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He Pou a Rangi
Climate Change Commission

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Tēnā kotou katoa,

SUBMISSION ON THE DISCUSSION DOCUMENT: REVIEW ON WHETHER EMISSIONS FROM INTERNATIONAL SHIPPING AND AVIATION SHOULD BE INCLUDED IN THE 2050 TARGET, AND IF SO HOW.

This submission has been prepared by Nadia M Trent (PhD) (University of Waikato) and Oli Floerl (PhD) (Land Water People – LWT Ltd.) with data purchased from MarineTraffic for ongoing maritime connectivity research at the Waikato Management School.

The purpose of this submission is to highlight the necessity of considering a maritime network view when analysing the potential impacts of future actions. In the current document[1], network impacts are mentioned only briefly. In particular, we want to illustrate that the choice of emission measurement outlined in Chapter 4 of the current document could result in markedly different future states for Aotearoa New Zealand's maritime network, with implications for the economy and biosecurity.

In this submission, we describe characteristics of Aotearoa New Zealand's maritime container shipping network that can only be appreciated when one considers the trajectories of the vessels that visit the country's ports. Based on these characteristics, we then discuss future economic and biosecurity implications if emissions are measured either by 1) fuel use to/from *next* port or 2) fuel use to/from *final* port. The current document offers fuel use to/from next port as a preferred measure, primarily due to the relative ease of implementation.

Considering the network characteristics of container imports/exports, including emissions based on the *fuel use to/from the next port* is an especially inaccurate proxy for the emissions of the entire cargo journey. In addition, this measure is vulnerable to evasive behaviours from shipping lines that would negate its benefit and, in a worst case scenario, could incentivise a restructured maritime network that inequitably snuffs out certain trading markets while making Aotearoa New Zealand even more remote.

On the other hand, including emissions based on the *fuel use to/from the final port* is a far better proxy for international shipping emissions that has the potential to incentivise meaningful change. Given Aotearoa New Zealand's maritime remoteness and vessel constraints, green corridors are a likely pathway to change. However, a green corridor to Australia could leave Aotearoa New Zealand more remote in a maritime sense and might increase biosecurity risk. Although the business case is more precarious, a green corridor to Southeast or East Asia would be advantageous for maritime connectivity, but there remains a biosecurity risk if the corridor entrenches direct connectivity with temperate regions in East Asia.

Given this preliminary analysis of potential maritime connectivity impacts for import/export containers, **we strongly urge the Commission to reconsider the measurement alternatives tabled and how these would be applied to container shipping. More in-depth network analysis and insights from engagement with the shipping lines, freight forwarders, cargo owners and the ports should be included in the decision-making.** Our submission concludes with a discussion of avenues for further

[1] Throughout this submission, 'current document' refers to the *Discussion document: Review on whether emissions from international shipping and aviation should be included in the 2050 target, and if so how.* published by He Pou a Rangi, the Climate Change Commission for comment by 31 May 2024

analysis that can be pursued if the Commission deems it useful. Thank you for your time in considering our submission. We hope it adds value to the decision-making conversations.

Sincerely,

Trent NM

Nadia M. Trent (PhD)

1 Aotearoa New Zealand as a connectivity taker in container shipping

Aotearoa New Zealand relies profoundly on ocean transport (55 billion tonnes of trade worth NZD 126 billion in 2022), including containerised ocean transport (32% of trade volume and 72% of trade value in 2022) (New Zealand Ministry of Transport, 2024). Table 1 shows who Aotearoa New Zealand's most prominent trading partners are when it comes to imports and exports shipped via containers and refrigerated ("reefer") containers. East Asia, Southeast Asia, and Australia are most significant with North America and Western Europe being our most important "distant" partners.

Table 1: Percentage contribution in terms of volume and value of different world regions to Aotearoa New Zealand's total containerised imports and exports in 2022 (Source: New Zealand Ministry of Transport (2024))

REGION	**VOLUME**		**VALUE**	
	Import	Export	Import	Export
East Asia	33%	36%	39%	39%
Southeast Asia	14%	19%	13%	13%
Australia	24%	13%	14%	11%
North America	6%	8%	8%	13%
Western Europe	6%	3%	9%	4%
Western Asia	3%	4%	2%	5%
Southern Asia	2%	4%	3%	2%
Northern Europe	3%	2%	4%	3%
Latin America and the Caribbean	3%	2%	2%	3%
Oceania	1%	3%	0%	2%
Rest of the world	5%	6%	6%	5%

Container shipping is unique amongst the maritime cargo types (e.g. dry bulk like grains, liquid bulk like petroleum or chemicals, or break bulk like steel) as container vessels are organised in regular services that call at multiple ports in a single voyage instead of direct origin-destination routing. The regular services of container vessels allows for the consolidation of containers belonging to thousands of cargo owners onto one vessel, enabling economies of scale. These regular services make container shipping services akin to bus routes in a city. Commuters have little influence over the route a bus will take or the stops it will make, they can only choose whether to get on a bus or not. It is similar with container shipping. Factors that influence the establishment of a container service include demand (container volumes) at the various ports along the service, the freight rates that could be charged, cost factors (fuel, labour, insurance), and competition for the service. Adding an emissions charge for international shipments could influence both demand and costs, which alters the business case for service. Therefore, policy decisions around the inclusion and measurement of international shipping emissions could potentially impact the container services that stop in Aotearoa New Zealand.

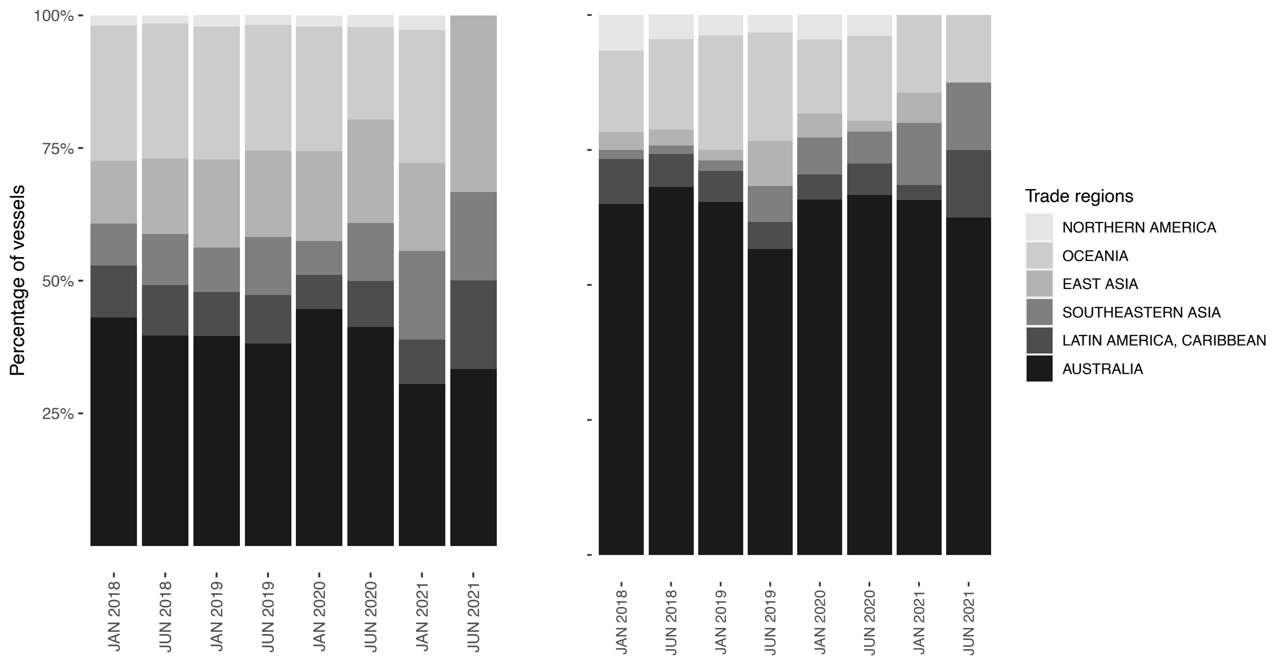
Aotearoa New Zealand is a "small advanced economy" dependent on "far-flung" global supply chains (Skilling, 2022). In the case of container shipping, the country does not have much market power. Without an international merchant marine fleet, it is completely reliant on foreign-owned companies to route their container vessels to its shores. The business case for these foreign companies is built on a small (in terms of shipping volumes) economy. Geographic isolation, dependence on foreign service providers, and low market power make Aotearoa New Zealand a *connectivity taker* in container shipping (Trent et al., nd) with very little influence over how routes are designed. With this context in mind, we consider potential impacts to the country's maritime connectivity if two of the emissions measurements in Chapter 4 of the current document were implemented.

2 Current maritime network

There is no readily available database that tracks the movements of import/export containers. As a proxy, researchers use vessel trajectories (i.e. the sequence of port calls) to understand the flow of container cargo. A maritime network perspective, in this submission, considers ports to be the nodes of the network connected by the vessels that travel between them (links of the network). The data used in this submission originated from MarineTraffic, an established and widely used provider of global shipping data, and has been processed to extract vessel trajectories relevant to Aotearoa New Zealand. The dataset spans from January 2018 to June 2021.

2.1 First/last international port call for container exports/imports

Most of Aotearoa New Zealand's arriving vessels (carrying imports) and departing vessels (carrying exports) visit a port in Australia as their first/last international port call (Figures 1b and 1a). As the ramifications of the COVID-19 pandemic wore on in the maritime world in 2021, the country's direct connectivity concentrated to Australia, Latin America & Caribbean, Southeast Asia, and East Asia. Arguably, many of the country's import and export containers potentially have direct access to their origin/destination markets in Australia, Southeast Asia, and East Asia because of this. However, it is not a foregone conclusion that containers are loaded onto vessels that travel a direct route between the country and our trading partners. Vessel schedules and the choice of origin/destination port affect whether a container can capitalise on a direct connection or travels an indirect route[2]. It is important to understand the patterns of vessel trajectories *beyond* the first/last international port call.



(a) Departing vessels (exports)

(b) Arriving vessels (imports)

Figure 1: The proportion of vessels whose first/last international port call, after/before Aotearoa New Zealand, was in a specific region. (Source: MarineTraffic data analysed by authors.)

[2]While our dataset does enable a port-level analysis, this submission focusses on a regional level.

2.2 Onward connectivity to trading partner regions

From January to June 2021, the country's primary outgoing and incoming routes were consolidated to four regions: Australia, Southeast Asia, East Asia, and Latin America & Caribbean (Figures 1b and 1a). To explore the vessel trajectories beyond the first/last international port calls during this timeframe, we define a *feedering range* as follows: A container travelling to, for example, Southeast Asia that is loaded onto a vessel that first stops in Australia, will travel onwards to its destination on the same vessel if it can reach its destination region within a certain number of port calls, called the feedering range. If it cannot reach its destination on that vessel within the feedering range, it will likely be transhipped onto another vessel. We've defined the feedering range as three international port calls for the purpose of this submission. Figure 2 shows the feedering ranges of the vessels that visited Aotearoa New Zealand in the first half of 2021.

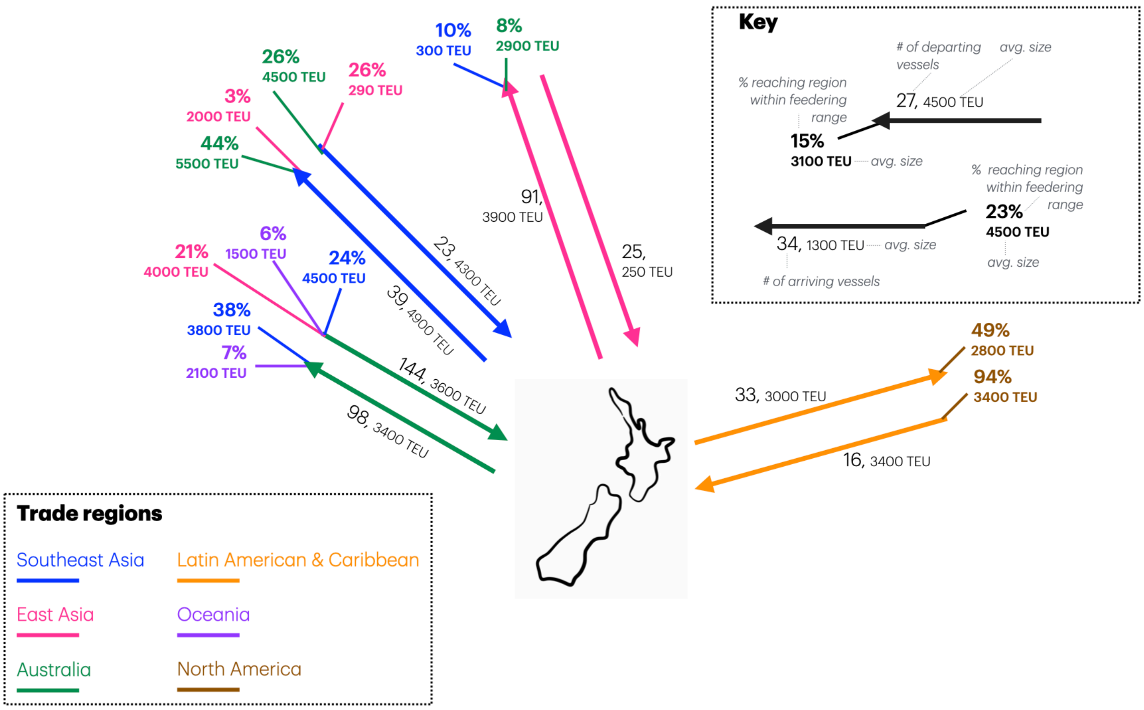


Figure 2: Onward connectivity to major trading partner regions within a feedering range of three international port calls

From Figure 2, we notice that vessels with a first/last port call in Australia often travelled to/from Southeast Asia shortly after/before reaching Australia. This makes it likely that containers that were headed to/from Southeast Asian destinations were not transhipped in Australia. Conversely, it seems likely that containers headed to East Asia on these vessels were either transhipped in Australia or travelled to Southeast Asia to be transhipped there as none of the vessels visiting Australia travelled onward to East Asia within the feedering range. Imports from East Asia did have an option to reach Australia within the feedering range. The vessels travelling to/from Southeast Asia and East Asia via Australia are around 4 000 TEU in size. This is the most common size of international container vessel visiting Aotearoa New Zealand. Notably, vessels that feeder to the rest of Oceania via Australia are smaller, owing to the smaller cargo volumes within the region.

Many vessels travelling directly to Southeast Asia play a reciprocal role to those going via Australia by offering connectivity to/from Australia within the feedering range. It is plausible that some containers to/from Australia travelled indirectly via Southeast Asia, although this would not be the most desirable routing. Less than 3% of these vessels feeder exports to East Asia, but it is interesting to note the relatively high proportion of these vessels (26% of arriving vessels) that bring imports from East Asia via Southeast Asia on small reefer vessels.

Vessels travelling directly to/from East Asia do not offer many feedering opportunities. However, it's interesting to note that the arriving vessels are predominantly small reefer vessels, as are the departing vessels that feeder to Southeast Asia.

The Latin America & Caribbean trunk is a unique connector to North America. Nearly all of the arriving vessels (imports) have feedered from North America while nearly half of the departing vessels (exports) did the same. This does not mean that no containers travel to/from North America via Australia/Asia trunk routes, but rather that the Latin America & Caribbean trunk offers the most direct connection.

To summarise, this preliminary network analysis suggests that export containers from Aotearoa New Zealand with a first international port call in...

- Australia are either destined for that market, or will travel onward to Southeast Asia to serve that market or be transhipped at a hub there.
- Southeast Asia either serve that region or are transhipped there. It is also possible that these containers are feedered on to Australia via Southeast Asia.
- East Asia are likely destined for that market or are transhipped there. A small proportion of reefer vessels seem to feeder to Southeast Asia via East Asia.
- Latin America & Caribbean are equally likely to be feedered on to North America or transhipped.

Regarding imports, the analysis suggests that containers to Aotearoa New Zealand with a last international port call in...

- Australia either originate in that market, or originated in or were transhipped in Southeast Asia.
- Southeast Asia either originated there or were transhipped there. It is also possible that these containers are feedered on from Australia via Southeast Asia. A significant proportion of these vessels seem to be reefers feedering containers from East Asia.
- East Asia likely originate there or are transhipped there.
- Latin America & Caribbean are feedered from North America, either because they originated there or were transhipped from European markets.

3 Possible future network implications

Keeping in mind how import and export containers travel to/from Aotearoa New Zealand, we explore potential implications of two of the six emission measurement mechanisms tabled in Chapter 4 of the discussion document.

3.1 Fuel use to/from next port

This measure incentivises a low emissions 'first leg' of the shipping journey. This can be achieved in a few ways: shorten the distance of the first leg; lower sailing speeds on the first leg; or use cleaner technology (alternative fuels or more efficient vessels) on the first leg. The definition of 'next port' is critical in the case of container shipping. It is unclear whether the definition of 'next port' is literal or means the first/last international port call. We explore both options below.

If 'next port' is regarded literally, it could be domestic as many international vessels that call in Aotearoa New Zealand, stop at more than one domestic port in one voyage. If this interpretation is allowed, shipping lines would be incentivised to add an unnecessary domestic port call after/before its primary call so that the containers loaded/unloaded during the primary port call are only charged for the emissions on the domestic leg. Whether this practice would be financially viable for shipping companies depends on how the cost of an additional, potentially loss-making, port call balance out against lowering the emissions costs for the Aotearoa New Zealand containers. If this evasive practice were to become common, it would nullify the benefits from including international shipping in the target and could drive up congestion at Aotearoa New Zealand's ports.

Continuing with the literal interpretation, suppose that shipping lines do not see the value of adding an additional domestic port call to offset the cargo owners' emissions, cargo owners themselves may be incentivised to restructure their supply chains. Coastal shipping may become a stronger option for long distance domestic travel so that the first/last leg of the international shipment becomes a short coastal shipping leg instead of a truck or rail trip. While this outcome would reduce domestic freight transport emissions, it would add lead time and potentially increase inventory across supply chains. It should also be considered that the current domestic coastal shipping capacity could not handle a big increase in volumes in the near future, the shortfall may be filled by international shipping lines.

A more likely interpretation of 'next port' is the first/last international port for exports/imports. In this case, lowering sailing speeds or shifting to cleaner technology for the first/last international leg would be a relatively easy operational solution to reduce the emissions on the leg. If vessels were to do this purely to avoid the charge, switching back to higher speeds or more cost-efficient technology for the remainder of the journey, the benefits of including emissions would be negated.

If the cost burden of including the emissions is sufficiently high (regardless of whether vessels are slow steaming or switching technologies), the demand/supply for container shipping may change markedly, causing a structural change in our global supply chains. Containers travelling to/from North America and Europe via Latin America & Caribbean would incur a greater emission cost than those travelling to the same markets via Australia and Southeast Asia. However, routing via Australia and Southeast Asia may result in a longer journey with more transhipments and port calls, increasing the risk of delays and, potentially, overall emissions. Global supply chains may reconfigure to favour longer routes that have a shorter first/last leg or some markets may become prohibitively expensive to serve, not because of the total emissions of the journey, but because of the length of the first leg.

In all likelihood, this measure would greatly favour shipment via Australia to direct shipment to/from Southeast Asia and East Asia, where the major transhipment hubs lie. Over time, this would see Aotearoa New Zealand become an even more remote spoke of the regional network as Australia's mediating role becomes more entrenched. Losing direct connectivity to the Southeast and East Asia hubs could increase costs and decrease the resilience of our global supply chains.

A deeper reliance on Australia as a connectivity mediator could also have biosecurity ramifications. Australia has considerably more marine and terrestrial regions and habitats that feature environmental conditions similar to Aotearoa New Zealand compared to Southeast Asia (which is primarily tropical). Geographic shifts in maritime trade could result in a net increase in biosecurity risk to Aotearoa New Zealand, both with regard to primary industry pests and environmental pests. Managing this increase in risk would place an operational and financial burden on Aotearoa New Zealand, and failure to manage it might impact its natural heritage and multi-billion dollar primary industries. Such consequences are far from guaranteed — but should be carefully considered while making decisions that may alter Aotearoa New Zealand's maritime network.

For imports and export via maritime containers, including emissions based on the first/last international port call is an especially inaccurate proxy for the emissions of the entire journey. In addition, this measure is vulnerable to evasive behaviours from shipping lines that would negate its ability to reduce total emissions and, in a worst case scenario, could incentivise a restructured maritime network that inequitably snuffs out certain trading markets while making Aotearoa New Zealand even more remote.

3.2 Fuel use to/from final port

Measuring the fuel use to/from the final port is the most accurate measure of emissions and therefore the most likely to effect the true change the policy is seeking: reducing international greenhouse gas emissions. But we acknowledge the current document's point that this is also the most difficult and costly measurement to make. Notwithstanding, we explore some of the potential maritime network implications that this measure could have.

If in place, this measure would incentivise cargo owners to ship their containers along shorter routes using more emission-efficient technology. It is this pressure that would reportedly assist Aotearoa New Zealand supply chains to keep abreast with our major trading partners (and competitors) as they transform their international maritime connections. This is a plausible reality if:

- Aotearoa New Zealand's maritime connectivity does not deteriorate, and
- the country's export/import containers have cost-effective access to emission-efficient routes.

The likelihood of these assumptions depends on how the maritime market forces shape the restructuring of global container shipping routes and how the global container fleet is transitioned to low or zero-emission vessels. We first discuss these market forces before commenting on the impact of measuring emissions through fuel use to/from the final port.

Aotearoa New Zealand is a connectivity taker in container shipping. It is worthwhile to underscore that the country has limited influence on the shipping lines that call at its ports. The COVID-19 pandemic has shown that when shipping lines are under market pressure, rationalisation of services is the primary response to remain competitive. This rationalisation favours hub ports, maritime highways, and large vessels that offer economies of scale, often cutting services to regional ports or remote regions. Aotearoa New Zealand is a remote region with low cargo demand that cannot accommodate larger vessels. Faced with the financial pressure of converting their fleet — at least in the medium term — the commercial case to sail to Aotearoa New Zealand may diminish. There is a real possibility that the global move to more emission-efficient shipping may reduce Aotearoa New Zealand's maritime connectivity, at least in the short to medium term as the transition plays out. Fewer services to the country result in fewer shipping alternatives, longer transit times for cargo, and likely longer travel distances between origins and destinations as goods are transhipped multiple times. All of these supply chain consequences would eventually increase the cost of imported goods and raise the competitive barrier for the country's exports.

Access to emission-efficient routes implies that Aotearoa New Zealand's import/export containers can get onto vessels that use alternative fuels. The global goal is to have the entire merchant marine fleet using alternative fuels in the future, in which case any routes we have access to would be emission-efficient. It is the access during the transition period — which could well be up to and beyond 2050 — that should be considered in this discussion.

To date, as the size of vessels in the global fleet keeps increasing, larger vessels are deployed on main routes while smaller & older vessels are cascaded onto regional routes with lower volumes. Continuous technology improvements make newer vessels more emission-efficient than older ones, even before the transition to alternative fuels. Therefore, through cascading, lower-volume, regional routes are also upgraded in time, albeit with a time lag. However, there is a natural limit to the size of vessels that can visit Aotearoa New Zealand based on our port infrastructure. The Port of Tauranga is the only port routinely receiving vessels larger than 6 000 TEU (Deloitte, 2021), but even they are limited in how frequently they can receive the larger vessels due to operational constraints. The majority of vessels that visit the country's ports are between 4 000 and 6 000 TEU (Deloitte, 2021). According to United States Department of Agriculture (2024) only 30% of the world container fleet fall within the 3 000 – 5 300 TEU size class, representing 40% of the global TEU capacity. Meanwhile, 28% of the global fleet is larger than 5 300 TEU, comprising 57% of the global TEU capacity. With a continuing trend towards larger vessels, the opportunity for technology upgrades through cascading on the routes that visit Aotearoa New Zealand will diminish or disappear unless port capacity is significantly increased.

The transition to alternative fuels adds additional complexity to the evolution of the global container vessel fleet. Not only is there uncertainty about the type of fuel that the market will commit to, but also about the vessel classes that will be replaced first. If ship owners choose to first replace larger vessels, it will be a very long time before alternative-fuel vessel routinely call in Aotearoa New Zealand.

A future state where maritime connectivity to Aotearoa New Zealand becomes more strained and the fleet on the maritime highways transitions faster than the fleet calling at the country's ports is plausible. In such a case, the measurement of emissions through fuel use to/from final port could incentivise the establishment of so-called "green corridors" to the closest, "greenest", transhipment hubs. A green corridor implies that new, relatively small, alternative fuel vessels carry containers between Aotearoa New Zealand and a transhipment hub, for example Singapore in Southeast Asia, where containers can be transhipped to larger alternative-fuel vessels. Unlike the vessels that currently call in the country, vessels on a green corridor would be dedicated to a small set of ports to provide a frequent green feedering option. Whether a business case could be made for such a service depends on the choice of transhipment partner, the cost implication of incorporating international shipping emissions into the supply chain, and global maritime trends beyond Aotearoa New Zealand's control.

Australia may not be able to offer the best transhipment options when compared to Southeast Asia or East Asia, but the shorter distance strengthens the business case for the green corridor. If this corridor were established and many cargo owners shift to it, Australia once again becomes a stronger mediator, and Aotearoa New Zealand becomes more remote in the maritime network with implications for the cost and resilience of its global supply chain. This shift may also increase biosecurity risk, as discussed before.

A flourishing green corridor to Southeast Asia or East Asia would be preferable from a maritime connectivity perspective, but this may not be viable due to the longer distance and strong competition. However, the current network suggests a niche market for direct connectivity to East Asia with reefers, so this may present an opportunity. The concern with an East Asia corridor — particularly to ports in temperate China and Japan — would be a potential increase in biosecurity risk as these areas also have cold temperate environments like Aotearoa New Zealand.

The business case for green shipping corridors is still uncertain. Amidst regional and global competitors, it is unlikely that companies from Aotearoa New Zealand would provide the green corridor services, unless the business case is uniquely compelling through, or example, government subsidies. While including the emissions based on fuel use to/from the final port could incentivise these green corridors, it is debatable how strong that incentive would be for shipping lines and cargo owners.

In summary, including emissions based on the fuel use to/from the final port is a far better proxy for international shipping emissions that has the potential to incentivise meaningful change. Given Aotearoa New Zealand's maritime remoteness and vessel constraints, green corridors are a likely pathway to change. However, a green corridor to Australia could leave Aotearoa New Zealand more remote in a maritime sense and might increase biosecurity risk. Although the business case is more precarious, a green corridor to Southeast or East Asia would be advantageous for maritime connectivity, but there remains a biosecurity risk if the corridor entrenches direct connectivity with temperate regions in East Asia.

4 Further analysis

The analysis in this submission is based on data purchased, processed, and analysed for an ongoing research project at the Waikato Management School. Given more time, current data (2023–2024) can be obtained through the authors' subscription to the Starboard Maritime Intelligence platform and more detailed analyses could be conducted. Particular refinements could include:

Port-level analysis: The analysis in this submission is on an aggregate region-to-region level to suit the long timeframes required to transition the maritime fleet. Nonetheless, the current dataset and datasets obtained from Starboard Maritime Intelligence are on the port-level, making more detailed analyses possible.

Transhipment opportunities: The current dataset contains only the vessel movements of container vessels that have visited Aotearoa New Zealand at some point between January 2018 – June 2021. The vessel size constraints at the country's ports naturally filter out a large proportion of the fleet operating in Oceania and the Pacific. To better understand transhipment opportunities, a dataset of all vessel movements in the region can be obtained from Starboard Maritime Intelligence.

Feedering range exploration: The feedering range of three international port calls was chosen based on the authors' intuition of the container shipping market. This range could be explored and refined by: engagement with shipping lines or freight forwarders, experimentation with the datasets, or merging with additional datasets regarding cargo or trade movements[3]

2023–2024 analysis: Through the Starboard Maritime Intelligence platform, any analyses can be repeated for the 2023-2024 period.

Environmental similarity: The biosecurity conclusions in this submission are based on broad climatic patterns and the authors' familiarity with geographic sources of past shipping-mediated pest incursions to Aotearoa New Zealand. A more detailed examination of the country's exposure to vessels and cargo from environmentally similar climatic regions as a consequence of shifts in maritime trade can be undertaken using existing approaches and data such as presented in Lenzen et al. (2023) and Tzeng et al. (2024).

Given this preliminary analysis of potential maritime connectivity impacts for import/export containers, **we strongly urge the Commission to reconsider the measurement alternatives tabled and how these would be applied to container shipping. More in-depth network analysis and insights from engagement with the shipping lines, freight forwarders, cargo owners and the ports should be included in the decision-making.**

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[3] The source of such datasets is unclear at this stage.

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