018), high producing exotic grassland (9,056 to 9,137), and exotic forest (1,433 to 1,365). Manuka and/or kanuka acreage decreased from 694 to 624 hectares between 1996 and 2018 (Figure 23).

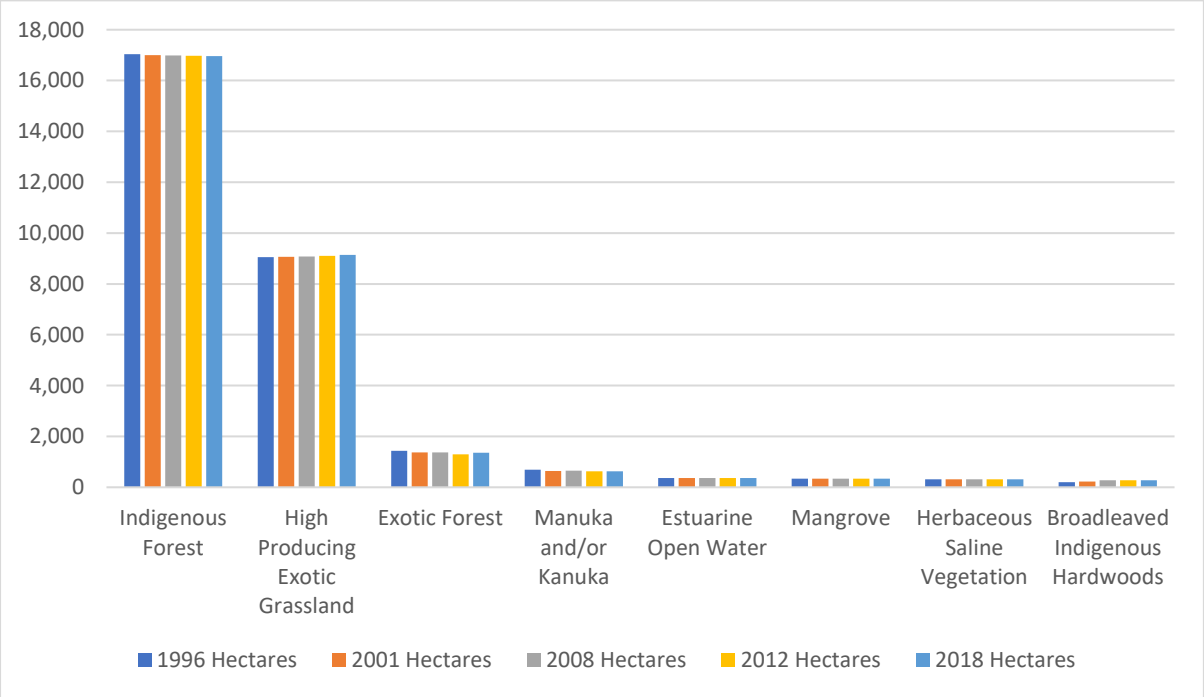

Figure 23. Waihou River Catchment by Land Type (Part 1)
Source: Manaaki Whenua Landcare Research (2020).

Harvestable forest land has fluctuated, with an overall increase between 1996 and 2018 from 10 hectares to 52 hectares. Low producing grasslands (40 hectares to 51 hectares) and deciduous hardwoods (36 hectares to 39 hectares) have also increased. Gorse and/or broom, which are considered pest species by many landowners, has increased by 7 hectares over the time period (23 to 30 hectares). Human settlement area increased slightly from ten to 12 hectares between 1996 and 2018 (Figure 24).

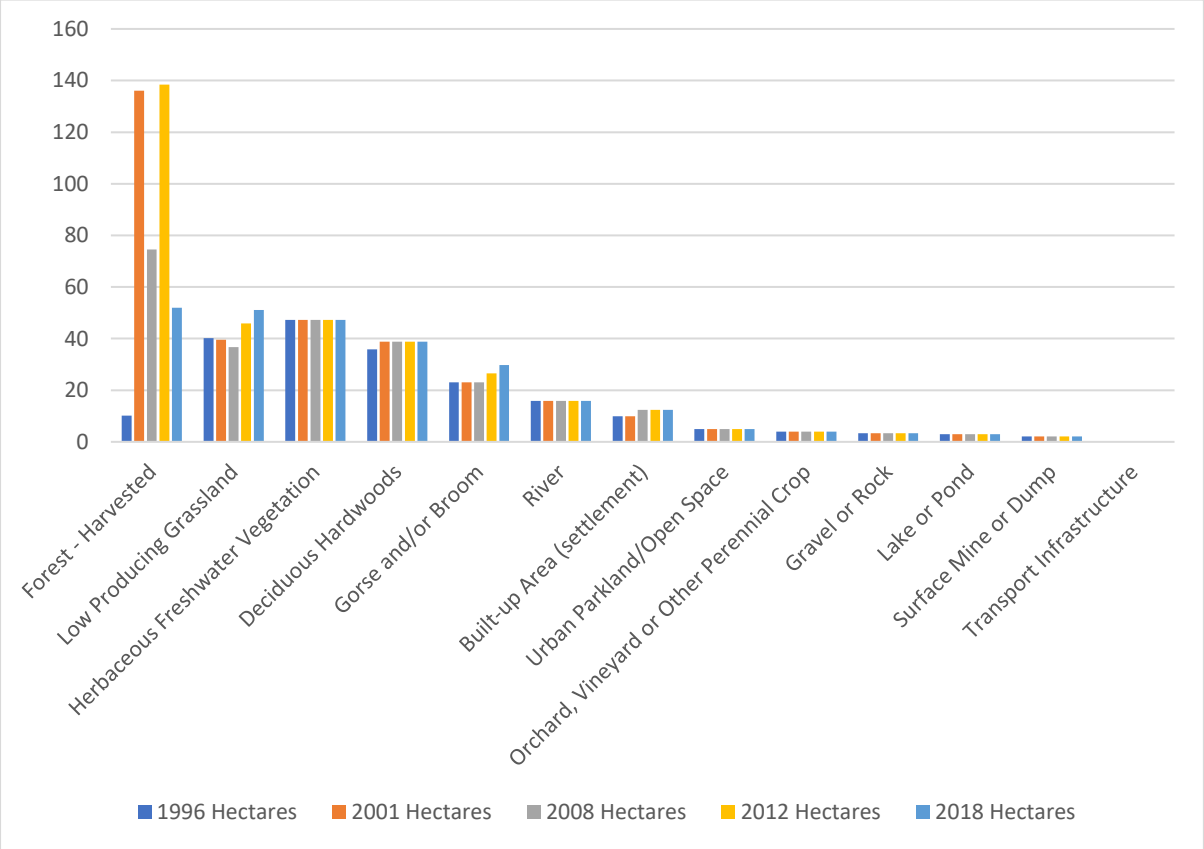

Figure 24. Waihou River Catchment by Land Type (Part 2)
Source: Manaaki Whenua Landcare Research (2020).

Waipoua River Catchment Land Use

The Waipoua River Catchment covers an area of 11,286 hectares. Three land types comprise over 93% of the Waipoua River Catchment: indigenous forest (74%), exotic forest (14%), and high producing exotic grassland (5%) (Figure 25).

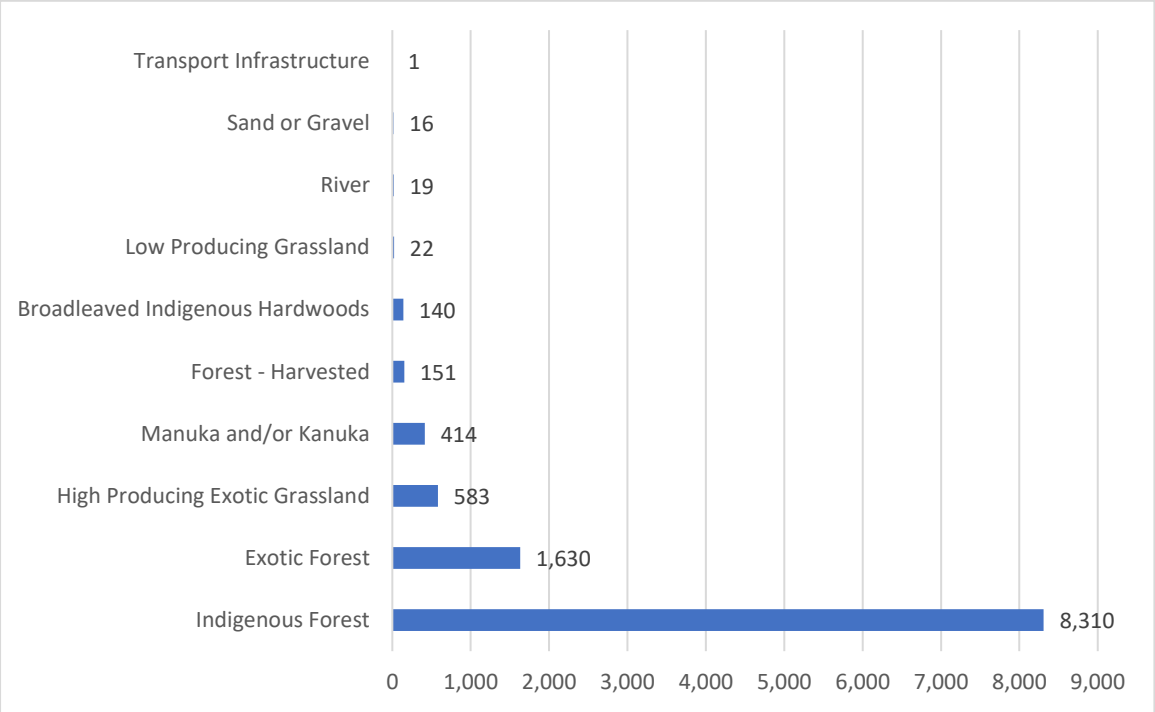

Figure 25. Waipoua River Catchment Land Types in Hectares (2018)
Source: Manaaki Whenua Landcare Research (2020).

Land use in the Waihou River Catchment has changed only slightly over the years since 1996. Of the largest land cover type, we find no change in the acreage of indigenous forest. High producing exotic grassland decreased from 736 hectares in 1996 to 583 hectares in 2018. Exotic forest increased (1,236 hectares in 1996 to 1,630 hectares in 2018), as has manuka and/or kanuka (254 hectares in 1996 to 414 hectares in 2018). Harvested forest has decreased from 531 hectares in 1996 to 151 hectares in 2018. In 1996, there were 5 hectares of deciduous hardwoods, but in 2018 there were none (Figure 26).

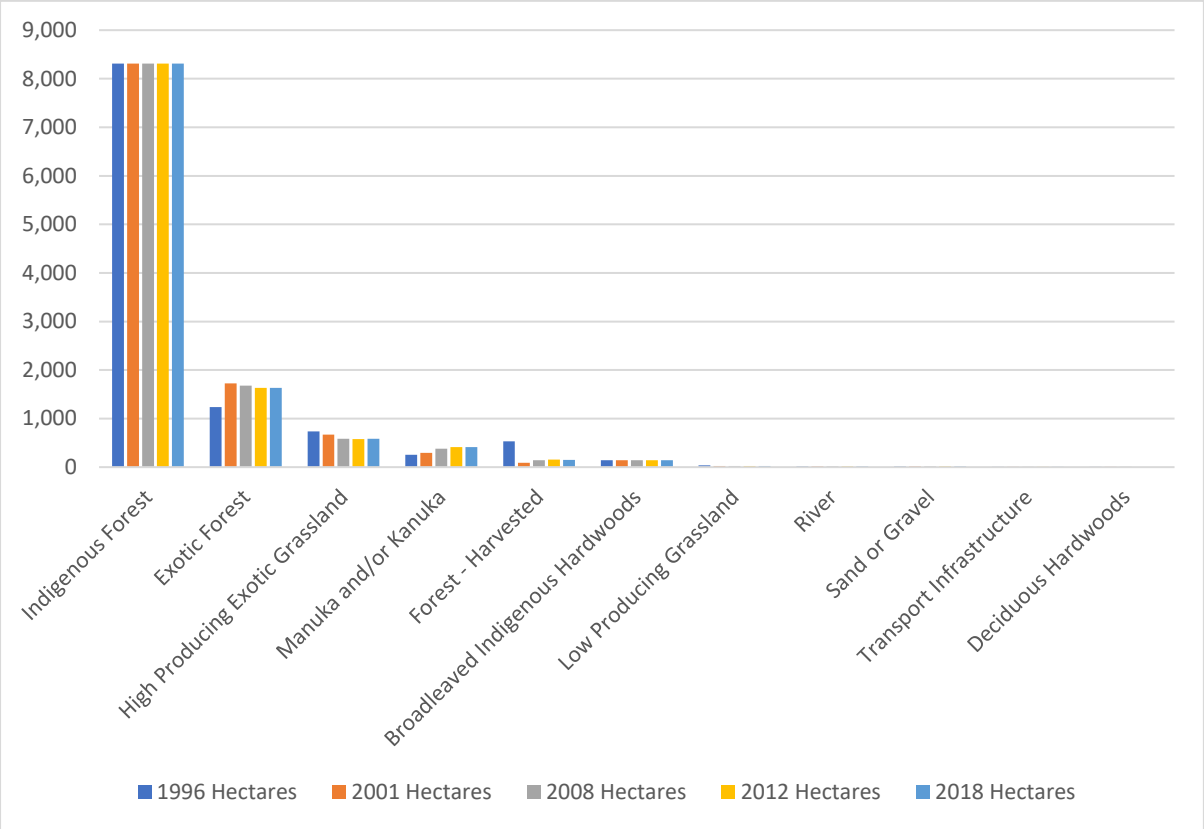

Figure 26. Waipoua River Catchment by Land Type
Source: Manaaki Whenua Landcare Research (2020).

Tourism

Tourism in New Zealand is a multi-billion-dollar industry. It is also an important industry in the Northland Region. Between 1999 and 2019, NZ tourism expenditures increased significantly (Figure 27). Of course, Covid 19 had an effect on tourism in 2020 and 2021, resulting in fewer international trips, but this also resulted in an increase in domestic trips, and hence, an increase in domestic spending on tourism.

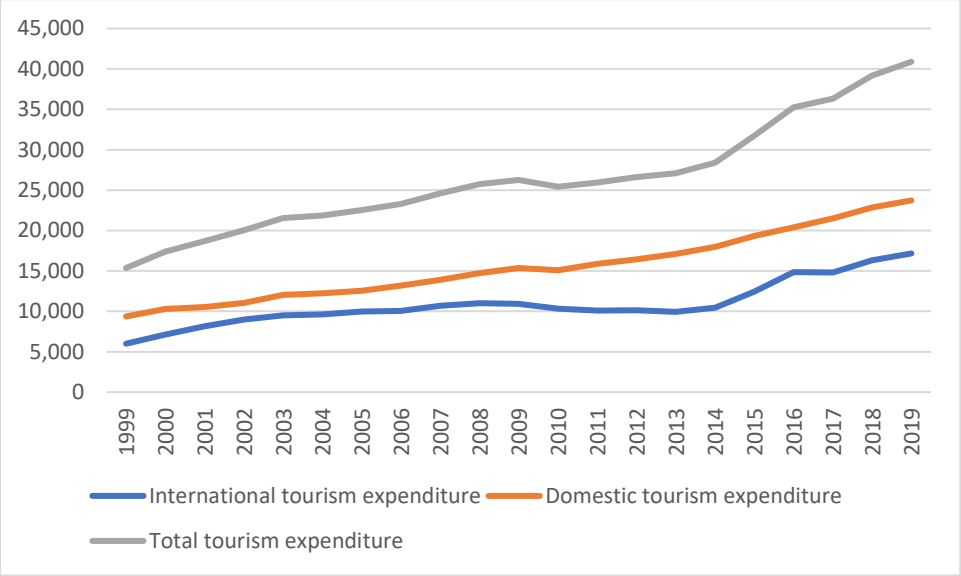

Figure 27. New Zealand Tourism Expenditures by Tourist Type ($ Million)
Source: Statistics NZ (2021b).

In 2019, New Zealand's total tourism expenditures amounted to $40,891 million (or $40.8 billion), where $23,726 million was from domestic tourism and $17,166 million was from international tourism. As can be seen in Figure 27, domestic tourism has always been greater than international tourism. Domestic tourism has also had a more consistent increase. If we break these numbers down, we find that, in 2019, the average expenditure per day for international tourists was $191.74, while the average expenditure per trip was $3,345.26 (Statistics New Zealand, 2021d). Daily and trip expenditures were not made available by Statistics NZ for the domestic tourism market for 2019. It is expected that daily and trip expenditures would be slightly lower for domestic tourism, as less money would be spent on accommodation, since people have the option of doing day trips from their homes.

Northland Tourism Expenditures were obtained from the Infometrics Northland Region Economic Profile (Infometrics, 2021).[3] Over a billion dollars annually is spent on tourism in the Northland Region. Figure 28 illustrates a similar pattern to the New Zealand tourism industry in that tourism expenditures have been increasing from 2010 to 2020. However, what was a more consistent increase over the last decade for domestic tourism in New Zealand overall, in Northland, we see an increase to 2019 and then a flattening off. There also seems to be less international tourism in the Northland, as compared to domestic tourism, than in New Zealand, in general (Figure 28). Hence, perhaps more focus for tourism in the Northland should be on domestic tourism.

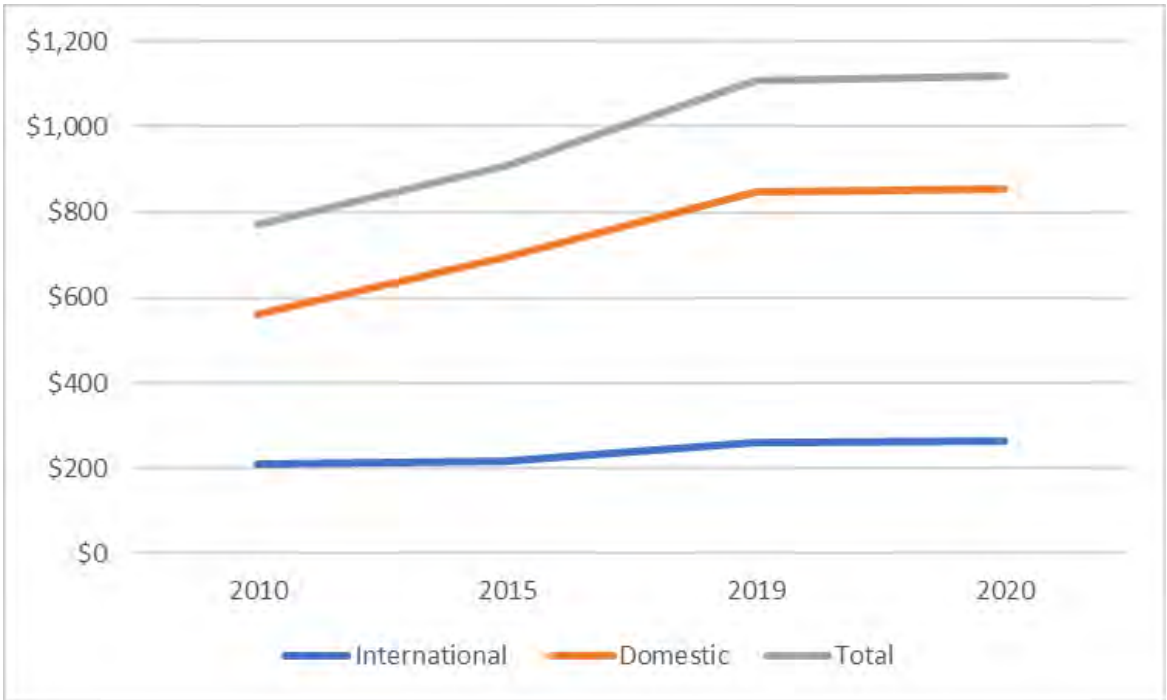

Figure 28. Northland Tourism Expenditures ($ Million) by Tourist Type
Source: Infometrics (2021).

[3] The data on the Infometrics page (https://ecoprofile.infometrics.co.nz/northland%2Bregion/Tourism/TourismSpendStructure) differs significantly from the data obtained directly from Statistics New Zealand, but the Infometrics data appears to be the information printed on the Northland Tourism website.

By breaking down Northland Tourism expenditures into categories, we find that a large majority of the money that is spent is on retail sales. Retail sales were further broken down into 'other,' 'fuel and other automotive products,' and 'alcohol, food and beverages.' 'Cultural, recreation, and gambling services' earned the least of the tourism categories (Figure 29). This is important to keep in mind for future planning.

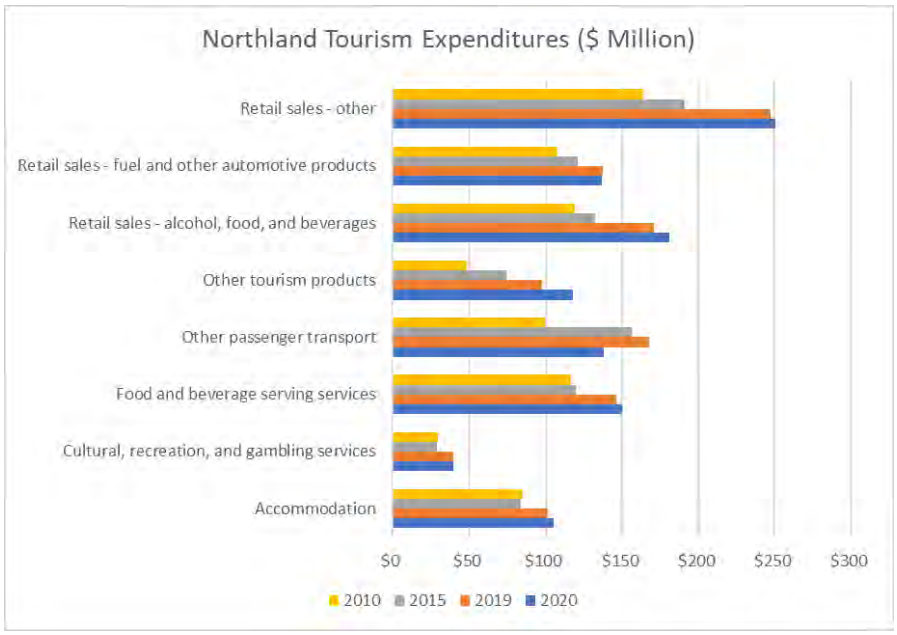

Figure 29. Northland Tourism Expenditures ($ Million) by Type
Source: Infometrics (2021)

International tourists come to New Zealand for many reasons. The International Visitor Survey (Statistics New Zealand, 2021b) asks visitors about the specific activities that they participate in while visiting the country. There are over 60 ranked categories of which the top 11 are presented in Figure 30 (See Appendix A for the full list). Many of the top 11 activities are important to the Northland tourism sector, as well as the three Northland Ngā Awa river catchments. These activities include: going for a walk, hike, trek or tramp; visiting natural attractions (e.g., mountains, lakes, rivers); seeing native birds; going to a beach; visiting public museums or art galleries; going on a scenic boat trip and visiting places significant to Māori (e.g., landmarks, fortified hills).

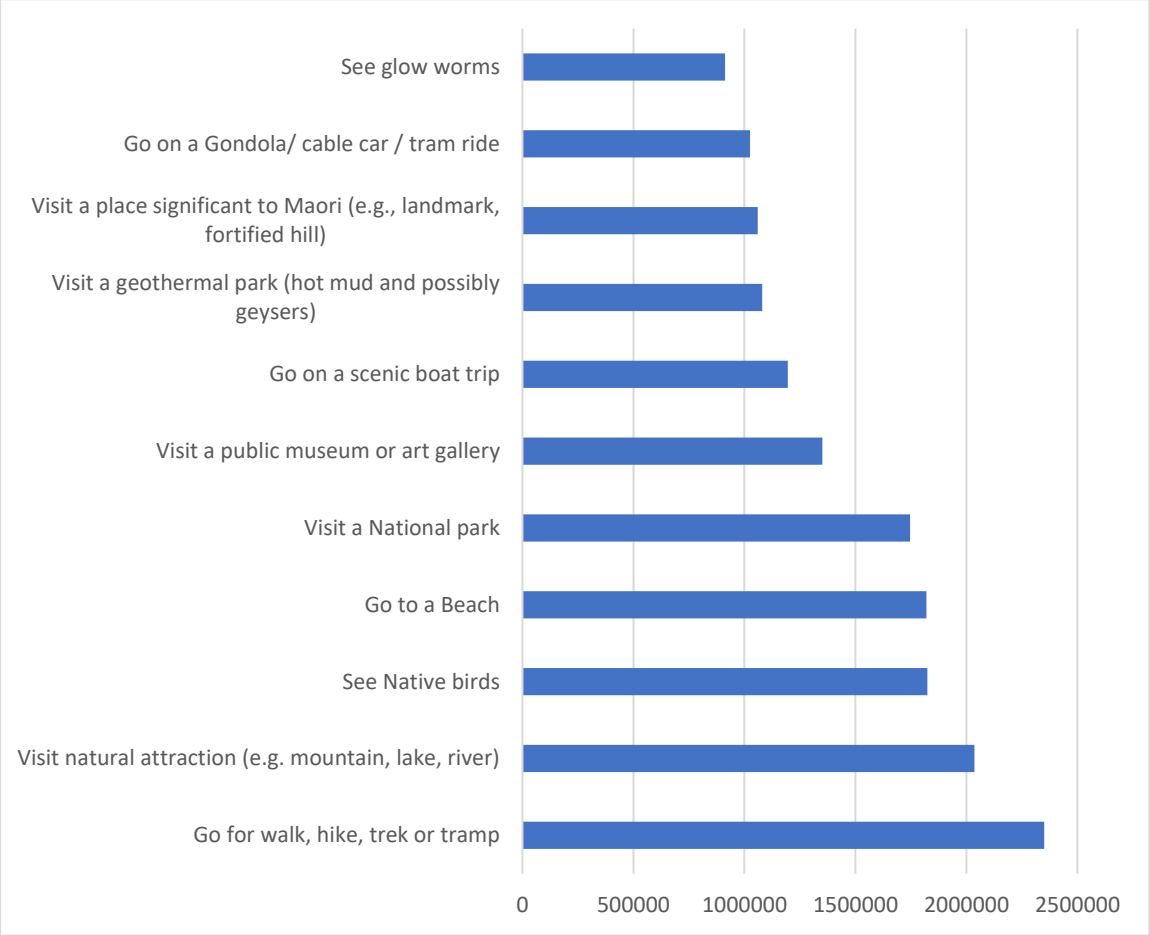

Figure 30. Top 11 International Visitor Activities in Northland by Number of Participants (2019)
Source: Statistics New Zealand (2021b)

Within the activity listing of the International Visitor Survey are several Māori specific activities. These include visiting landmarks, fortified hills, and marae, as well as eating traditional Māori food and experiencing Māori traditions, such as story-telling. All of these activities experienced an increase in international visitation between 2014 and 2019, while

visiting a place significant to Māori (e.g., landmark, fortified hill) was the most popular. In terms of popularity, these activities were 9th, 15th, 23rd, and 27th most popular (Figure 31). No specific Māori related activities were listed in the domestic tourism activities list. This should be kept in mind for future planning.

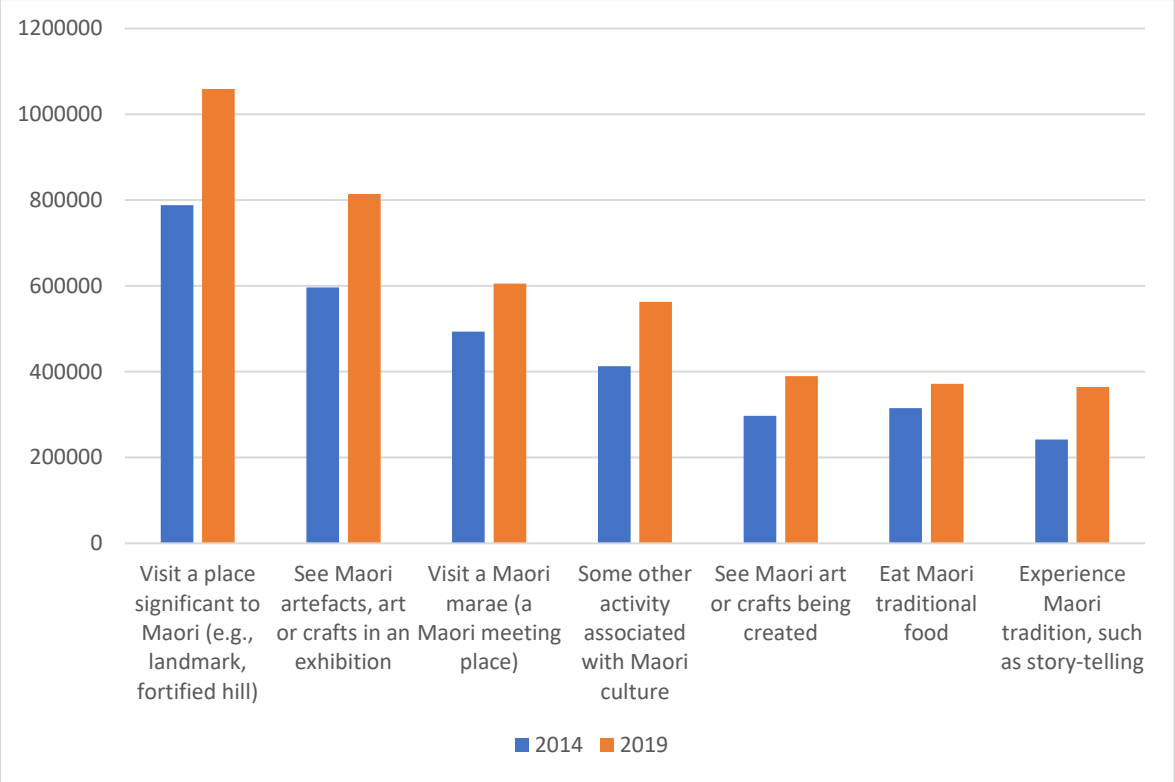

Figure 31. Māori Specific Tourism Activities in Northland by Number of Participants
Source: Statistics New Zealand (2021b)

Domestic tourism activities have also been accounted for by Statistics NZ (2021e), although the most recent survey was in 2012. The domestic tourism activity list differs from that of the international tourism activity list, so these categories are not exactly comparable. Despite this, we can gain some insight into the interests of domestic tourists from this information. It is important to remember that domestic tourists can do day trips as well as overnight trips, while international tourists are away from their home country, and therefore, are participating in overnight trips.

The domestic tourist activity list ranks over 60 activities (see Appendix B for the full list). The Top 11 are listed in Figure 32. Here, we find that many of the top 11 activities are important to the three Northland Ngā Awa river catchments as well as the Northland tourism sector. These activities include: swimming; other scenic/natural attractions; and walking and trekking.

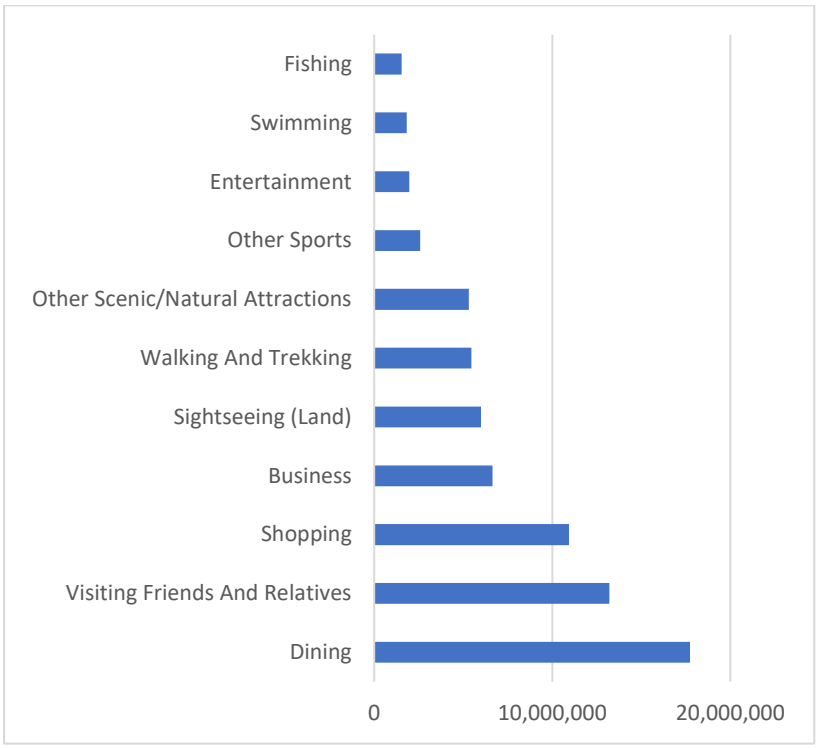

Figure 32. Top 11 Domestic Tourism Activities in Northland by Number of Participants
Source: Statistics NZ (2021e)

Ecosystem Services

Ecosystem services are the benefits, or services, provided by ecosystems to humans. These ecosystem services can be divided into four general categories: Provisioning Services, Regulating Services, Cultural Services and Supporting Services (Millennium Ecosystem Assessment, 2005) (Table 4). Provisioning Services are products that ecosystems provide, such as tuna and karaka berries for human consumption. Regulating Services focus on the regulation of ecosystem processes; river catchments provide many regulating services including, but not limited to, flood protection, water purification, and climate regulation. Cultural Services are non-material services, such as the strong spiritual connections that whānau have to the environment and the opportunity to walk to a significant landmark (i.e., Tāne Mahuta) or swim at a river hole. Supporting Services are services necessary to produce other ecosystem services, such as worms assisting with soil formation and aquatic ecosystems providing nutrient retention. The current investigation will follow this classification system.

Table 4. Ecosystem Service Categorization

Provisioning Services	Regulating Services	Cultural Services	Supporting Services
Food	Pollination	Aesthetic	Nutrient cycling
Fresh water	Climate regulation	Educational	Soil formation
Fiber	Water purification	Cultural Heritage	Primary production
Genetic resources	Water regulation	Recreation and ecotourism	
Fuelwood	Disease regulation	Inspirational	
Biochemicals		Sense of place	
		Spiritual and religious	

Source: Millennium Ecosystem Assessment (2005).

Currently, there is no “one” approach to measuring and valuing ecosystem services. Consequently, the Ecosystem Services Partnership was developed. The Ecosystem Services Partnership is a global organization made up of over 3,000 ecosystem services practitioners, scientists and policy makers from around the world. To assist in the development of the approaches, the Ecosystem Services Partnership has created more than 40 working groups in which team members are continually updating concepts for a more pluralistic approach (Ecosystem Services Partnership, 2021). The themes are constantly evolving as new information comes to light. When this investigation was conducted, there were 18 ecosystem service themes, but just five years previous, there were only 13 (Table 5). This investigation focuses on the themes of: economic and monetary valuation (#7), cultural services and values

(#8), ecosystem services and public health (#9), and the role of ecosystem services in ecosystem restoration (#13).

Table 5. Ecosystem Services Partnership Themes (Ecosystem Services Partnership, 2021)

2021 Theme Numbers	Ecosystem Services Partnership Theme	Theme Description
1	Ecosystem services assessment frameworks and typologies	Determining the frameworks that are most suitable to guide the assessment of ecosystem services.
2	Biodiversity and ecosystem services	Better understanding the biophysical structures and processes that provide ecosystem services.
3	Ecosystem services indicators	The indicators that are believed to be most appropriate in the other parts of the ecosystem services approach (e.g., mapping, modelling, valuing, scenario development, and biophysical quantification).
4	Mapping ecosystem services	A technique used to integrate ecosystem services into conservation programs and landscape planning; these maps can be made at a variety of spatial and temporal scales to better understand the flows and values of ecosystem services.
5	Modelling ecosystem services	The development of tools, standards and guidelines to improve upon the ecosystem service analysis process.
6	Integrated valuation of ecosystem services	To include strong sustainability and environmental justice in valuation methodologies. Provide awareness in relation to the ecological, economic and social implications of valuation choices.
7	Economic and monetary valuation	The development of guidelines and standards for integrating both market and non-market ecosystem services values.
8	Cultural services and values	The development of a coherent approach to cultural ecosystem services research
9	Ecosystem services and public health	To assess the connections between ecosystem services and human health
10	Ecosystem services in trade-off analysis and project evaluation	Evaluating how some ecosystem services can be enhanced at the expense of other ecosystem services.
11	Global ecosystem services flows	Acknowledging that ecosystems are not bound by political borders.
12	Ecosystem services and disaster risk reduction	How ecosystem services play a role in hazard mitigation and reducing vulnerability.
13	Role of Ecosystem Services in Ecosystem Restoration	Determine how the reinstatement of autogenic ecological processes permits ecosystems to become functional and resilient communities that can adapt to changing conditions
14	Application of ecosystem services in planning and management	How ecosystem services can be used in the decision making and practical planning process in terms of land management, land planning, decision-making and governance.
15	Ecosystem services and poverty alleviation	This is a new working group. They have yet to determine their objectives.
16	Ecosystem services financing mechanisms	This group focusses on developing instruments and guidelines for applying the concept of ecosystem services in relation to biodiversity conservation and sustainable ecosystem management financing mechanisms.
17	Ecosystem services accounting and greening the economy	Assessing services as flows to provide information for sustainable management practices and land use, as well as identifying the causality nexus between humans and ecosystem services.
18	Governance and institutional aspects	Using ecosystem services information to improve governmental and institutional decision making, as well as the science-policy interface.

As discussed previously, there are many different uses for land in New Zealand. In 2013, Patterson and Cole (2013) updated an ecosystem service valuation of the various New Zealand land types. They divided their valuations into use values and passive use, or non-use, values. Here, use values would be values for using the resource, whether it is producing crops or kayaking down a river, while the non-use values would be the values of not directly using the resources, such as worms producing soil or spiritual values. When you add the use values to the passive use values you obtain the total economic value.

The values from the Patterson and Cole (2013) study were updated according to the New Zealand consumer price index (Statistics NZ, 2021f) and are presented in Table 6. The values are presented per hectare. As can be seen, there is no data for some of the passive use value categories. That being said, the table reveals something very important for the river restoration project. More specifically, rivers ($27k/hectare) and wetlands ($58k/hectare) provide the largest total economic value on a per hectare basis.

Table 6. Ecosystem Service Value of New Zealand Ecosystems by Patterson and Cole (2013)

New Zealand Ecosystems (2019 NZ$)	Use Value/ Hectare (2019 NZ$)	Passive Use Value/ Hectare (2019 NZ$)	Total Economic Value/ Hectare (2019 NZ$)
Wetlands	$57,529	$383	$57,912
Rivers	$25,129	$1,570	$26,699
Lakes	$25,033	$969	$26,002
Estuaries	$15,865	$231	$16,096
Horticulture and cropping	$8,320	n/a	$8,320
Forests	$2,453	n/a	$2,453
Agriculture	$2,083	n/a	$2,083
Intermediate agriculture-forest	$1,455	n/a	$1,455
Forest-scrub	$1,241	n/a	$1,241
Scrub	$1,135	n/a	$1,135
Intermediate agriculture-scrub	$982	n/a	$982

Source: Patterson and Cole (2013) and Statistics NZ (2021f).

Since there were many missing passive use values in the Patterson and Cole (2013) study, values from an ecosystem services assessment for the Manawatu-Wanganui (van den Belt et al., 2009) are presented (Table 7). These values were also converted to 2019 per hectare values with the aid of the consumer price index values (Statistics NZ, 2021f). Again, we find that wetlands have the highest value per hectare ($34,014). Rivers ($14,722) and estuaries ($18,393) also have a high value per hectare. It is important to note that van den Belt et al. (2009) place horticulture and cropping into separate categories. Hence, in this Manawatu study, it becomes clear that horticulture has a much higher value per hectare ($14,919) than cropping ($669). Sheep & beef ($565) and dairy land ($1,411) have much lower values per hectare.

Table 7. Ecosystem Services Value of Manawatu Region of New Zealand

Ecosystem Service	Direct Use/ Hectare (2019 NZ$)	Indirect Use/ Hectare (2019 NZ$)	Total Economic Value/ Hectare (2019 NZ$)
Wetlands	$4,131	$29,884	$34,014
Estuaries	$1,443	$16,950	$18,393
Horticulture	$14,853	$66	$14,919
Lakes	$9,889	$4,833	$14,722
Rivers	$9,889	$4,833	$14,722
Coastal	$419	$6,620	$7,038
Exotic forests	$384	$1,406	$1,790
Native forests	$165	$1,457	$1,621
Dairy	$1,094	$317	$1,411
Other farming	$521	$349	$870
Scrub	$196	$654	$850
Cropping	$603	$66	$669
Sheep & beef	$216	$349	$565

Source: van den Belt et al. (2009) and Statistics NZ (2021f).

These values are only estimates of ecosystem service values and are either nationwide estimates (i.e., Patterson and Cole, 2013) or specific to the Manawatu region (van den Belt, 2009). For example, in the Manawatu study, native forests were only assigned a total economic value of $1,621/hectare. However, if these forests were used for tourism, say, as in the Waipoua Forest, then the values would increase. If we apply the indirect use value of National Parks at $7,844/hectare (Patterson and Cole, 2013; Statistics NZ, 2021f) to the Manawatu native forest direct use value of $165, the total economic value of the Waipoua Forest becomes approximately $8,009/hectare.

Valuation of Innovative Practices

There are many ways to produce crops (e.g., greenhouse, organically, drip-irrigation). Sandhu et al. (2008) compared the ecosystem service values of producing crops organically and conventionally in New Zealand. He examined many important, and often overlooked, aspects, including the number of worms in the soil and the number of good pests eating the unwanted plant pests. It was found that the ecosystem services valuations consistently demonstrated differences in organic farming and conventional practices. This may be relevant to New Zealand where in recent years there has been increasing interest in regenerative and organic farming – which aligns well with New Zealand's "clean and green" branding internationally.

Sandhu et al. (2008) found the total economic value of organic fields to range from $3,290/ha (2019 NZD) to $39,682/ha, and for conventional fields, the range was from $2,595/ha to $29,772/ha (Table 8).

Table 8. Ecosystem Service Values of Different Cropping Systems

Cropping System	Range of Total Economic Value/ Hectare (2019 NZ$)
Organic	$3,290 to $39,682
Conventional	$2,595 to $29,772

Source: Sandhu et al. (2008)

There were many ecosystem services that were enhanced in the organic operations, as opposed to the conventional operations. They include:

- biological control of pests;
- mineralization of plant nutrients;
- soil formation;
- food;
- carbon accumulation;
- soil fertility;
- hydrological flow; and
- shelterbelts.

More specifically, there were more worms in the organic farms, which resulted in better soil formation and nutrients in the soils. There were also more 'good insects' present, which helped

to naturally reduce the amount of ‘unwanted’ insects on the crops. I will not discuss all aspects of the Sandhu et al. (2008) study, but note that his valuation illustrates that if farmers raise their crops using organic techniques, indirect values in particular, are increased and the ecosystem becomes (or remains) more diverse and thus more resilient. Higher indirect values also tend to support landowner and community wellbeing – an aspect of economic development that is being given more weight in recent years.

The Tai Tokerau Northland Economic Action Plan

The Tai Tokerau Northland Economic Action Plan (2019) is a partnership between industry, the community (including hapū and iwi Māori), and local and central government. The primary aim of the plan is for people to collaborate and co-operate to support the transformation of the economic well-being of Northland.

Priority outcomes for the Action Plan include:

- a thriving Tai Tokerau Mäori economy;
- an equitable environment for whanau well-being;
- a safe, resilient and efficient multi modal transport system;
- a state-of-the-art technology ecosystem;
- top regional visitor destination;
- better use of water; and
- a skilled local workforce.

It is hoped that an increase in capability, productivity and opportunities will occur in several sectors of the economy (i.e., forestry, honey, agriculture, aquaculture, horticulture). Many of the Action Plan goals are related to the successful restoration of the three Ngā Awa Northland catchments (DOC, 2019).

The goals that are relevant to river restoration include:

- assessing which higher value crops could be grown in the region;
- developing a horticultural action plan;
- expansion of berry production;
- expansion of avocados;
- increasing honey production;
- determination of the feasibility of an indigenous Tōtara industry;
- developing Far North cycleway and walkway projects;
- upgrading tracks and visitor facilities in the Waipoua Forest (i.e., Rakua Rangatira); and
- determining the potential for the commercial extraction of oils from Mānuka.

Climate Change Resilience

The Ngā Awa River Restoration project aims to increase climate change resilience as well as the ecological resilience of three Northland catchments: Doubtless Bay, Waihou River and Waipoua River. This is important, as climate change is currently impacting and will continue to affect the Northland Region (NRC, 2016; Ministry for the Environment, 2018). While many of these impacts are negative, some positive opportunities exist, such as the ability to grow sub-tropical crops that did not flourish in the region previously and the ability to rear young livestock during the winter months.

According to the Ministry for the Environment (2018) and NRC (2021), Northland climate change impacts include:

- a lack of winter chilling may result in kiwifruit crops becoming uneconomical to produce;
- an increase in the time spent in drought may result in water shortages;
- animals may experience an increase in facial eczema;
- water resources may experience increased pressure during droughts;
- cattle may be affected by increased heat stress;
- coastal infrastructure may be affected by coastal erosion and inundation;
- coastal roads may be affected by coastal erosion and inundation;
- droughts may likely increase in intensity;
- droughts may likely increase in length;
- erosion control may become more important;
- floods may occur more frequently;
- food borne diseases may increase (e.g., Listeria);
- invasive pest numbers may increase and affect crops;
- temperatures may increase;
- storms may occur more frequently;
- the risk of damage from heavy rains may increase;
- the risk of damage from strong winds may increase;
- the occurrence of vector borne diseases may increase (e.g., Dengue Fever, Ross River Virus);
- the occurrence of water borne diseases may increase (e.g., Salmonella);
- the growing season may lengthen;
- frosts may become rare;
- the new climate may result in better growing conditions for sub-tropical crops (e.g., citrus, avocado); and
- young livestock may be reared during winter months.

For rivers, current predictions are that climate change will decrease rainfall and river flows in Northland (Collins et al., 2005). As sea levels rise, coastal waters and groundwater may become saline further inland. In addition, at times, there may be more intense storms and rainfall (NRC, 2021). At present, there is a great deal of uncertainty around regional climate change predictions. Hence, local managers will need to be prepared to adaptively manage as trends emerge (Clearwater, 2021, Robertson et al., 2016).

Ngā Awa river restoration programmes will be developed with mana whenua and other catchment stakeholders. These programmes will generally aim to minimize existing stressors (e.g., erosion, nutrient inputs, pest species) and thereby maximise the adaptive capacity of these ecosystems. In itself, this will increase the climate change resilience of the river catchments (Clearwater, 2021).

To mitigate climate change impacts specifically, depending on local needs and priorities, habitat corridors may be established (e.g., along the riparian margins of rivers) to allow species to migrate as their habitat changes (Robertson et al., 2016). This will have to be partnered with greater surveillance and management of pest species that may thrive in warmer and drier climates, and also use the corridors. Other initiatives may be necessary to create diverse aquatic habitat (e.g., wetlands, pools, and shaded backwaters) with "redundancy" to allow native species to thrive and increase the probability that they will adapt to climate change. If communities decide on actions such as the 'coastal retreat' of infrastructure (e.g., removing beachfront buildings and roads), this may present opportunities to create climate refuge areas for species impacted by climate change, particularly at vulnerable points in their life cycle (e.g., nesting or spawning).

Working toward increased climate change resilience in river catchments will have impacts on many facets of the environment and will influence management choices. For example:

- erosion control will be more effective;
- waterways will ideally be more shaded, lowering instream water temperatures;
- communities will want more water set aside to protect instream ecological values; and
- land-use change toward drought-tolerant and sub-tropical species will be promoted over crops with high water demands.

Other River Restoration Study Data

It is important for government agencies, non-government organizations and private land owners to work together to respond to climate change. This will result in an improvement in water policy, urban development, land management and other diverse matters. That being said, at present, government agencies are potentially not responding to climate change quickly enough to allow for 'ecological adaptation'. Riparian ecosystems especially need to be prepared for climate change and will help provide climate change resilience if restored (Seavy et al., 2009).

Both policymakers and politicians need to know if local citizens are interested in supporting river restoration measures. Brouwer et al. (2016) conducted a survey in the countries of Austria, Hungary and Romania to determine if households were willing to contribute an annual payment for the restoration of rivers (Table 9). They found that people were willing to contribute more money if it meant water quality increased and the frequency of flooding decreased.

Table 9. Willingness-to-Pay for River Restoration in Annual Payments (2019 NZD)

Policy Scenario	Austria	Hungary	Romania	Average
Scenario A:	$98.64	$24.43	$42.25	$55.10
Good water quality				
Flood return baseline				
Scenario B:	$116.17	$34.33	$51.14	$67.22
Very good water quality				
Flood return 25 years				
Scenario C:	$125.88	$34.86	$49.58	$70.11
Very good water quality				
Flood return 75 years				

Source: Brouwer et al. (2016).

Most 'willingness-to-pay' river restoration studies were conducted prior to interest in river restoration for climate change. As such, the goals of river restoration for many of these investigations focussed on restoring and protecting fish populations, restoring and protecting threatened or endangered species (which may include fish), improving wildlife habitat, and improving water quality for boating. As can be seen from Table 10, 'willingness-to-pay' for river restoration per household per kilometre of river restored ranged from $0.24 to $12.21 km/year.

Table 10. Annual Willingness-to-Pay Per Household Per Kilometre for River Restoration

Authors	Annual WTP Per Household Per Kilometer of River Restored (2019 NZD)
Berrens et al. (1996)	$0.24
Bliem and Getzner (2012)	$1.53
Broadbent et al. (2015)	$1.22
Broadbent et al. (2015)	$0.73
Brouwer et al. (2016) Austria	$5.54
Brouwer et al. (2016) Hungary	$1.13
Brouwer et al. (2016) Romania	$0.43
Collins et al. (2005)	$7.63
Holmes et al. (2004)	$5.19
Kenney et al. (2012)	$12.21
Loomis (1996)	$1.48
Loomis et al. (2000)	$0.61
Mansfield et al. (2012)	$1.74
Weber and Stewart (2008)	$3.11
Weber and Stewart (2008)	$9.78
Welsh et al. (1997)	$0.53

Source: Bergstrom et al. (2016).

Tait et al. (2016) conducted a study on the non-market valuation of improvements in freshwater quality for New Zealand residents in relation to changes in stock exclusion policies (Table 11). They found that New Zealand residents were definitely willing to pay for stock exclusion to increase water quality. What is interesting is that people were willing to pay the most for water clarity, when compared to ecological quality and human health risk. It is important to note that willingness to pay for human health risk water related improvements was the least valued of all the water quality improvement outcomes. Perhaps if the questions were asked differently (e.g., How much would you be willing to pay to decrease the chances of your children getting sick when they swim?) the results would differ.

Table 11. Willingness to Pay for Better Water Quality

Water Quality Outcome	Willingness to Pay for a Percentage Point Increase in Water Quality Outcomes (2019 NZD)
Human Health Risk (1:20)	$0.75
Human Health Risk (1:100)	$1.23
Human Health Risk (1:1,000)	$3.54
Moderate Ecological Quality	$2.29
Good Ecological Quality	$6.07
Moderate Clarity	$4.41
Good Clarity	$7.90

Source: Tait et al. (2016).

New Zealand Emissions Trading Scheme and Other Initiatives

The New Zealand Emissions Trading Scheme (NZETS) began operating in 2008. It is a primary element of New Zealand's commitment to mitigating climate change. The NZETS is a scheme that changes with national circumstances, and hence, evolves over time. One of the things that the NZETS does is include forest landowners as mandatory participants. This is because carbon sequestration by forestry is an important part of New Zealand's goals to reduce greenhouse gas emissions (Satchell, 2021).

Pine forest harvesting on a ~ 25 to 30-year cycle causes significant sediment inputs, and other impacts on waterways at the time of harvest. Negative effects on macroinvertebrate communities can persist for approximately ten years, depending on the size of the waterway and the harvested area and the forestry practices that were followed (Berg, 2008; Neale et al., 2017; Reid et al., 2010). Hence, it may be possible to reduce impacts on waterways by continuing to improve forestry practices (e.g., larger setbacks and better sediment control during road construction and use). In addition, as forests grow, they can alter the hydrology of nearby waterways, wetlands and seeps due to the significant water uptake of rapidly growing trees.

The NZETS provides revenue to growers of new forests on pastoral land. The revenue comes from the sale of carbon units (Satchell, 2021). There are two main types of forestry to consider in the NZETS. The first is clearfell forestry. This is typically the growing and harvesting of radiata pine. It has been found that clearfell forestry provides higher returns than pasture. This is because of the carbon price obtained as a result of the NZETS. However, if the rules are changed and radiata pine no longer obtains emission units under the NZETS, then the profitability compared to pasture declines. It is still expected to be higher than pasture, but non-significantly (Satchell, 2021).

Permanent forestry is when there is a continuous cover of trees, and hence, the trees are not harvested. This improves environmental outcomes, because it mitigates the sedimentation of water bodies and erosion. At present in Northland, half of the establishment cost for a permanent tōtara forest can be subsidized from soil conservation grants. When this is accounted for, establishing tōtara forest becomes more profitable than pasture. This is true for all interest rates and carbon prices. According to the NZETS, a permanent forest may not be clear-felled.

In addition, the landowner must maintain at least 30 percent of the canopy (per hectare) for a minimum of 50 years (Satchell, 2021).

It is important to note that tōtara plantations can be established with a manuka nurse crop. Hence, there is the potential for income from manuka honey and/or manuka oil while the tōtara plantation is getting established (Satchell, 2021). It is likely that this is also the case for kanuka.

Water Usage

One of the many important reasons to restore rivers is water quantity. If rivers, especially smaller streams, are shaded by natural vegetation, there may be less evaporation, and hence, more water in the rivers. Water extraction from rivers will often affect the quantity of water remaining, and these effects can be cumulative (i.e., from multiple abstraction points). Conversely, river restoration to improve ecological values often requires that 'environmental flows' are re-established (i.e., less abstraction occurs) or limited to ensure that sufficient water remains in the waterway to support a wide range of native species (and all their life stages). In addition, 'environmental flows' include a 'natural' timing and pattern of high and low flows (i.e., the flow regime) in a waterway to provide seasonal cues for activities such as fish spawning and migration, and support other processes such as sediment movement in the waterway.

More research is needed to determine the amount of water used by different crops and agricultural uses in New Zealand. Nederhoff and Stanghellini (2010) calculated the world averages for product water use in litres per kilogram for 65 nations over the period of 1997 to 2001. The Nederhoff and Stranghellini study provides interesting information (Table 12). We see that a large water user is beef cattle (15,497 litre/kg). 'Eggs in the shell' production uses 3,340 litre/kg, apricots use 1,391 litre/kg, grapes use 655 litre/kg, kiwifruit uses 430 litre/kg and strawberries use 276 litre/kg.

Table 12. Product Water Use for the Production of Various Foods

Product	Product Water Use (litre/kg)
Beef (fresh)	15,497
Olives	4,393
Eggs in shell	3,340
Asparagus	1,473
Apricots	1,391
Bananas	859
Apples	697
Grapes	655
Oranges	457
Kiwifruit	430
Strawberries	276
Lettuce	133
Carrots	131

Source: Nederhoff and Stanghellini (2010).

Nederhoff and Stanghellini (2010) also found that the use of water to produce 1 kg of fresh tomatoes can vary widely. Growing tomatoes in an open field can use up to 300 litres of water per kg of tomatoes, while growing tomatoes in an open field with drip irrigation may use 60 litres/kg and growing tomatoes in a closed greenhouse may only use 4 litres/kg. This type information versus the availability of water resources and climate change should be considered in future land use planning, for example when considering establishing or expanding avocado orchards or berry crops.

Ranking Land Use Changes And Economic Opportunities

There are 92,539 hectares of land in the 3 Ngā Awa Catchments in Northland. The bulk of the land cover is made up of indigenous forest, exotic forest and manuka and/or kanuka (Table 13). Some of the indigenous and exotic forests are being used for walking tracks and sightseeing. This is something that can be expanded upon in the future.

Other current land uses in the three Ngā Awa catchments include the harvesting of forests for timber and pulp and paper, orchards (e.g., citrus), vineyards and other perennial crops, beef and sheep grazing, dairy cattle farming, grain farming, fishing, livestock farming, and hunting. The Tai Tokerau Northland Economic Action Plan 2019 identifies opportunities for the expansion of berry and avocado orchard production, increasing honey production, determining the feasibility of an indigenous tōtara industry, developing cycleway and walkway projects, upgrading tracks and visitor facilities in the Waipoua Forest and examining the potential for commercial manuka oil extraction.

Table 13. Land Types in the 3 Ngā Awa River Catchments

Land Use	Doubtless Bay	Waihou River	Waipoua River	Total
Indigenous Forest	9323	16956	8310	34589
High Producing Exotic Grassland	22691	9137	583	32411
Manuka and/or Kanuka	8242	624	414	9280
Exotic Forest	4679	1365	1630	7674
Broadleaved Indigenous Hardwoods	2128	275	140	2543
Estuarine Open Water	770	370	0	1140
Forest - Harvested	836	52	151	1039
Low Producing Grassland	783	51	22	856
Mangrove	281	334	0	615
Gorse and/or Broom	566	30	0	596
Herbaceous Saline Vegetation	96	313	0	409
Orchard, Vineyard or Other Perennial Crop	301	4	0	305
Built-up Area (settlement)	259	12	0	271
Mixed Exotic Shrubland	170	0	0	170
Deciduous Hardwoods	101	39	0	140
Sand or Gravel	116	0	16	132
Herbaceous Freshwater Vegetation	47	47	0	94
Urban Parkland/Open Space	69	5	0	74
River	38	16	19	73
Lake or Pond	58	3	0	61
Surface Mine or Dump	20	2	0	23
Short-rotation Cropland	18	0	0	18
Matagouri or Grey Scrub	17	0	0	17
Transport Infrastructure	3	0	1	4
Gravel or Rock	0	3	0	3
Landslide	2	0	0	2
Totals	51614	29639	11286	92539

Source: Manaaki Whenua Landcare Research (2020).

Given that manuka and kanuka are the third most prevalent land cover in the three catchments, there is a clear opportunity for the production of manuka and kanuka honey (which may already be occurring) or manuka and kanuka oil. It is important to note that manuka oil production and manuka honey production cannot take place at the same time, because harvesting for oil prevents the manuka plants from flowering. That being said, kanuka produces more oil per hectare than manuka. In addition, kanuka does well in warmer temperatures, which are predicted for Northland as climate change progresses. Kanuka may therefore be a more sustainable option in the long term (Manuka Farming, 2017).

Manuka is currently more popular than kanuka, but this may not continue to be the case in the future for several reasons. Manuka honey contains the compound methylglyoxal, a bio-active substance shown to inhibit bacterial growth, while kanuka honey contains arabinogalactan proteins, another bio-active substance that increases the amount of the 'tumour necrosis factor alpha', which helps stimulate the immune system (Tranzalpine, 2019). Studies have already

shown that kanuka honey is as effective as prescription medication in treating cold sores (Semprini et al., 2019).

Māori have used the seeds, bark, and leaves of both manuka and kanuka for many herbal remedies including coughs, inflammation, treating wounds, burns and diarrhoea. Hence, both of these species (i.e., manuka, kanuka) have significant healing benefits. More research will evaluate the importance of kanuka oil, which may be better economically for Northland as a result of climate change (Semprini et al., 2019; Tranzalpine, 2019).

Total Economic Valuation of Economic Opportunities

An estimated ranking was conducted for the proposed economic opportunities relevant to river restoration (Table 14). Preliminary total economic valuation estimates were calculated from the Patterson and Cole (2013), van den Belt et al. (2009), Manuka Farming (2017) and Satchell (2021) studies. These values are not developed from the cost and benefit analysis of each industry; hence, it is recommended that more information be collected to improve the quality of these preliminary rankings. The results reveal that, when considering a total economic valuation, berry production and more avocado plantations have the highest value per hectare – but note that water use intensity is not included in this valuation (see subsequent discussion).

Table 14. Estimated Total Economic Value of New Northland Land Uses

New and Current Land Uses	Total Economic Value/ Hectare (2019 NZ$) (Estimation)
More berry production	$14,919
More avocado plantations	$8,320
Upgrading tracks and facilities in the Waipoua	$8,009
Cycleway and walkway projects	$8,228
More honey production	$2,692
Indigenous Totara industry	$2,290
Commercial Manuka oil production	$2,453
Dairy	$1,411
Sheep & Beef	$565

Sources: Patterson and Cole (2013), van den Belt et al. (2009), Manuka Farming (2017) and Satchell (2021).[4]

It is important to note that a more detailed study can reveal more specifics as the numbers in Table 14 are just a rough estimate. For example, according to NZ Avocado (2021), one hectare of avocado trees can yield an income after expenses of $28,209 in one year, while Tupu.nz (2021) discusses that one hectare of blueberries can yield $180,000 to $240,000 after expenses in one year. Therefore, more work is needed to determine more accurate Northland values.

Valuations that include indirect use values are more appropriate to consider than just direct use value data when contemplating land use change, particularly in the context of catchment-scale river restoration. Another important piece of the puzzle to consider is water use, as some crops

[4] The values in this table were extrapolated from Patterson and Cole (2013), van den Belt et al. (2009), Manuka Farming (2017) and Satchell (2021). More exact numbers can be obtained from a more thorough investigation.

and cropping methods demand more water than others. Northland has limited freshwater resources, and drought frequency and air temperatures are likely to increase with climate change, while river flows are expected to decrease (Collins et al., 2005). When ranking land uses, it is imperative to consider the amount of water that is available now and in the future.

Crop and land use diversification is also important. If there is a monoculture in an area and a disease breaks out, an entire crop can be lost. However, if land use is diversified, for example, with income variously from honey, carbon credits and trees, tourism and agriculture, negative impacts from one activity may not affect other income streams. Also, diversity is generally positive for ecosystems, creating a suite of habitats for different species and life stages and making them more resilient to pressures.

It would be interesting for a future report to include a more comprehensive comparison of the proposed economic initiatives and current economic activity in the Northland region that included total economic valuation and resilience to a low emissions scenario of climate change (e.g., ranking initiatives that align with river restoration, low water demand, resiliency to climate change, active climate mitigation, and improving social well-being).

Discussion and Conclusions

This study investigated the win-win opportunities for economic growth according to the ecosystem service values of three river catchments over the next ten years in the Northland Region: Doubtless Bay, Waihou and Waipoua. This is important to consider for many reasons, including freshwater health, river restoration and climate change plans supporting Ngā Awa's emerging river restoration initiatives in the region. The following is a list of the perceived win-win opportunities for these catchments:

1. The restoration of river catchments will develop climate change resilience and support New Zealand's economic viability. Activities core to river restoration include riparian fencing and planting, and the mitigation of erosion. Prevention of erosion is beneficial to waterways; it also retains the land's future productivity and farm soil capital. Reducing sediment inputs to waterways and preventing stock access will improve water quality and ecosystem services (e.g., swimming and fishing). Downstream estuaries and coastal areas will also benefit from river restoration. Hence, river restoration in itself is a win-win activity from economic, social and environmental perspectives.

2. The New Zealand Emissions Trading Scheme (NZETS) is a carbon trading programme where people that plant trees can earn money to maintain the presence of the trees on the land. Satchell (2021) has illustrated that steep land planted in trees, such as indigenous tōtara, is more valuable than grazing land. At the same time, the planting of a forest increases the ecosystem service value of the land and reduces sedimentation. Consequently, it is recommended that native tōtara be planted on steep land and possibly also in the river corridors, if not in other locations. In addition, since tōtara plantations can be established with a manuka nurse crop, there is the potential for income from manuka honey and/or manuka oil while the tōtara plantation is getting established (Satchell, 2021). To obtain income from a permanent forest, the forest must remain on the land for a minimum of 50 years. At the current point in time, NZETS also provides carbon trading income for clear-felled forests, but the felling of a forest results in significant sediment inputs into waterways at the time of the harvest.

3. Tourism is directly enhanced by the restoration of the river catchments, and, in turn, can uphold cultural and environmental values if these are taken into account during

development. Tourism development, such as the establishment of new trails, can be beneficial for several reasons:

a. New trails can provide new recreation opportunities for domestic and overseas trampers/walkers and bicyclists.
b. New trails can provide significant community assets, which attract increasing numbers of users who obtain both mental and physical health benefits.
c. New trails can provide an increase in economic activities in nearby communities, as well as the districts and regions they are located in.
d. New trails can help to preserve and enhance the historic, cultural, and heritage attributes.

4. Bees produce honey, which is an important commodity. However, they also pollinate the flowers of many plants, including important crops. This benefits the ecosystem service value of an area, despite it being difficult to quantify on a per hectare basis across the entire Northland region. The production of honey can easily tie in with the opportunities to produce manuka and kanuka honey, as well as manuka and kanuka oils in the three river catchments, especially since there are currently established tracts of manuka and kanuka.

In the Doubtless Bay catchment, population growth is expected over the next ten years. This will result in some pasture area being converted to housing. There will also be small patches of land conversions of pasture to horticulture. No new dairy land conversions are expected (Jones, 2021a). As the Doubtless Bay catchment will have the fastest growing population, it is important to plan walking and biking trails that start in or near these towns to improve accessibility in the local resident community. These trails can connect with other trails further away from the larger population centre. This can attract tourists to the area, and provide health and well-being benefits to the locals. Tourists will spend more money in the area via accommodation, food and other retail products.

In the Waihou River catchment, little land cover/land use change is predicted over the next ten years. There is also no significant population growth expected (Jones, 2021a). The plantation/commercial forestry blocks are expected to be logged. This will result in sediment loss that will impact the river catchment. In the upper Waihou River catchment, it may be possible to update walking trails and increase the amount of local accommodation to provide more tourist opportunities in the Puketi Forest, which has linkages to the Te Araroa Trail that could be expanded (although ‘kauri dieback’ risks must be managed effectively).

In the Waipoua River catchment, not a lot of land cover/land use change is expected over the next ten years (Jones, 2021a). No significant population growth is expected either. There is ongoing harvesting of plantation/commercial forestry which can impact the rivers through sediment loss unless managed effectively (e.g., large setbacks from river margins, sediment control linked to road runoff) (Jones, 2021a). The Waipoua Forest community, led by Te Roroa, is planning to update their walking trails, upscale local accommodation and provide more tourist opportunities. Three Northland iwi are collaborating on a three year long, $760k Jobs for Nature project, 'Taiaororoa o Waipoua,' that is focussed on the management of kauri dieback, which is an essential component of these activities. It is also important for the community in the Waipoua Forest to develop trails and other visitor services. This could increase awareness of local cultural values. It will also bring more money into the local economy. The local people will also be able to provide tourists with local knowledge which will help maintain the cultural aspects of the area for generations.

The restoration of the Ngā Awa river catchments is extremely important for climate change, the associated local ecosystems, and the health and value of the lands themselves. Hence, such restoration work has the potential to be of significant historic importance to the region.

This short desktop project is an initial examination of the ecosystem service values of restoring the Doubtless Bay, Waihou and Waipoua River Catchments. Future research could be conducted to determine more detailed information and a more accurate valuation that is specific to the catchments themselves. This could include a valuation of the precise recreation activities that take place in the three catchments, and collecting primary data or more specific secondary data. Information was located on water usage for some crops, but these numbers were averages from many non-New Zealand countries. More research is needed to determine the amount of water used by different crops and under specific agricultural practices in New Zealand. It is also important to determine more detailed information on the value of kanuka vs. manuka for both honey and oil, as in the future kanuka is expected to grow better than manuka in Northland as a result of climate change (Semprini et al., 2019; Tranzalpine, 2019). More detail could also be determined for the value of tōtara and other native forests in relation to the carbon credits and as harvested forests. In addition, the ecosystem service valuations were primarily based on the information available in Patterson and Cole (2013) and van den Belt et al. (2009). These

are both older studies that took their estimates from various areas around the world, hence, a more detailed study specific to New Zealand and the Northland region would provide more accurate numbers.

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Appendix A: International Tourism Activities (2019) – Full List

International Tourist Activities (2019)	Total Number of Visitors
Go for walk, hike, trek or tramp	2,350,612
Visit natural attraction (e.g. mountain, lake, river)	2,036,736
See Native birds	1,824,552
Go to a Beach	1,820,362
Visit a National park	1,746,738
Visit a public museum or art gallery	1,350,768
Go on a scenic boat trip	1,196,015
Visit a geothermal park (hot mud and possibly geysers)	1,080,295
Visit a place significant to Maori (e.g., landmark, fortified hill)	1,059,213
Go on a Gondola/ cable car / tram ride	1,024,624
See glow worms	912,159
See seals	886,526
Visit a bar or nightclub	830,898
Relax in some hot pools	819,466
See Maori artefacts, art or crafts in an exhibition	814,511
Visit a farm or orchard	799,151
Visit a film location	790,329
Visit a vineyard / wine trail	749,445
Take a scenic tour by bus or train	737,536
Visit other building or site	728,807
See other wildlife	707,151
Go to a garden or flower show	664,041
Visit a Maori marae (a Maori meeting place)	605,120
Marine park or marine reserve	598,142
Swimming / surfing	595,514
Zoo or wildlife park	573,391
Some other activity associated with Maori culture	562,586
Live performance	537,520
Other boating	515,919
Dolphins	502,323
Penguins	501,216
Food and/or wine event	409,291
Theme park or leisure park	408,280
See Maori art or crafts being created	389,869
Jet-boating	381,290
Eat Maori traditional food	371,690
Experience Maori tradition, such as story-telling	364,127
Rafting, canoeing, kayaking	326,312
Scenic flight	307,611
Other public museum or art gallery in the North Island	306,883
Other exhibition / Expo	299,786
Extreme ride e.g. Luge, fly-by-wire	268,502
Cycling	267,525
Health spa or day spa	261,762
Mountain climbing, rock climbing, abseiling, caving	260,598
Watching or playing other sport	217,710
Casino	191,209
Conference / convention	188,244
Rugby (watching or playing)	184,520
Air activities such as paragliding, hang gliding, ballooning, skydiving	173,717
Whales	154,209
Fishing or hunting	146,481
Skiing, snowboarding or other snow sport	127,698
Bungy jumping	110,928
Playing golf	85,954
Horse riding / horse trekking	82,016
Scubdiving or snorkelling	73,603
Quad biking, 4WD vehicle tour	71,310
Canyon Swing	60,362
Other water activity such as water-skiing	43,415

Appendix B: Domestic Tourism Activities (2012) – Full List

Domestic Tourist Activities (2012)	Total Number of Visitors
Dining	17,732,044
Visiting Friends And Relatives	13,208,663
Shopping	10,948,474
Business	6,653,369
Sightseeing (Land)	6,006,757
Walking And Trekking	5,450,593
Other Scenic/Natural Attractions	5,306,847
Other Sports	2,581,379
Entertainment	1,964,346
Swimming	1,820,459
Fishing	1,548,838
Other Attractions	1,450,651
Museums And Galleries	1,420,470
Volcanic/Geothermal Attractions	1,189,223
Medical Visit	917,762
Other Water Activities	860,180
Performing Arts	761,478
Theme And Leisure Parks	699,819
Cycle Sports	576,889
Boating	538,667
Golf	534,963
Snow Sports	505,910
Gardens	505,246
Zoos/Wildlife/Marine Parks	501,598
Other Land Activities	470,742
Hunting/Shooting	425,331
Other Business/Edctnl Activities	416,141
Motor Sports	392,538
Other Activities	383,753
Wineries	374,342
Canoeing, Kayaking, Rafting	362,357
Convention/Conference	335,931
Farms	316,239
Education/Study/Language School	289,045
Heritage Attractions	288,511
Other Major Events	272,998
Sporting Event	237,158
Lookouts And Viewing Platforms	183,902
Garden/Floral Show	168,307
Bird Watching	167,646
Working Holiday	166,980
Climbing	161,691
Horse Trekking/Riding	155,996
Other Arts & Culture Activities	155,900
Arts And Crafts	138,101
Casinos	133,017
Other Wildlife Encounters	127,885
Cultural Attractions	81,704
Food And Wine Festival	80,834
South Island National Parks	72,851
Major Art/Culture Event	69,002
Bungy Jumping	63,728
Sky Diving/Parachuting	46,552
Dolphin Watching	41,104
North Island National Parks	33,874
Sightseeing (Air)	31,469
Caving	29,891
Other Air Activities	26,402
Gliding	18,014
Whale Watching	15,925
Paraponting	4,171
Ballooning	2,424