

New Zealand Hydrographic Risk Assessment 2024

Report and Findings

Objective ID: [A6048633](#)

New Zealand Hydrographic Authority



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Introduction

This report details the methodology of the hydrographic risk assessment carried out by LINZ in 2024. The report reviews the risk results obtained and assesses them by region, recommending areas in need of hydrographic survey.

Why are we doing this

In accordance with SOLAS, Ch V, Reg 9, LINZ as NZHA is responsible for the NZ civil safety of Navigation survey Programme called "[HYPLAN](#)". This has been delivered over the past seven years (2017-2024). The basis for this survey programme was a risk assessment completed in 2016. Many of the survey areas in HYPLAN have since been completed and it is prudent to review hydrographic risk to see what risk remains.

2016 Risk Assessment

The 2016 hydrographic risk assessment was carried out by Marico Marine Limited (Marico). The risk assessment methodology used a data-based approach to identify risk by spatially analysing 39 different risk criteria along with 12 months of Automated Identification System (AIS) vessel traffic information. The assessment area, limited to NZ's Exclusive Economic Zone (EEZ) (excluding the Sub-Antarctic Islands), was divided into grid cells of varying resolution (i.e. 500m, 1000m, 3000m). AIS data tracks were used to calculate density of the various vessel classifications which then were used to calculate overall traffic risk scores for each grid cell.

An output of the 2016 assessment was a "risk score" based on the various inputs and their respective weightings and classifications. The 39 risk criteria and their weightings can be found in Appendix A.

A raster heat-map of risk was produced using Jencks natural breaks classification to classify the risk score into six classifications ranging from "Insignificant" to "Heightened". A national scale plot of the 2016 risk score can be seen in Figure 1 below.

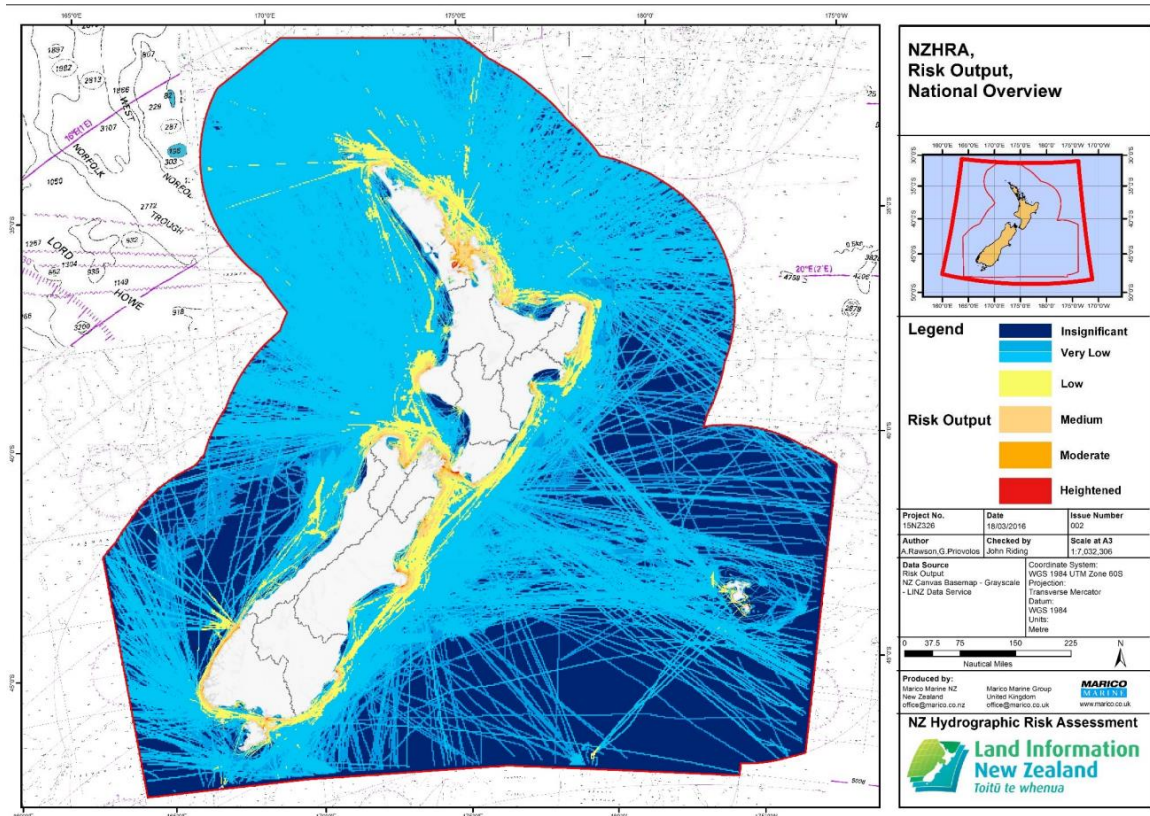


Figure 1 - National overview of risk output from 2016 risk assessment

2024 Risk Assessment

The purpose of the 2024 risk assessment process was to guide decision-making on a future programme of hydrographic surveys. The key thinking behind repeating the risk assessment was to determine if there had been any change to hydrographic risk in the areas of interest. In contrast to the 2016 process, the 2024 risk assessment used cloud-based Postgres databases, in the hope that this would speed up the calculations and allow for different outputs to be generated.

Methodology

Risk logic

The risk assessment logic is identical to that of the 2016 risk assessment, based on the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) process and the most likely/worst credible risk methodology. Event trees for different scenarios of likelihood and consequence were developed and reviewed with marine expertise to derive weightings and risk scores for the different variables and vessel traffic types. More information can be found in the 2016 Risk Assessment report (see references section).

Re-running the 2016 Risk Assessment

To compare the results of the 2016 and 2024 risk assessments there had to be certainty that the risk models worked in the same way.

The 2016 risk assessment was run by Marico with the resultant GIS deliverables rendered to LINZ. The rendered dataset was purely the inputs and outputs of the project with a report outlining the process. None of the working projects were rendered to LINZ, which would have provided little value as the GIS software would need all inputs to be correctly configured to repeat the process. This is the nature of the risk calculation/model.

Previous work had been done by the LINZ Data Services team to replicate the 2016 process and then to run a risk assessment for Samoa (part of the NZHA's area of responsibility). The work included obtaining the exact formulae to repeat the risk calculation. The formulae for calculating the various weightings and deriving a final risk score can be found in Appendix B. A GitHub repository (<https://github.com/linz/hydro-risk-models>) has been set up with these formulae applied in SQL programming language, as well as the various traffic weightings and classifications used in the traffic component of the model. It is envisaged that future risk assessments can be re-run easily using the information in this repository, with only minor re-mapping of some fields for the SQL scripts to complete the calculation. It should be noted that access to the repository is controlled by LINZ; it is not a publicly facing repository.

With all formulae and weightings identified, all inputs and traffic scores from the 2016 risk assessment were imported into an Amazon cloud-based Postgres database. On its first re-run, a different result was obtained to the 2016 risk assessment. After some troubleshooting, it was identified that the social amenity/recreational layer was not applied to the 2016 risk assessment result. While not ideal, the small weighting and relatively small spatial impact of these data meant that this had little effect on the final risk score in the 2016 assessment result. To successfully repeat the result, the social amenity layer was removed from the model calculation in this one instance, to ensure the new model worked. After the layer was removed, the newly calculated final risk scores agreed with the 2016 result and the layer was added for future calculations.

Running the risk model

All weightings and risk scoring of each variable were the same as the previous risk assessment.

To follow the working of the previous risk assessment, an identical cell grid pattern was used to run the risk model (Figure 2). This enabled unchanged variables to be copied across from the previous risk assessment but also allowed for uniform geometry when working with the data table in Postgres.

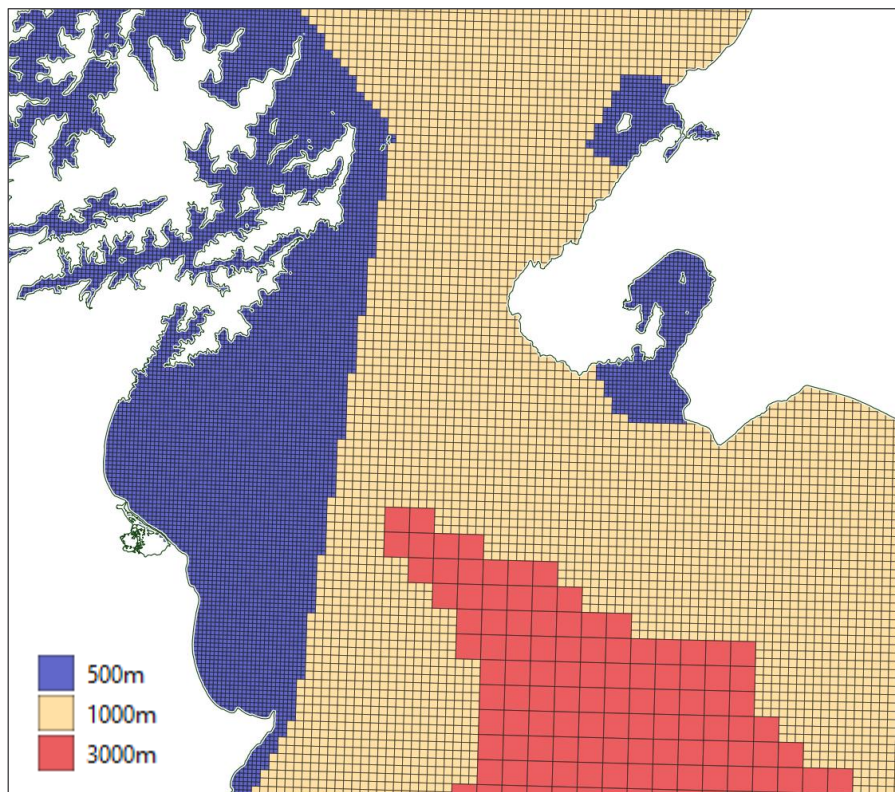


Figure 2 - Grid layout in Cook Strait area

For the 2024 iteration of the risk assessment, a Postgres database was set up on an AWS hosted database service. FME was utilised to interrogate the database and run the calculations within the database using SQL language. This was done primarily for speed and allowed for inputs to be varied and the model to be re-run easily. It is hoped that the cloud hosted database can be used for future revisions of the risk assessment.

All outputs were exported to shapefile format and viewed in QGIS. QGIS was utilised in the viewing and interrogating of data as it works better for this purpose.

Updating the risk assessment inputs

Of the 39 original input variables, only 4 were updated from the original risk assessment. The obvious ones to update were CATZOC and Survey Age, as they were influenced by the survey programme of the previous 6 years. The updated variables are listed below:

- Chart Quality
- Survey Age
- Marine Reserves
- Coastal Resources

The sections below explain how the updates to each layer were done.

All dataset layers were prepared in QGIS with the final spatial join to the model base grid being done in ArcGIS Pro. A spatial join was required to translate each layers data and fields to the model grid based on location. ArcGIS Pro was used to perform the spatial joins as it has more logic operators than QGIS and the “largest contributor” option was found to produce the best result that met the underlying data.

Chart Quality/Survey Age

Chart Quality and Survey Age were initially output from the Caris HPD Source database. The database utilises a number of scale bands, so some merging and deconfliction was required so that the best Chart Quality indicator was reflected in any one area. Chart Quality is categorized into 6 different classifications based on the Category of Zone of Confidence (CATZOC) which describe the reliability and accuracy of the underlying bathymetry in an area. These are based on the IHO S-57 specification. The deconfliction was done in the following order: A1, A2, B, C, D then U.

The final deconflicted polygons were then clipped by the HYPLAN/Bathy Database coverage areas which includes the extents of recent surveys as well as the planned extents of upcoming surveys. Using the HYPLAN/bathy database coverages allowed for the possibility that not all recent survey information is in HPD source database. The rationale behind this being that the data would eventually be on the database and that risk had already been mitigated in those areas by surveying or would be mitigated by surveys in the future. Once clipped, the HYPLAN/Bathy Database coverage polygons were added to the HPD Source database polygons to create a final picture of CATZOC.

Deconflicting the polygons and showing the “best” CATZOC in any one area is a slight departure from the way the original CATZOC input layer was constructed. The original CATZOC or Chart Quality layer contained a maximum and minimum CATZOC and Survey Age. To populate the risk model the “best” one was chosen. It is suspected that the worst-case scenario or minimum CATZOC was left in there to apply to the chart benefit assessment. This was a separate calculation in the original risk assessment and was not included in the 2024 risk assessment.

Finally, the survey age was classified based on the weightings and classifications in Appendix A to a score between 0 and 5. It is important to note that 2024 was used as the reference year for this determination. Changing the reference year from 2016 to 2024 may increase the risk in some areas if comparing this variable in the 2016 model.

Marine Reserves

The 2016 input marine reserves layer was analysed against the current published [DOC marine reserve layer](#)¹ available online. This identified 8 additional marine reserves had been added to the area of interest since 2016. These were added to the layer from the previous risk assessment.

In conjunction with the published marine reserves layer, the [DOC Sanctuaries to Protect Marine Mammals layer](#)² was added to the revised marine reserve input layer. This was something done in the first risk assessment and was repeated with the updated DOC Sanctuaries layer. The extents of the Sanctuaries have grown since the last risk assessment with areas added between Taranaki/Cook Strait and along the eastern coast of the South Island.

Coastal Resources

The coastal resources input layer from the 2016 risk assessment was added to the DOC-managed [Mātaitai](#)³ and [Taiāpure](#)⁴ layers available on the DOC Marine Data Portal.

The two new input layers were added to the original input by dissolving the polygons.

For each of the coastal resource/marine reserve layers, a buffer had to be created to determine the risk input score of 0 to 5. All buffering was done in QGIS using the same logic and distances from the marine reserve polygon as the original risk assessment. These distances and their associated risk scores can be found in Appendix A.

Domestic Traffic

As was done with the original risk assessment, a planned/domestic traffic file was used to supplement AIS traffic. This involved including some planned vessel routes encoded with indicative frequency/vessel type that added to the real AIS traffic. The thought process

¹ https://doc-deptconservation.opendata.arcgis.com/datasets/0e74f9682502447c9a14d51340512361_0/explore

² <https://doc-deptconservation.opendata.arcgis.com/datasets/abf12dd2f4cd43b3a7fdcf5a0a2ad2c9/explore?location=-39.579241%2C-2.068000%2C5.00>

³ https://doc-marine-data-deptconservation.hub.arcgis.com/datasets/6ad1543b243b43539b707618450e8fe6_0/explore?location=-40.983599%2C-7.279697%2C7.27

⁴ https://doc-marine-data-deptconservation.hub.arcgis.com/datasets/7d23e9063a2f44988d94902a26cbe207_0/explore?location=-40.409421%2C-6.312437%2C7.49

behind this was that some small operators didn't have AIS systems so would not be captured in the risk assessment result. On assessing this layer topology against the original risk assessment result, it is obvious that this layer has a significant impact on the risk result.

The 2024 risk assessment was first run with the original 2016 domestic traffic layer data. More traffic was then added into the domestic traffic based on discussions with Maritime New Zealand. These discussions highlighted future routes planned for New Plymouth to Nelson for a roll on/roll off vessel as well as potential for freight traffic to the West Coast ports of the South Island (Greymouth/Westport). The exact path of the routes were plotted using the shipping lane guidance provided in annual notice 10 of the NZ nautical almanac, i.e. the route was plotted 3 nautical miles off the coast between the two destinations.

Inherent Risk

Inherent risk is the risk model result without traffic added, the logic being that the risk still exists even if a vessel isn't transiting through that area. The concept of Inherent Risk was originally developed for the [Sub-Antarctic Islands Risk Assessment](#)⁵ to take into account the sparsity of vessel traffic and the unique and diverse ecological landscape of the islands. It represents the product of Causation and Consequence factors relevant to a ship grounding.

To calculate inherent risk, all traffic inputs were set to 1 and the risk scores were calculated solely on the 39 input variables and associated weightings.

The risk output was displayed using a different colour scheme to that of the other risk models. This is due to different inputs being used which influenced the range of the risk score away from a range you would expect from the normal risk assessment with traffic. A new Jencks Break natural classification colour scheme was generated to allow inherent risk to be displayed so that the relative risk from one location to the next could be more easily interpreted.

Data Gathering

In conjunction to the updated layers in the previous section there was some additional information used in the 2024 risk assessment. These datasets are mentioned in the following sections.

Stakeholder engagement

⁵ <https://www.lin.govt.nz/resources/research/new-zealand-hydrographic-risk-assessments-sub-antarctic-islands>

A large number of stakeholders were contacted seeking feedback via email with a similar form to that used in the original risk assessment's data gathering exercise. An example of the form can be found in Appendix C. The stakeholders were similar to the 2016 risk assessment, with some updates made to the list based on changes in email addresses and roles.

Minimal feedback was received from stakeholders, with only one harbourmaster providing feedback and another promising feedback. While it is unfortunate that information such as vessel movements was missing after this exercise, it is unlikely that the additional information requested such as spatial plans and oil spill response plans have changed significantly since the original risk assessment.

In conjunction to the stakeholders across the country, Maritime New Zealand (MNZ) were also consulted. MNZ were able to provide a list of international vessels that had visited ports in the 2018/2019 year which was very useful in verifying the AIS data (discussed later). As mentioned above, MNZ were also able to advise on potential future traffic patterns which was used to update the planned/domestic traffic layer.

AIS Data

A large component of the risk assessment model is the use of real vessel traffic data which was sourced from Kordia New Zealand. To get a representative picture of traffic, it was decided to obtain AIS data for the period 1st July 2018 to 31st June 2019. Although not the current state of traffic; 2018 and 2019 were clear of any impact of COVID-19 which will have impacted vessel traffic for the following few years due to disruptions to cruise traffic and international travel in general.

AIS Traffic Processing

The AIS data provided by Kordia was in its raw format, as a selection of points spread across many files logged per day and month. The data were supplied in two formats: IEC AIVDM strings and ITU CSV strings. The ITU CSV strings were used as these were already in a geospatial format and did not require decoding.

All AIS data were imported into amalgamated CSV files for each month using FME software. The different ITU messages were kept separate as the ITU18 messages were for Class B AIS traffic and ITU24 messages were for Class A AIS traffic. FME software was useful as the ITU messages could be reformatted for the next stage of the process.

Once all AIS data were loaded into amalgamated CSV files by month, all data were imported into an ArcGIS geodatabase using the [NOAA Marine Cadastre Track Builder](https://coast.noaa.gov/digitalcoast/tools/track-builder.html)⁶ tool ArcGIS Pro plugin. This was done to enable the conversion of the point data into string data using a different part of the Marine Cadastre tools. Once loaded into

⁶ <https://coast.noaa.gov/digitalcoast/tools/track-builder.html>

geodatabases, the track builder tool was run to generate AIS track lines from the points. Figure 3 shows the settings in the AIS track builder tool. The tool joins points within a certain time range and distance; the different options can be found in the screenshot below. The default time setting of 30 minutes was used, however the default distance value was altered from 1 mile to 10 mile to allow for data points farther from the coast to be joined by the tool.

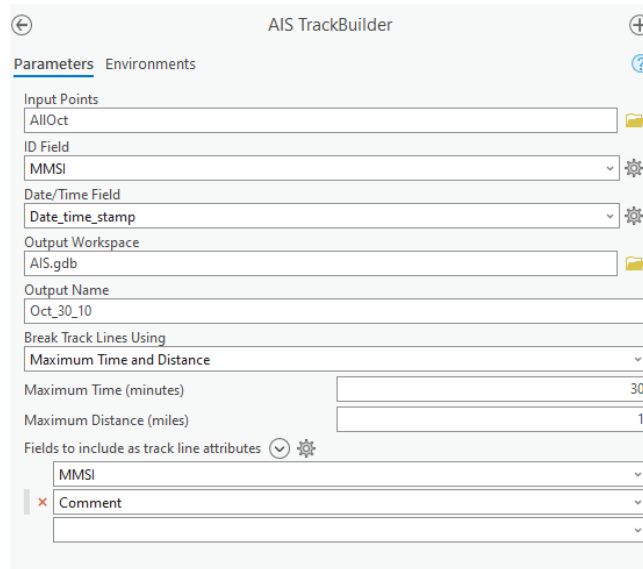


Figure 3 - NOAA AIS Track Builder settings

Once the tool was run on each month and Class of data, the track line data was checked. It was found that minimal cleaning was required on the Class A data, given the high update rate of Class A AIS systems. Class B data required significant cleaning, particularly around headlands and areas of complex islands/landforms i.e., narrow harbours and sounds/fjords. Cleaning of the data involved manually moving the vertices and adding vertices where a vessel would likely go around a headland.

In conjunction to the manual cleaning, the Class B data was also passed through an automatic cleaning process where lines were intersected with a buffer of the coastline. A Python script was developed to identify segments that intersected the buffered coastline and to delete the segments. The reason it was run after the manual cleaning process was so that actual tracks around headlands/islands would be preserved and added to the model rather than deleted by the automatic tool. The automatic tool was useful in removing segments where the AIS system had not updated for long periods of time or where the first and last update points had been mistakenly joined by the AIS track builder tool.

AIS Traffic Classification

In order for the AIS traffic to be used in the model, each AIS track had to be associated with a classification of vessel type. Vessel type is required by the model to assign the right level of risk: tankers/cruise vessels have a higher associated risk than that of a recreational vessel. The original model had 24 different classifications of vessels.

Unfortunately, the ITU strings in the Class A and Class B messages did not contain any information about the type of vessel. Only the MMSI number of each vessel was recorded with the location data so other information had to be used to assign details about each vessel track. Vessels were attributed using a combination of the ITU5 AIS attribute string and an MNZ provided list of vessel arrivals to NZ ports for the period of study. Greater trust was placed on the MNZ list given it came from a reputable source rather than an AIS system that may have been set up incorrectly on a particular vessel. Several hundred vessels were without attribution at the end of this process requiring a manual process to harvest the information from the internet, in particular, [MarineTraffic](#)⁷.

Following attribution, all AIS tracks were broken into segments for each cell in the model. Once broken up, they could be summed for each vessel type for input into the model.

All traffic calculations and weightings are available on the LINZ GitHub repository in SQL language.

AIS Traffic Checks

All processed AIS traffic was checked against the [Global Maritime Traffic Density Service](#)⁸ (GMTDS) provided by the National Geospatial-Intelligence Agency (NGA) online. This product presents global maritime traffic densities, aggregated by month, for billions of satellite and terrestrial-based AIS data from 2011 to present. To compare data, all traffic had to be rasterised into the risk output grid by totalling all the traffic segments in each cell. The other difficulty is that the GMTDS service has a slightly different grid layout and measure of density to that of the risk assessment, so only a visual check could be done. This was a useful check, however, and led to the discovery that at one point in the process only the Class B traffic had been included. The GMTDS check revealed that the Class A traffic was on another ITU string and required further importing.

Results

As mentioned above, two traffic-based model products were generated, one with actual AIS traffic and the other with the added planned/domestic traffic. All analysis was done on the result with both the AIS and planned traffic. This aligns with the 2016 risk

⁷ <https://www.marinetraffic.com/>

⁸ www.globalmaritimetraffic.org

assessment method. In conjunction to the traffic-based models an “inherent risk” result was also generated.

The outputs of risk with traffic and without (i.e. the inherent risk) were viewed separately. These results were used to supplement the risk result and provide a different lens of risk. The AIS traffic shows the impact of actual traffic on the result while the inherent risk picture shows what risk would look like if a new vessel passed through an area.

In line with the 2016 risk assessment, the risk model was viewed at a regional level along with the AIS traffic data to identify trends. In conjunction to the model and traffic information, existing charted high certainty (CATZOC A1/A2) areas were viewed along with the risk to understand exactly how hydrographic survey could mitigate risk in a particular area.

Discussion

For consistency with the previous risk assessment, only one of the risk outputs is used for discussing the risk picture. This is the risk output that includes the 2018/2019 traffic as well as the domestic traffic. The other outputs generated by the 2024 risk assessment are used to explore other avenues in the risk picture.

The risk picture has not changed in a significant way between the two risk assessments. Subtle differences can be found in a few areas but looking at the national picture the differences are not immediately obvious.

The risk assessment results demonstrate that surveying an area of high traffic volume to modern standards does not always result in a reduction of risk. This shows the high impact of traffic density on the risk model’s output. This can be seen in some areas of Fiordland or Banks Peninsula where recent survey work improved the CATZOC rating to A1, however the risk rating remains heightened due to the type and volume of traffic i.e. cruise ships navigating in these areas. These areas are removed from further discussion, as further hydrographic surveying will not reduce the level of risk. As an example, Figure 4 shows the risk plot around Queen Charlotte Sound/Tōtaranui, an area surveyed to CATZOC A1, but remaining as a heightened area of risk.

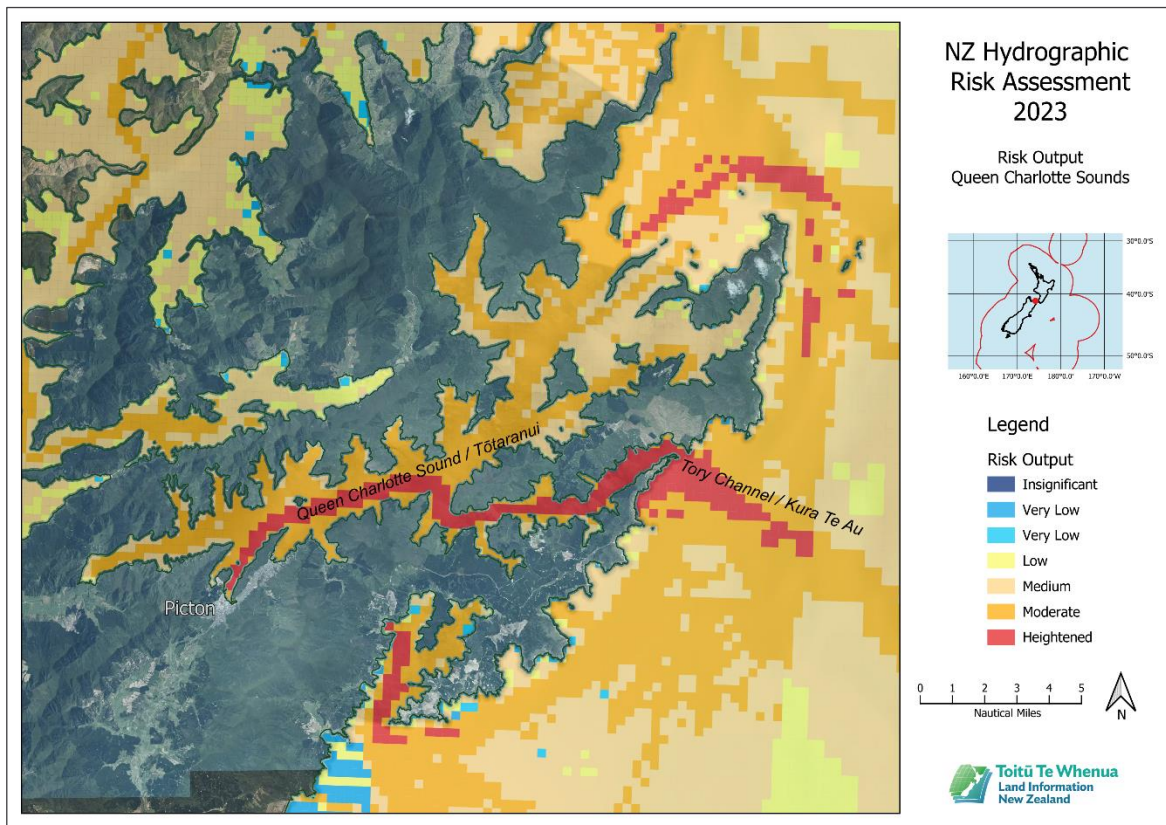


Figure 4 - 2024 Risk Output in vicinity of Queen Charlotte Sound and Tory Channel

Unlike the previous risk assessment report where all regions were discussed around the country regardless of any substantial risk, this report will focus on areas with “heightened” and “moderate” risk. The table below shows the areas identified and the sections below will review the risk in each region.

Region	Number	Reason	Classification
Approaches to Tauranga/Whakatāne	1	Major port, MPAs	Heightened
Approaches to Otago Harbour	2	Major port, new marine reserves nearby	Heightened
Approaches to Whanganui	3	Port upgrade	Moderate
Abel Tasman	4	Tourist traffic, anchorages	Heightened
Approaches to Wellington	5	Major port, critical infrastructure	Heightened
Approaches to Westport	6	Future development of port	Heightened (future state), Moderate (current state)
Approaches to Greymouth	7	Future development of port	Heightened (future state), Moderate (current state)
Marlborough Sounds	8		Moderate
Stewart Island / Rakiura	9	Anchorage/marine farms	Moderate (Heightened if intended traffic is accurate – check Real Journeys)
Kawhia	10	Port	Moderate
Snares	11	Isolated, cruise visitors	Heightened – from Sub Antarctic Assessment https://www.linz.govt.nz/sites/default/files/sub-antarctic_islands_report.pdf

Campbell	12	Isolated, research visitors	Heightened – from Sub Antarctic Assessment https://www.linz.govt.nz/sites/default/files/sub-antarctic_islands_report.pdf
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Table 1 – Areas of heightened or moderate risk

Approaches to Tauranga

The risk to safe navigation in the approaches to Tauranga is attributed to the high volume of traffic combined with the underlying age of survey data. The risk profile is similar to the 2016 risk assessment with subtle differences likely due to the variability in ship traffic during the two periods or subtle changes to the survey age since the last risk assessment as more time has passed. A pocket of heightened risk can be seen close to the port entrance with moderate risk extending seaward into and beyond the charted anchorages located 3 nautical miles offshore to the north and south of the harbour entrance.

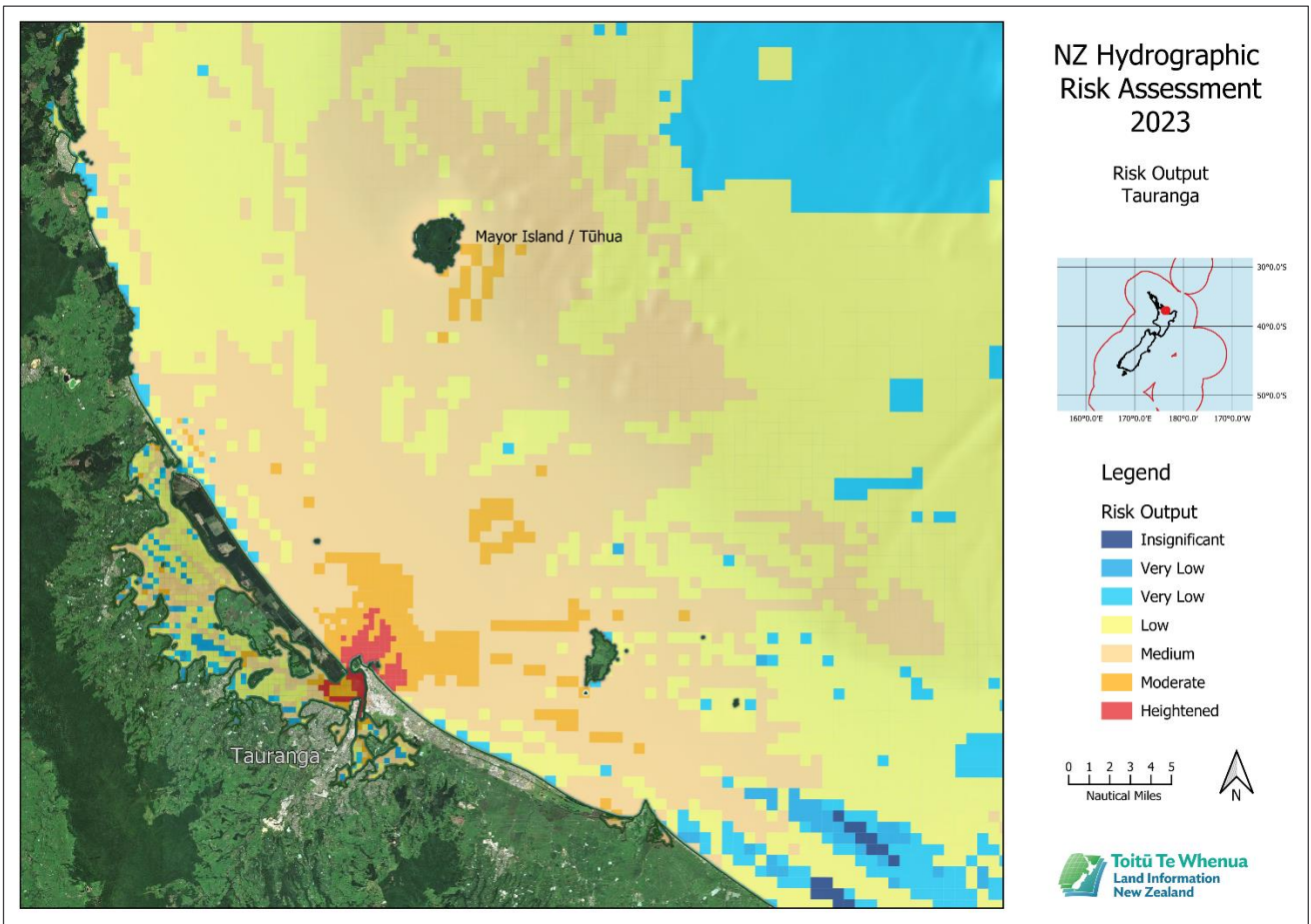


Figure 5 - 2024 Risk Output in vicinity of Tauranga

Tauranga is a major port which is reflected in the traffic data. A number of commercial vessels can be seen transiting into and out of the port. The shipping routes are similar to the data used in 2016, with north bound traffic heading either east or west of Mayor Island / Tūhua and east bound traffic mostly passing north of Astrolabe Reef and north of Whakaari/White Island heading towards East Cape.

The volume of traffic has increased slightly between the two risk assessments if you analyse the data visually. Much of this increase in traffic is related to inshore recreational vessels and smaller vessels with only a marginal increase in “Class A” AIS vessels.

One noticeable difference in the 2018/2019 traffic data is the use of anchorages increasingly farther away from the port entrance, particularly to the north. This is mainly bulk carrier and container ships. In conjunction to the observed patterns in the vessel traffic, there is also a lot of anecdotal evidence to suggest that since 2018/2019, the use of anchorages farther from the port entrance has dramatically increased. This knowledge has come from correspondence with the port in 2022. The increased anchorage use is an indicator of an increase in traffic to the port.

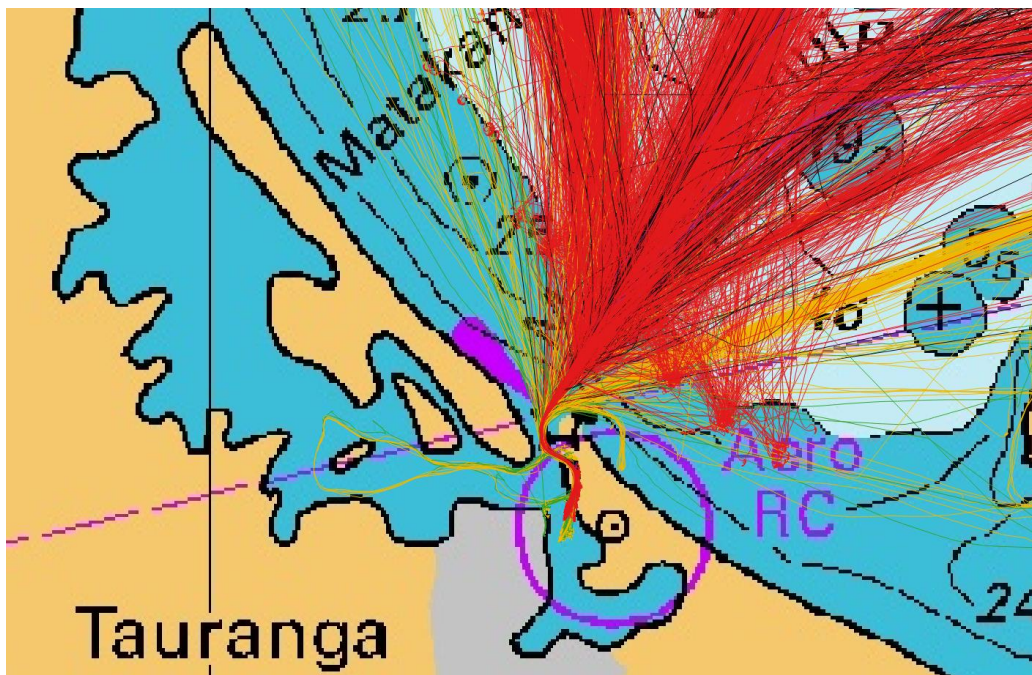


Figure 6 - 2014/2015 AIS traffic used in the 2016 Risk Assessment in vicinity of Tauranga

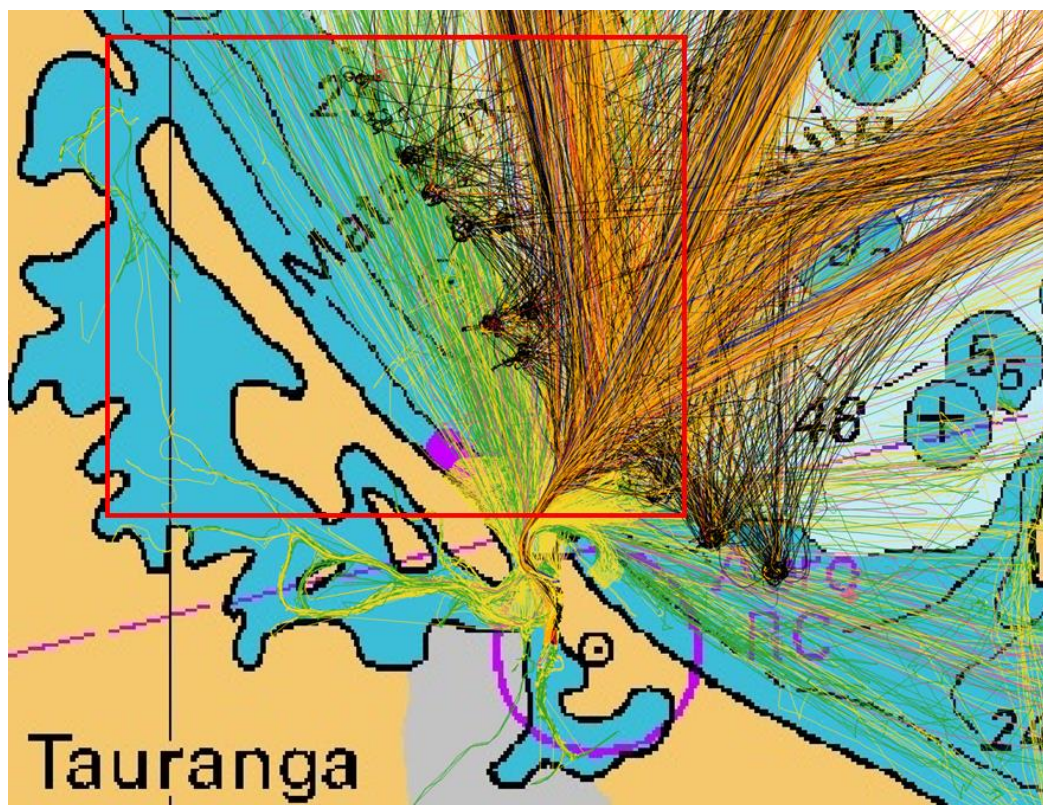


Figure 7 - 2018/2019 AIS traffic used in the 2024 Risk Assessment in vicinity of Tauranga, the red box shows the clustering of bulk carrier/container ships in new locations characteristic of anchoring activity

Cruise traffic is prominent in the data and these were noted in the 2016 risk assessment. There is a clear increase in cruise vessel traffic between the two risk assessments. Cruise vessels can also be seen anchoring off Whakaari/White Island although this ceased in December 2019 following the eruption of Whakaari/White Island. In general, traffic has decreased in the vicinity of Whakaari/White Island in the 2018/2019 data as a result of the eruption.

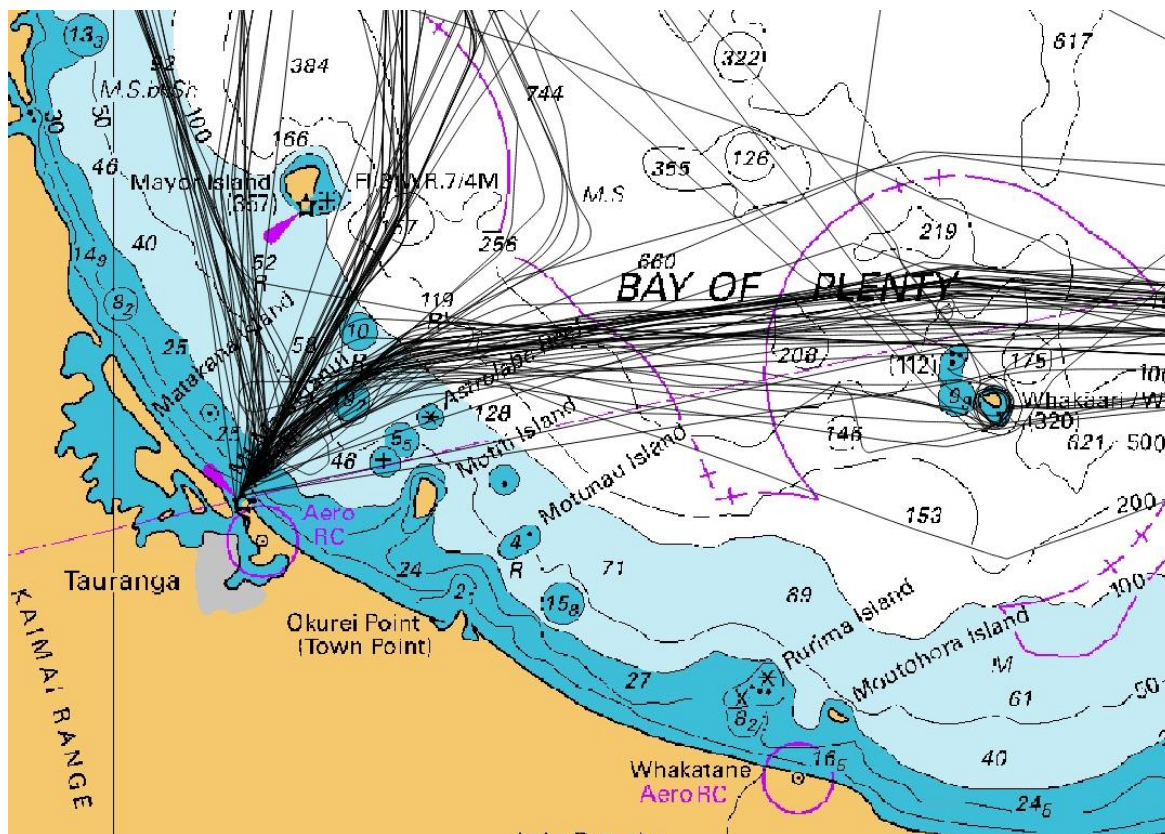


Figure 8 - 2014/2015 Cruise ship traffic from the 2016 Risk Assessment in vicinity of Tauranga

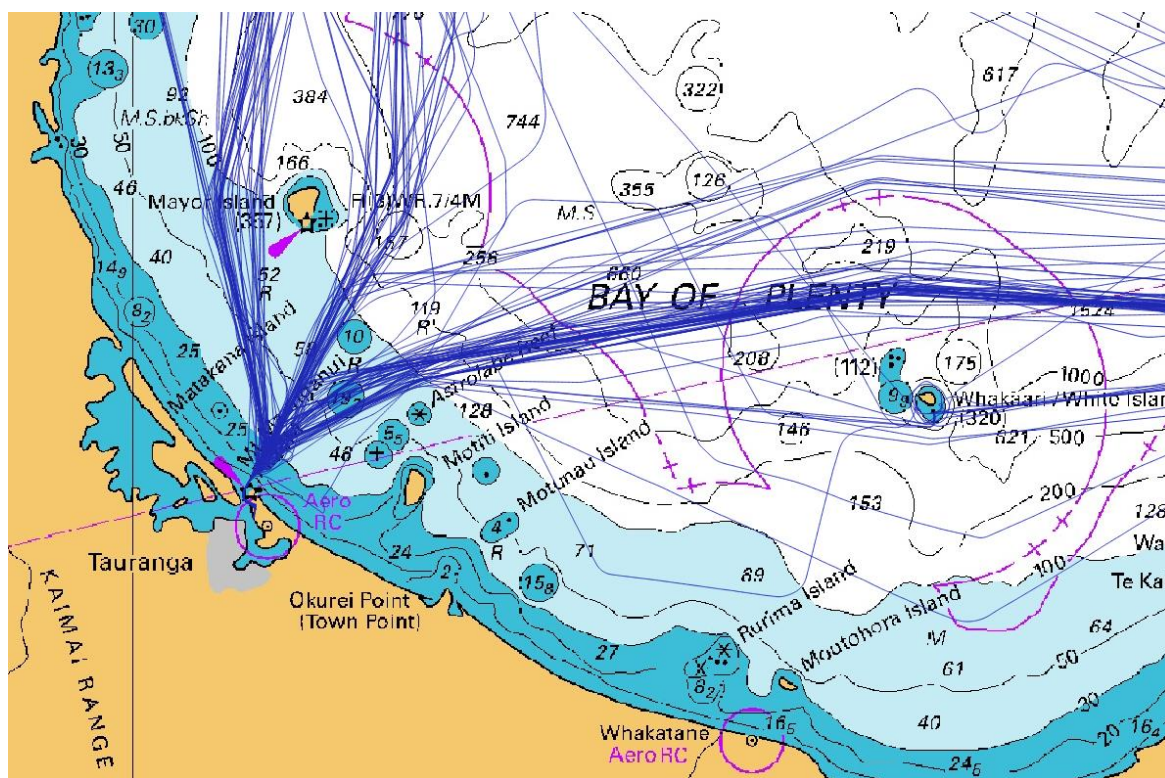


Figure 9 - 2018/2019 Cruise ship traffic from the 2024 Risk Assessment in vicinity of Tauranga

Whakatāne

The main contributing factors to the risk output in Whakatāne are the volume of small, local traffic in combination with the age/quality of the underlying survey data in the area. Some of the smaller variables such as access to tourism and recreational amenities have a relatively small influence on the result. As can be seen from the results, there is limited heightened risk with several cells in the marina itself. This can be attributed to there being more risk variables and higher weightings in close to the harbour.

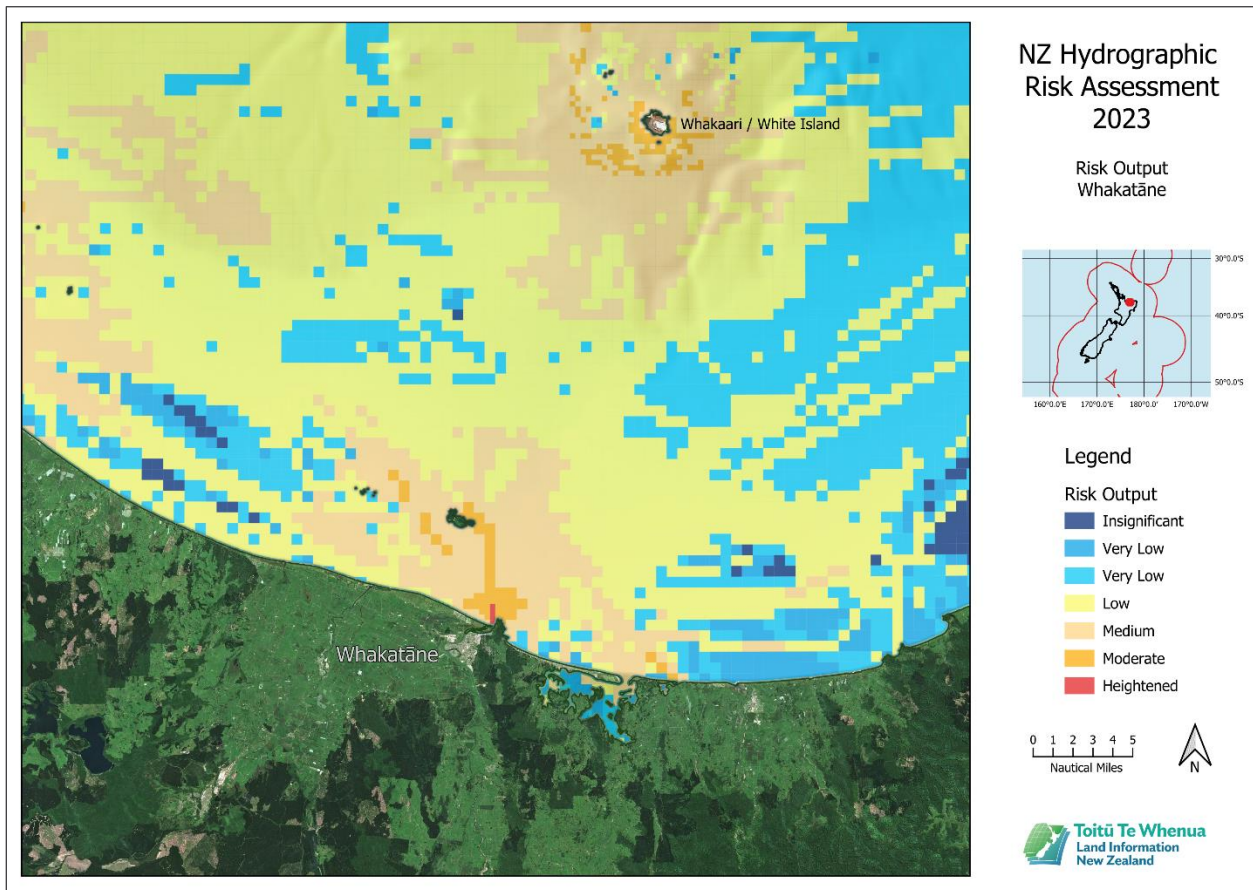


Figure 10 - 2024 Risk Output in vicinity of Whakatāne

Whakatāne is a busy marina/smaller port with the following vessels being the main users:

- Recreational
- Fishing
- High speed passenger

As noted above, much of the high-speed passenger traffic has reduced after the Whakaari/White Island eruption in December 2019.

Approaches to Otago

The entrance to Otago Harbour is situated between Heyward Point and Taiaroa Head.

The risk result for Otago Harbour and its approaches can be seen in Figure 11. The harbour itself shows a heightened risk but the risk extends beyond the harbour into the approaches and anchorages.

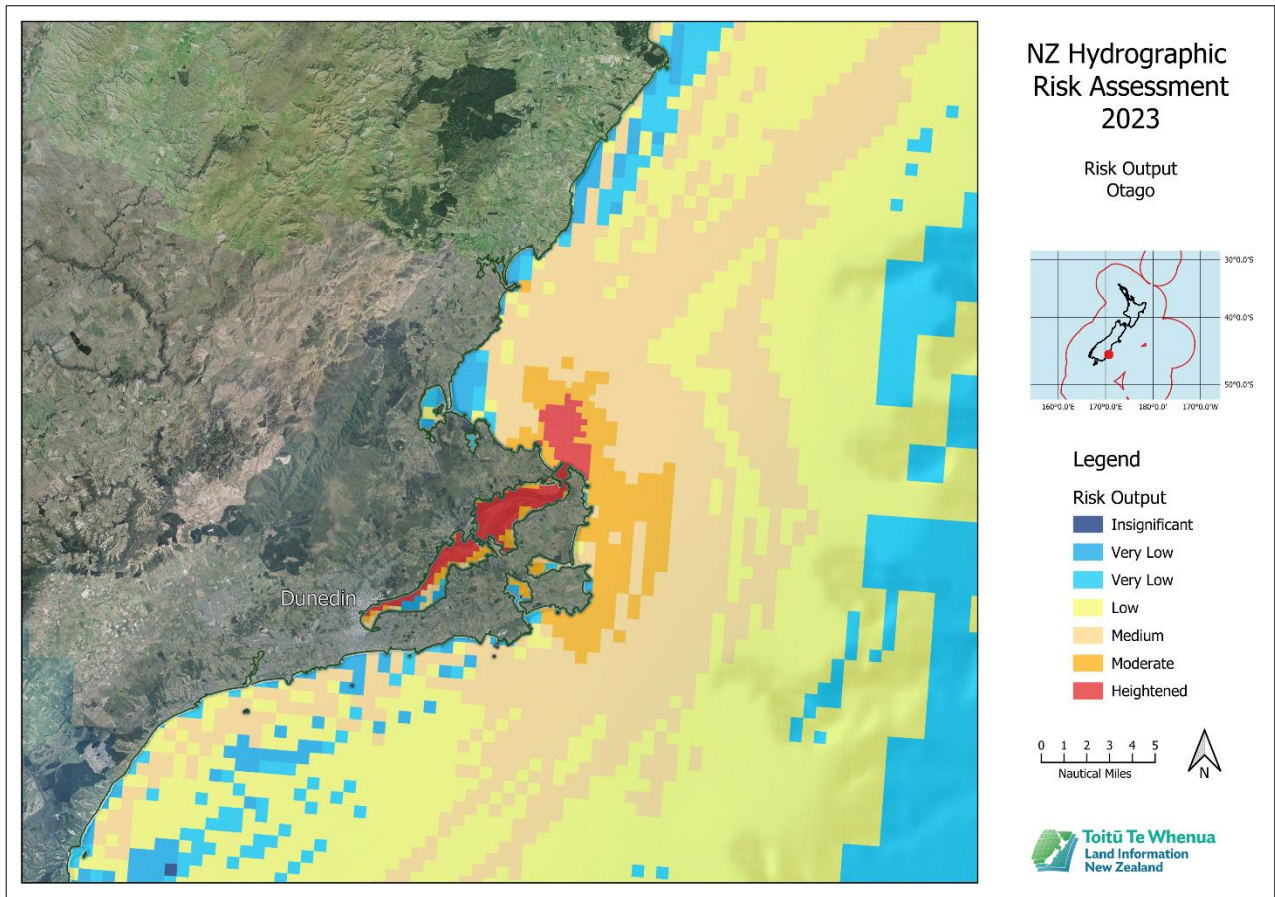


Figure 11 - 2024

2024 Risk Output in vicinity of Otago Harbour entrance

It is worth noting that the result is not too dissimilar to the 2016 risk assessment (Figure 12). The key difference when comparing the two is the widening of moderate risk around the approaches north and south of the harbour entrance. Another difference that can be seen is the expansion of heightened risk within the harbour. Both differences can be attributed to the higher amount of Class B traffic in proximity to the port which would heavily impact the risk result in these areas. Class B traffic typically has less frequent position updates than Class A system and may appear to cut corners rather than stay in the main channel.

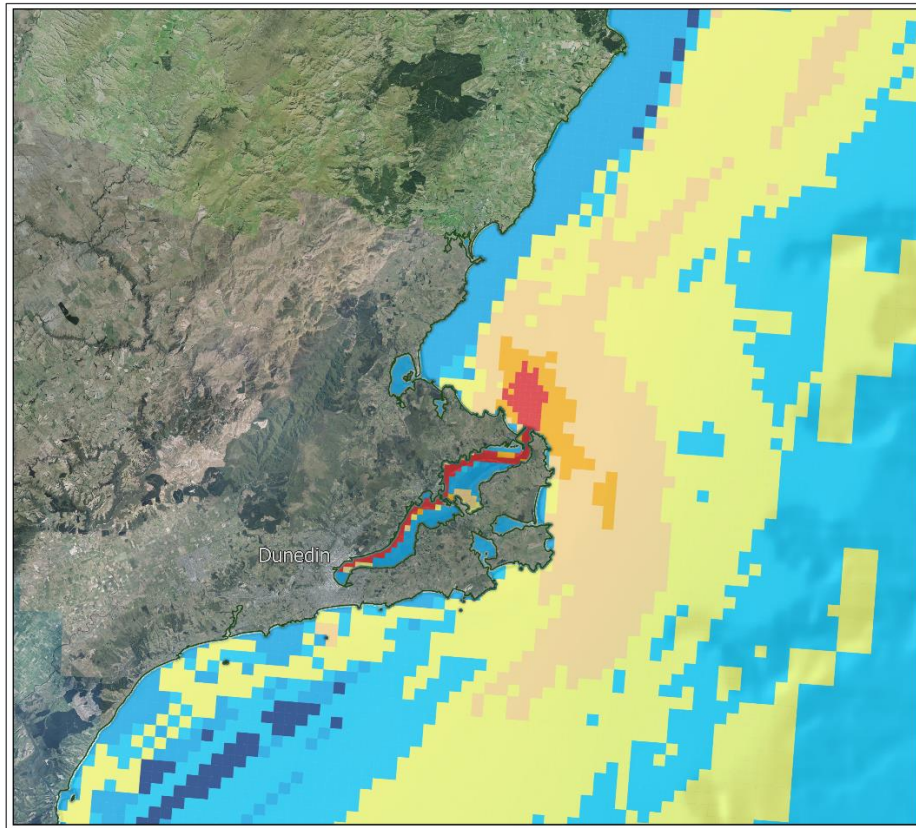


Figure 12 - 2016 Risk Output in vicinity of Otago Harbour entrance

Looking at the risk result without traffic there is a moderate to high degree of inherent risk centred around the Port Chalmers area. This is because Port Chalmers is a major port and several of the risk inputs are related to proximity to port activities.

The traffic for the 2018/2019 year is shown in Figure 13. It is clear that most of the larger vessel traffic is following the shipping lane northeast or proceeding along the recommended shipping route South by maintaining at least a 3 nautical mile distance from Taieroa Head.

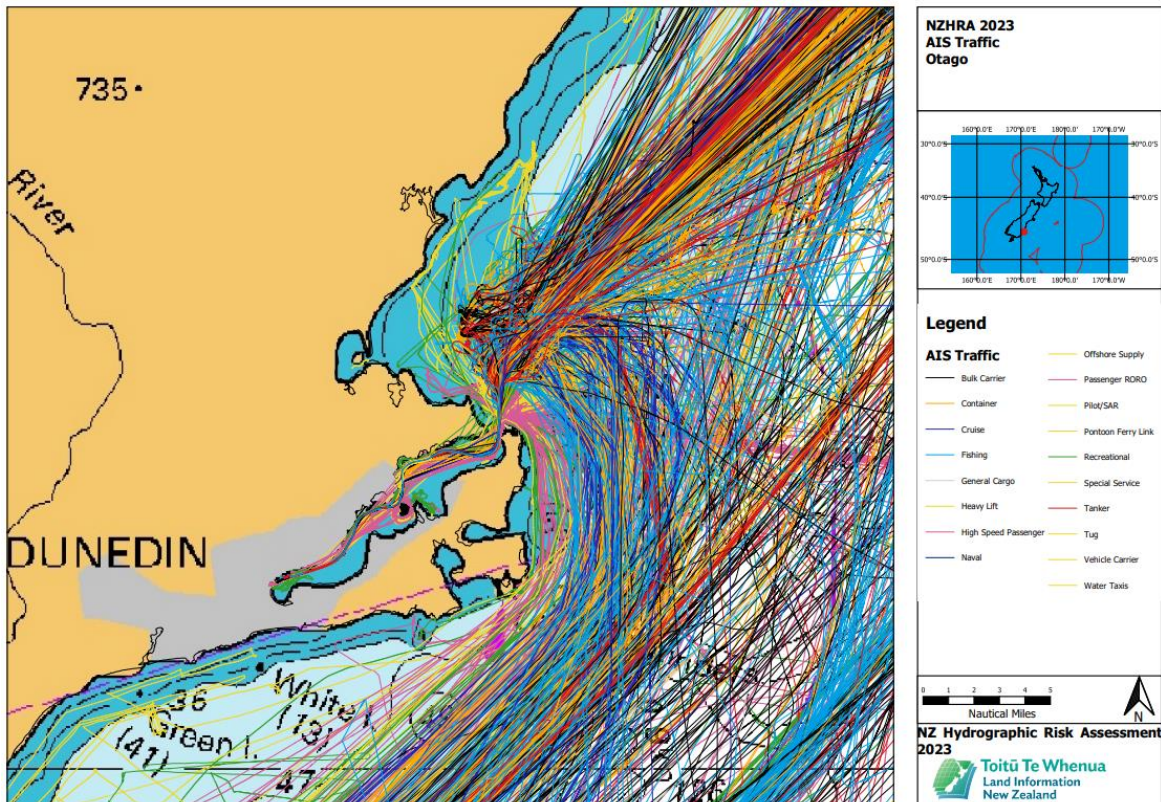


Figure 13 - 2018/2019 AIS traffic in vicinity of Otago Harbour

A visual comparison with the previous risk assessment suggests a higher number of smaller vessels i.e. Class B AIS traffic. It is suspected that the Class B traffic may have been omitted in the previous risk assessment, as the 2018/2019 Class A traffic alone looks very similar to the total 2014/2015 traffic used in the 2016 assessment.

The key difference that can be seen between the two traffic datasets is the increased use of the anchorages outside the port, in particular the anchorages farther west than currently charted. There is also a greater number of smaller vessel traffic in the vicinity of Taiaroa head and Blueskin Bay which is not visible in the 2014/2015 data. It is worth noting that the Taiaroa Head wildlife tourism boat is one of these vessels. The vessel is in the domestic traffic layer so is accounted for in the 2016 risk assessment results, however it appears that the actual vessel data has tracks going around the head instead of just staying in the main approach channel. These differences are likely the result of the 2016 risk input being too simplistic and not reflective of the real route followed.

One point worth mentioning is the recent addition of marine reserves in vicinity of Otago Peninsula and the wider Dunedin area. These were not enacted at the time of the 2024 assessment so were not included in the marine reserves layer. The plot below shows the new marine reserves, the closest one is within 5 nautical miles of the Otago Harbour approaches so will have significantly impacted the risk result.

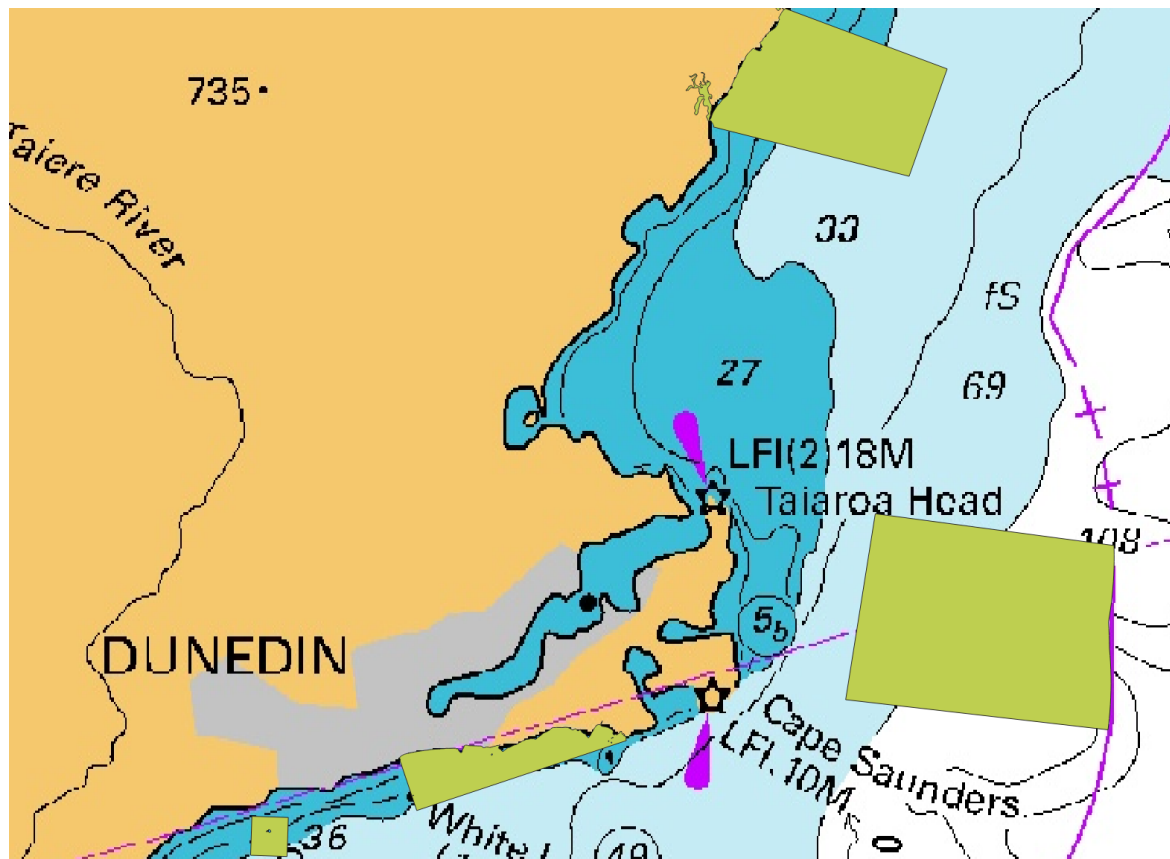


Figure 14 - New marine reserves (green areas) in vicinity of Otago Peninsula

Approaches to Whanganui

Whanganui Port is located at the river mouth of the Whanganui River. The port provides wharves and docking facilities for small coastal freight vessels and commercial boats. A boat building operation is also based at the port which at the time of the 2016 risk assessment, was building two 34m passenger ferries for Auckland ferry company Fullers. The Port is operated by joint venture between Tupoho Whanau Trust and Whanganui District Council (2016 Risk Assessment Report). More recently, a large re-development of the Port has been planned which will include wharf development, dredging and the strengthening of moles/revetments at the river entrance to make crossing the bar more reliable. The total investment for the project is over \$50 million with plans to do the work over three phases (Whanganui.govt.nz).

The risk profile in the approaches to Whanganui can be seen in Figure 15 below.

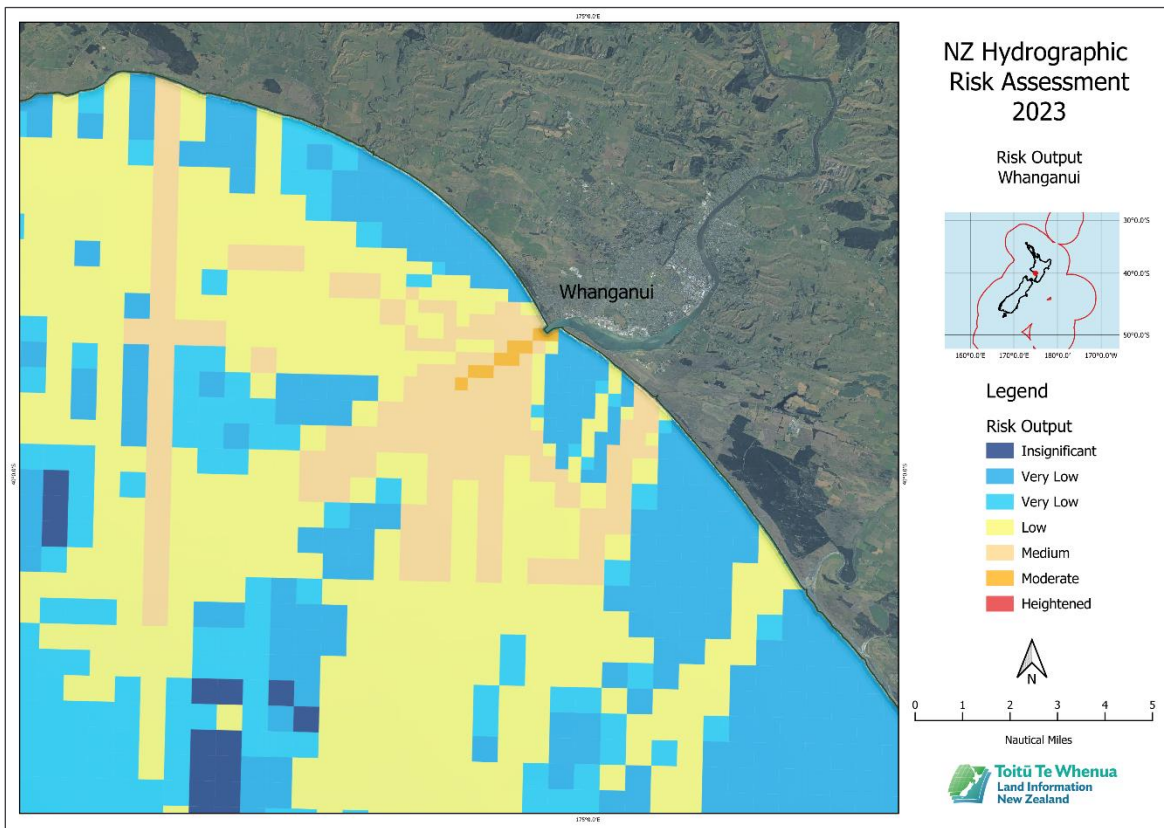


Figure 15 - 2024 Risk Output in vicinity of Whanganui

The volume of traffic in the area is relatively low. A significant portion of the traffic visiting in the 2016 risk assessment was the NIWA research vessel *RV Ikatere* which was constructed at the Port and could be seen transiting to an anchorage at Castlecliff (2016 Risk Assessment).

In the 2018/2019 traffic used in the 2024 assessment, it seems that traffic follows a similar pattern. Most traffic is Class B AIS and are mainly fishing vessels. Notably Whanganui is home to the *MV Anatoki* which is a bulk carrier that provides domestic services between Whanganui, Gisborne, Nelson and Timaru. The service that *MV Anatoki* provides is expected to be expanded in the coming years with more funding announced for coastal shipping and a 2nd larger bulk carrier vessel planned as part of that expansion.

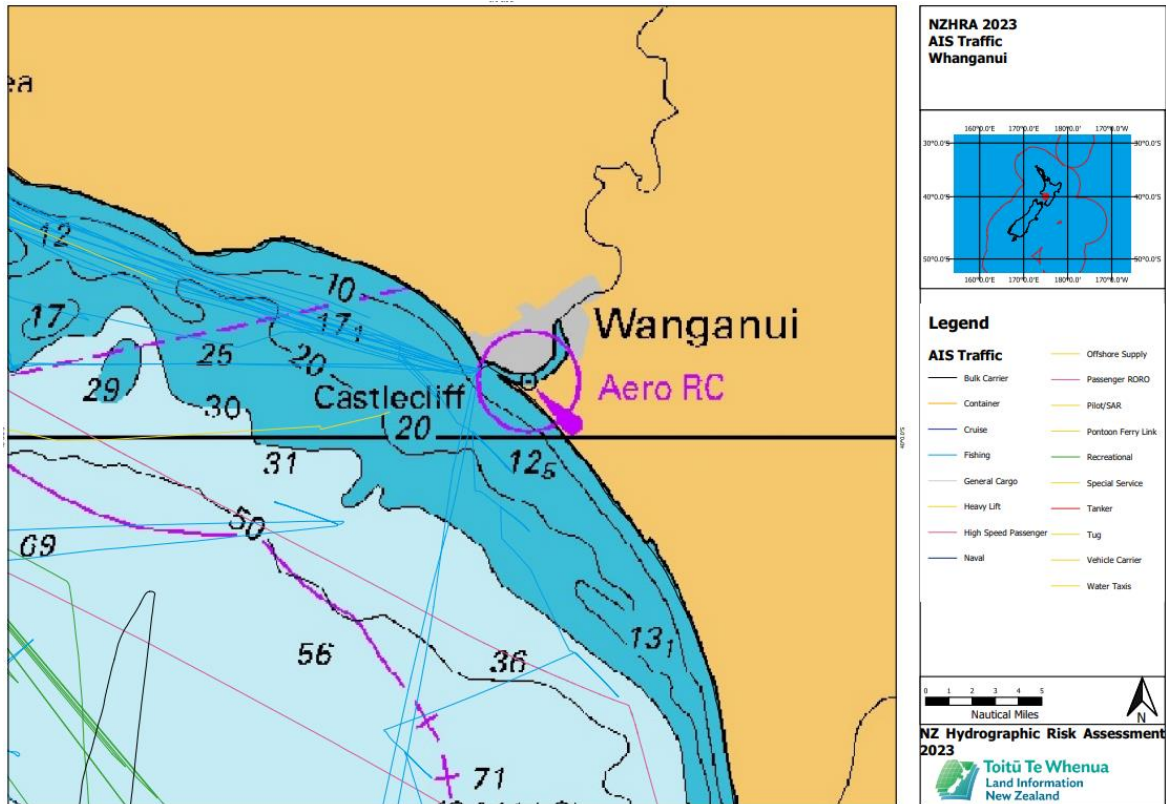


Figure 16 - 2018/2019 AIS traffic in vicinity of Whanganui

Given the planned developments, it is likely that the future state of traffic will be very different to the previous two risk assessments. If the entrance is to be improved, it may make the port a more viable option beyond its current planned traffic. To understand the risk picture, absent of traffic, the inherent risk can be seen below. This shows the risk to be moderate to low, with the moderate rating associated with proximity to the bar entrance and port area. The reason for the relatively low level of risk can be attributed to the fact the last survey in the area was done in the 1990s,, which has a CATZOC B classification. The two variables "survey age" and "quality" have a high weighting in the inherent risk calculation.

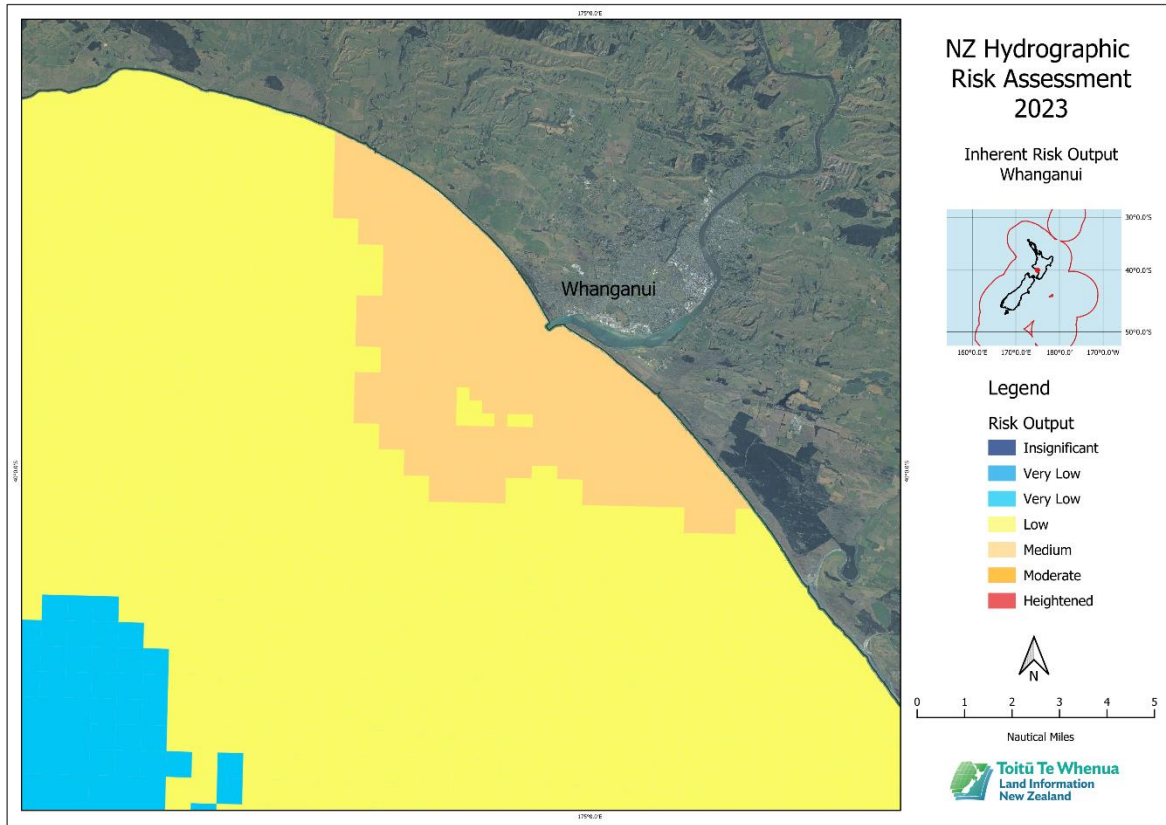


Figure 17 - Inherent risk calculation in Whanganui

Abel Tasman

Abel Tasman is part of the wider Tasman Bay / Te Tai-o-Aorere. It is the area adjacent to the Abel Tasman National Park, an area famous for its sea kayaking and water tourism. Abel Tasman is home to two marine reserves, one of which is the Tonga Island marine reserve, the second is between Awaroa Head and the headland separating Bark Bay and Mosquito Bay (2016 Risk Assessment).

In risk profile for the Abel Tasman below (Figure 18), several small pockets of heightened risk can be seen, with most of the coastal area designated as moderate.

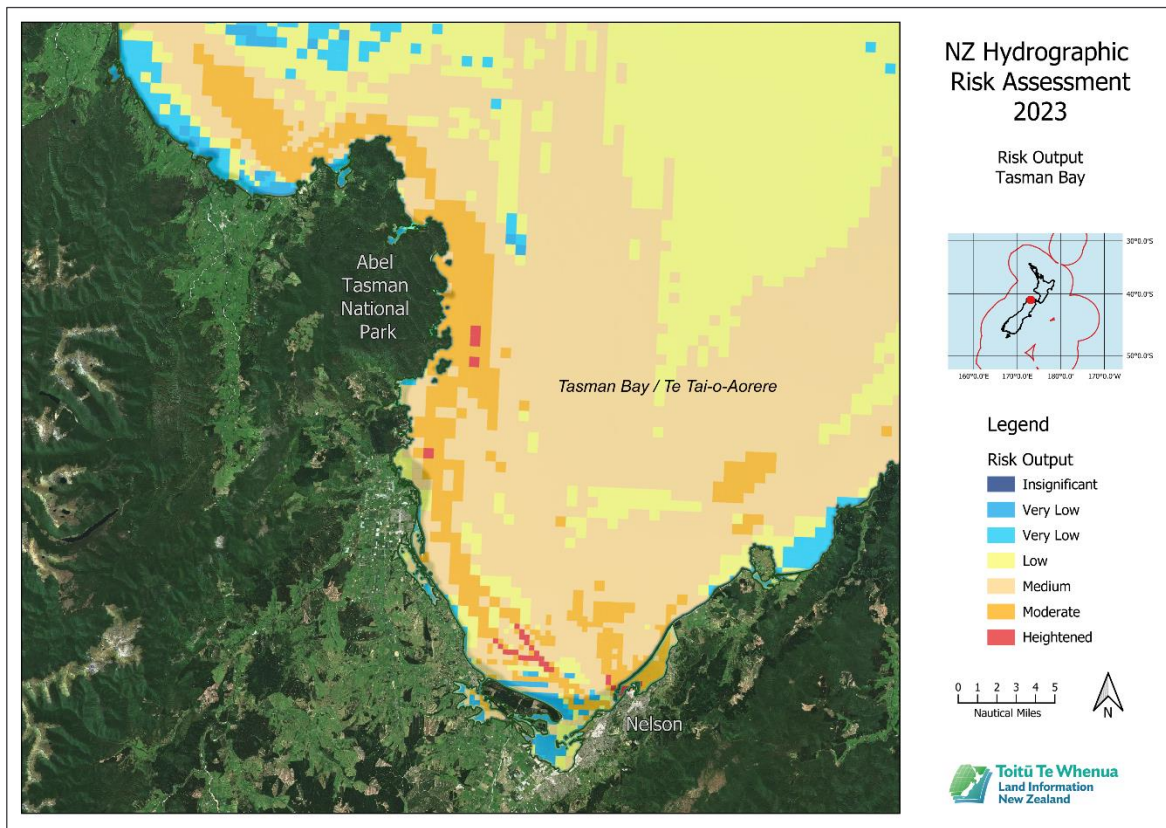


Figure 18 - 2024 Risk Output in Abel Tasman area

The pockets of heightened risk coincide with the routes taken by the water taxi services that operate from Nelson to Abel Tasman National Park. The domestic traffic route and the risk output overlay for the area are plotted in Figure 19.

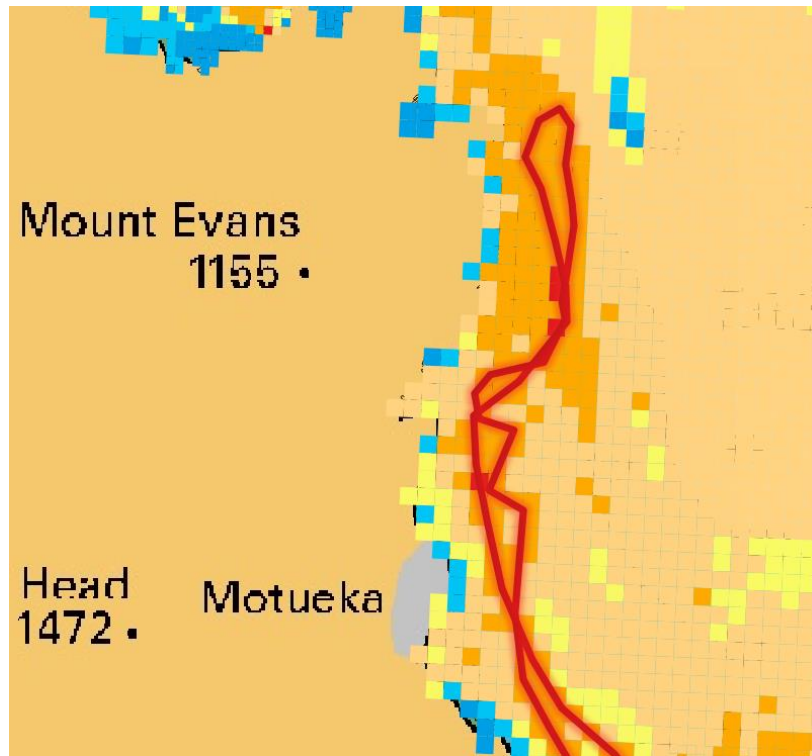


Figure 19 - 2024 Risk Output and domestic traffic /water taxi line (thick red line) in Abel Tasman area

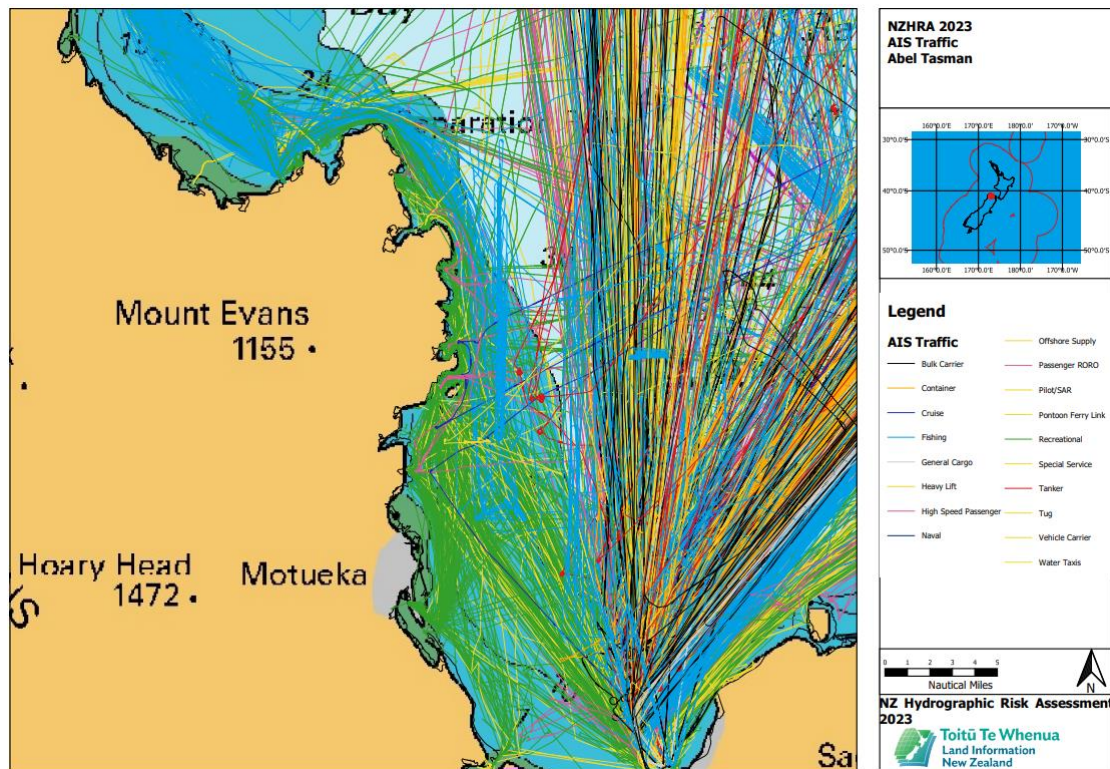


Figure 20 - 2018/2019 AIS Traffic in Abel Tasman/Tasman Bay area

The moderate risk extends beyond that of the domestic traffic layer and looks to be a result of the volume of actual traffic using the area. Traffic in the region is made up mainly of recreational vessels with a heavy presence of fishing vessel traffic and small passenger services, such as water taxis. Several small cruise ships anchor between Motueka and Kaiteriteri. Of further note are the tankers anchoring seaward of the 20m contour, 5nm east of Kaiteriteri.

As with the other regions there is a noticeable change in the density of traffic likely due to Class B traffic excluded from the previous risk assessment.

Approaches to Wellington

Wellington Harbour has a relatively narrow entrance and is situated toward the eastern end of Cook Strait – a stretch of water widely regarded as one of the most dangerous and unpredictable in the world. Sea currents and record wind speeds make the Wellington approaches and Cook Strait areas dangerous places to operate (2016 Risk Assessment report).

Wellington Harbour is a terminus for the North-South Island ferry services. Collectively, the two ferry operators running a service via Cook Strait to Picton in the South Island transport over 1.2 million passengers (KiwiRail Interisland Ferries and Terminals Detailed Business Case, 2021). The two ferry operators also have a relatively even share in the transporting of inter-island freight.

CentrePort manages port operations in Wellington Harbour and approximately 10.5 million tonnes of cargo are handled by the Port each year. CentrePort is New Zealand's busiest port by ship movements. While being a freight port, CentrePort hosts an increasing number of cruise ships: 89 in the financial year ending June 2023 (CentrePort Annual Report 2023). At the time of writing this report cruise shipping faces an uncertain future in New Zealand due to bio security and increased fees that come with operating in New Zealand waters and visiting New Zealand ports.

The risk output for the approaches to Wellington area can be seen in Figure 21.

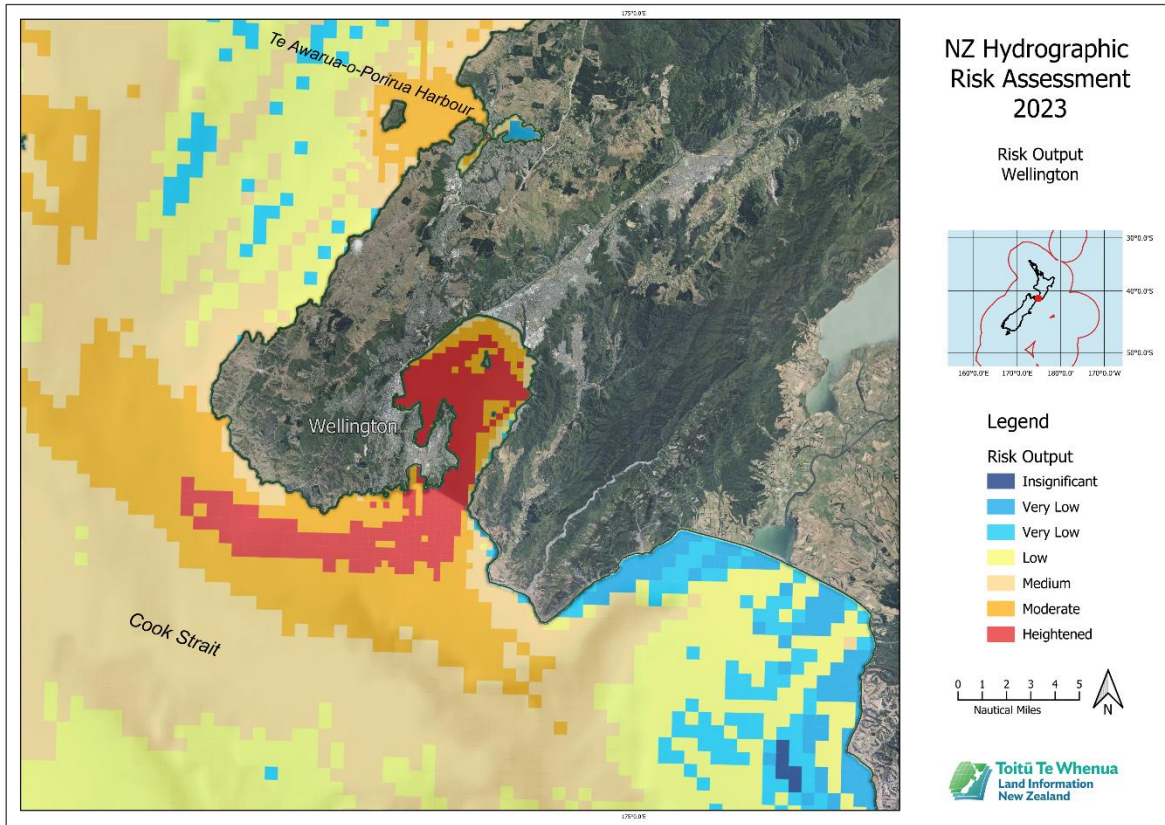


Figure 21 - 2024 Risk Output in Wellington area

Most of the heightened risk is present inside the harbour and the harbour entrance. The remaining heightened and moderate risk can be seen in the approaches to Wellington Harbour. The level of risk is primarily a result of the high volume of traffic, the majority of which can be attributed to the presence of the Cook Strait ferries which being passenger roll on/roll off classification have a high weighting in the risk model.

The risk pattern in the approaches to Wellington Harbour has not changed significantly since the last risk assessment. There is a small increase in moderate risk around the coast to the east and west of the harbour entrance and in the approaches to Te Awarua-o-Porirua Harbour. It is likely this is the result of increased Class B traffic which is most likely the predominant traffic type to be operating in these areas.

Traffic in the Wellington region for the 2018/2019 year can be seen in Figure 22. As expected, traffic volume is high along the interisland ferry route and with most other large vessels approaching wide of Baring Head/Ōrua-pouanui and the Miramar Peninsula. Smaller vessels are seen transiting inside the harbour and closer to the coast. Porirua Harbour traffic is dominated by recreational and smaller vessel traffic. Comparing against the 2014/2015 traffic used in the 2016 assessment, there is a dramatic increase in Class B traffic as well as significantly more traffic approaching Tory Channel / Kura Te Au.

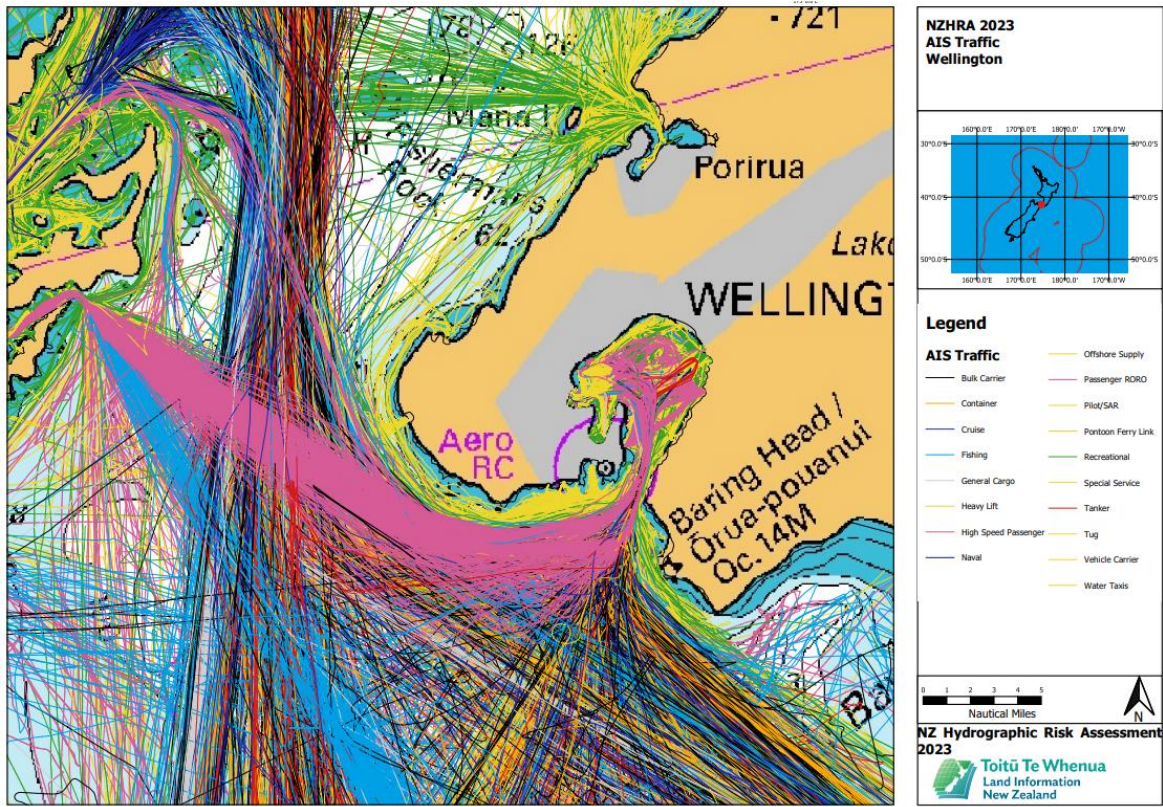


Figure 22 - 2018/2019 AIS traffic in vicinity of Wellington

Given the objective dangers of navigating in Cook Strait and the approaches to the Wellington region, it is prudent to review the inherent risk picture. Using this approach has merit as the objective dangers in the area make it more likely for a vessel to transit into less used areas. A plot of the inherent risk can be seen below.

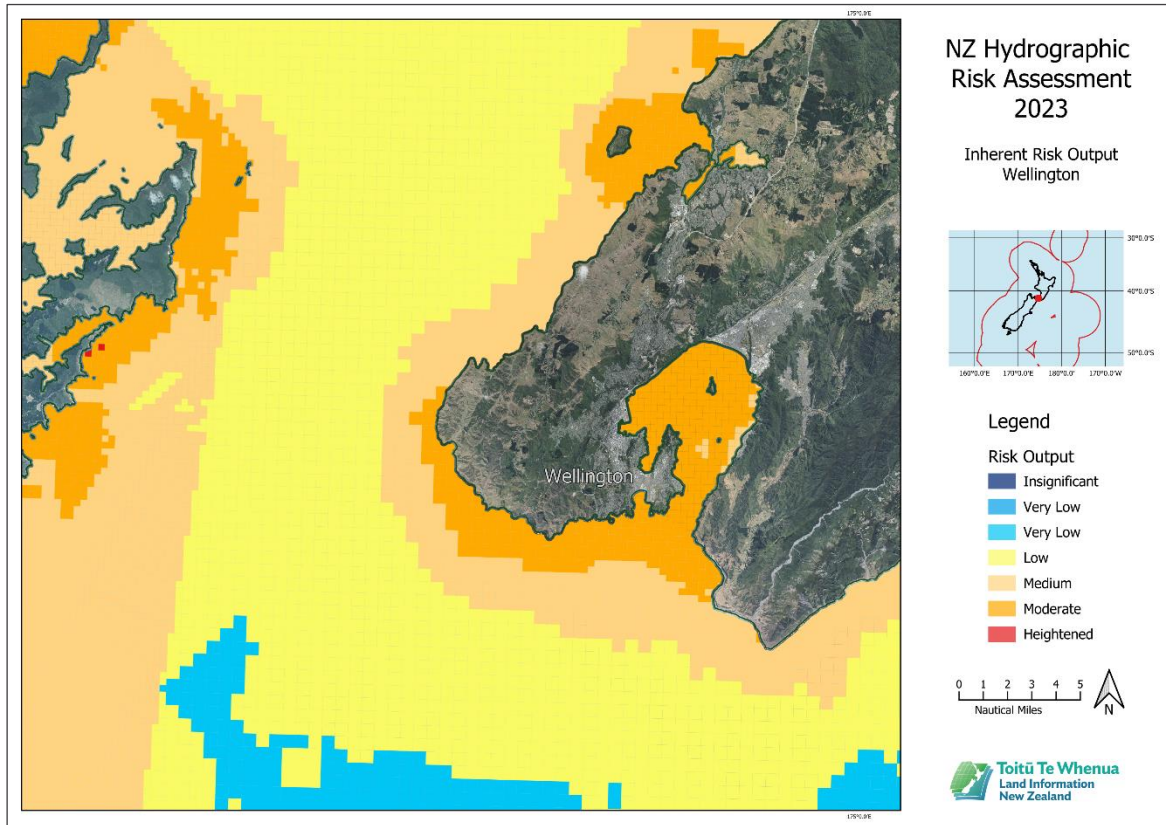


Figure 23 - Inherent risk calculation in Wellington

The entire harbour, entrance and approaches are predominantly classified as moderate in the inherent risk output as a result of a number of factors such as proximity to the major shipping routes, interisland ferry routes, survey quality and age of the underlying survey data. In conjunction to these factors the moderate risk looks to follow the 15m depth contour which despite being a risk variable with minor weighting in the model has heavily influenced the shape of the risk picture in the area. For reference the approaches to Wellington (excluding the main channel) were last surveyed in 1985. The approaches to Porirua were last surveyed in 1967.

Approaches to Westport

Westport Harbour sits at the mouth of the Buller River and provides services to fishing vessels and leisure boats, supplying pilotage, towage, berthage and marine services. The harbour is managed/owned by Buller Holdings Limited which is a Buller District Council holding company. The harbour has a highly migratory bar which requires regular surveying and dredging. Such is the requirement for dredging that the port operates its own dredger (2016 Risk Assessment).

The risk output for Westport can be seen in Figure 24.

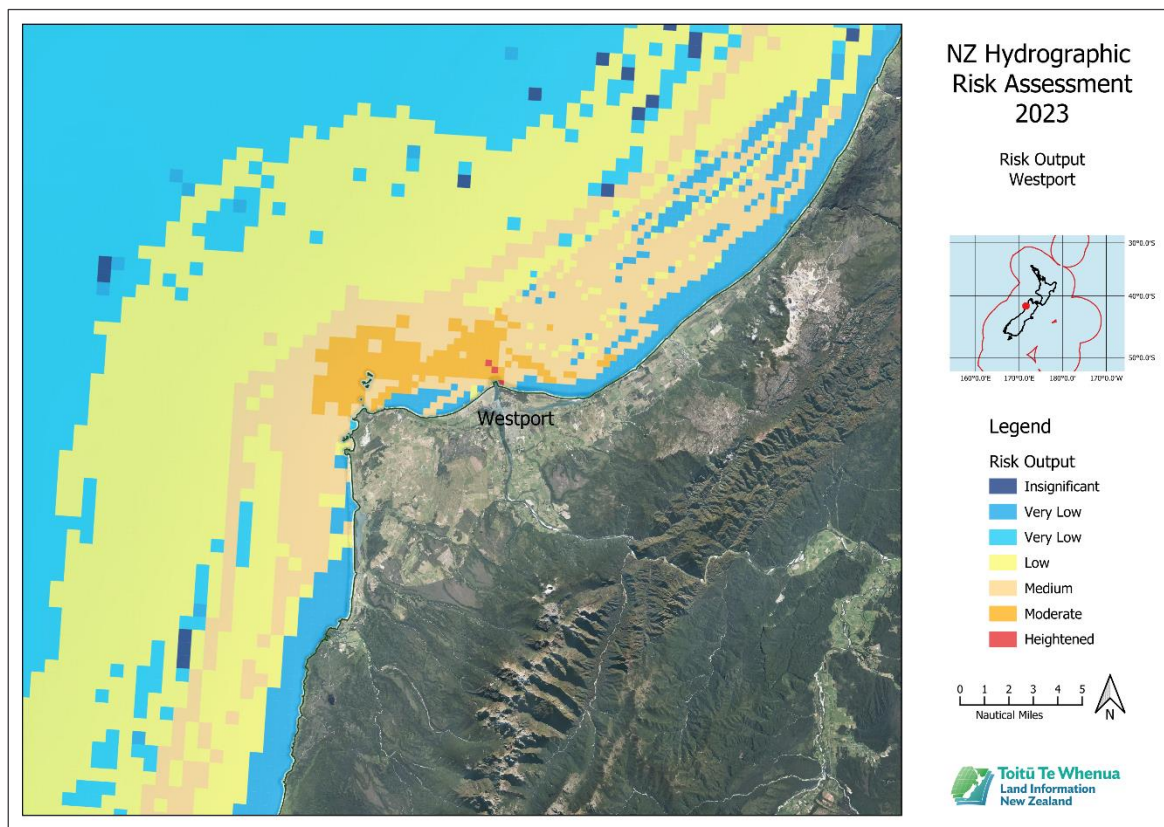


Figure 24 - 2024 Risk Output in Westport area

As expected, much of the risk is concentrated on the main approach to the port, with heightened risk shown along the leading line. There is a significant concentration of moderate risk on the western approach. This is due to the proximity of traffic to the reef area (Black Reef and Three Steeples) that lies to the west of Westport.

The plot for Westport traffic in the year 2018/2019 can be seen in Figure 25.

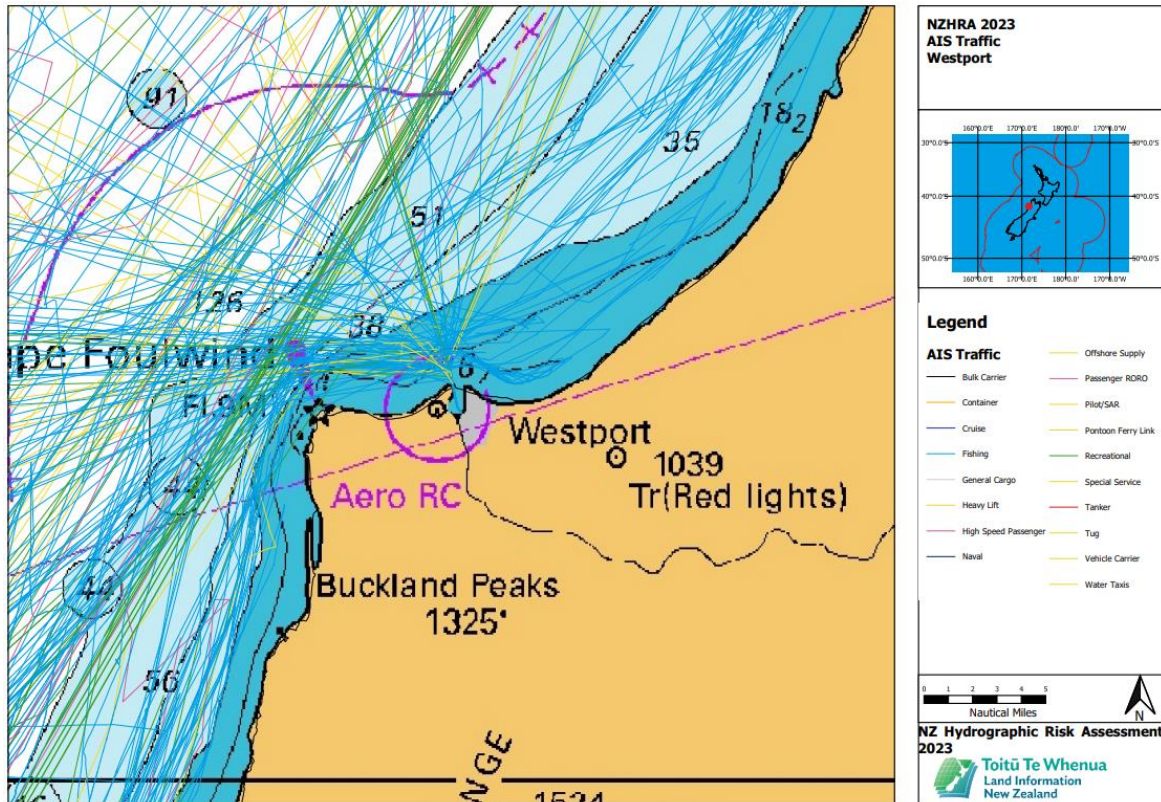


Figure 25 - 2018/2019 AIS traffic in vicinity of Westport

Most traffic is headed west from Westport with fishing vessels making up the bulk of the traffic. A band of smaller recreational/sailing vessel traffic can be seen approximately 3 nautical miles off the coast. Not visible in the above figure is the larger vessel traffic such as container/tanker vessels which pass by up to 50 km off the coast.

Notably absent is the cement carriers Milburn Carrier II and Westport as the cement works in Westport closed in 2016.

In discussions with MNZ, LINZ were made aware of plans to upgrade infrastructure at west coast ports with the rationale that they provide a vital link to raw products and provide resilience away from road transportation. To date, several reports on the state of coastal shipping in New Zealand have been undertaken by NZ Transport Agency Waka Kotahi, however no solid recommendations are made. As such, it is difficult to predict future traffic volume if investment is directed into such ports.

Figure 26 shows the inherent risk in the Westport area which is assessed as moderate to medium. Contributing to this result would be the proximity to reefs/dynamic seabed features (bar) as well as the age of survey (the approaches area was last surveyed in 1958).

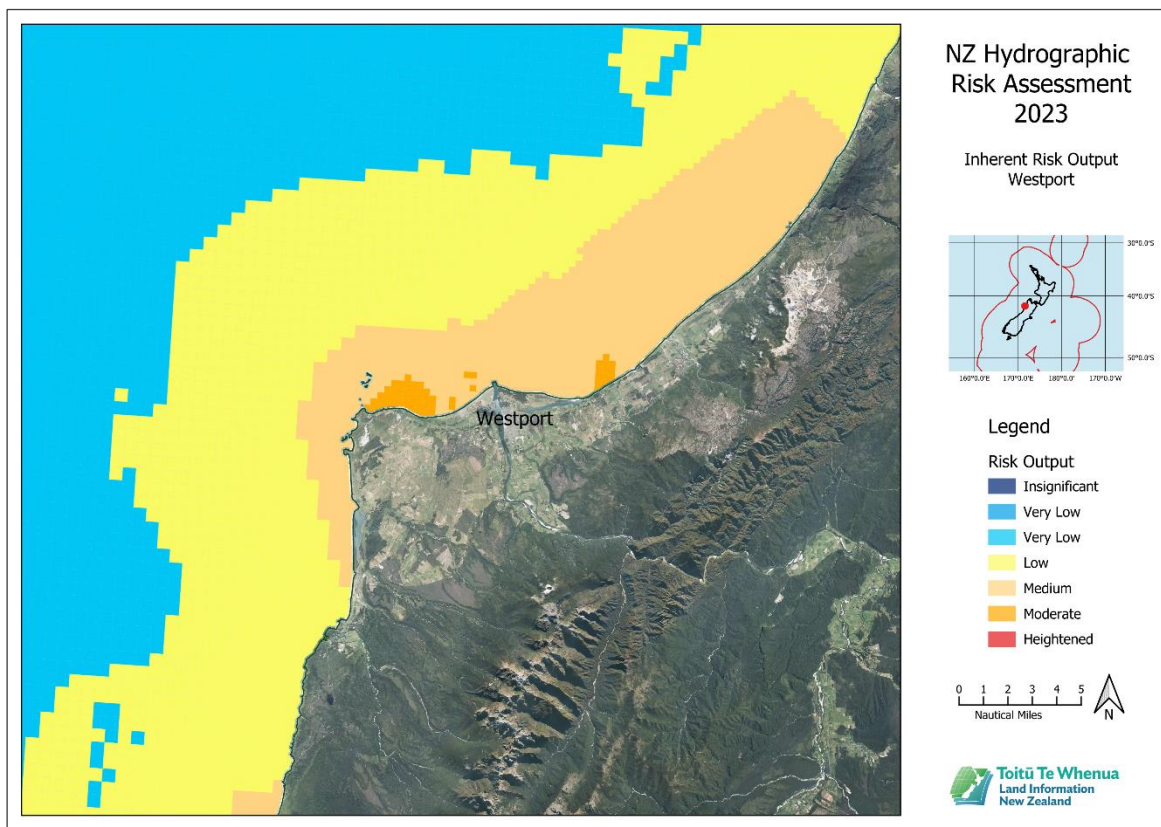


Figure 26 - Inherent risk calculation in Westport

Approaches to Greymouth

The port of Greymouth is a river port entered across a bar between two large breakwaters. The bar itself is highly migratory and is regularly surveyed by Grey District Council who take responsibility for operating the port. The port is host to a small number of commercial fishing vessels.

The risk profile can be seen in Figure 27.

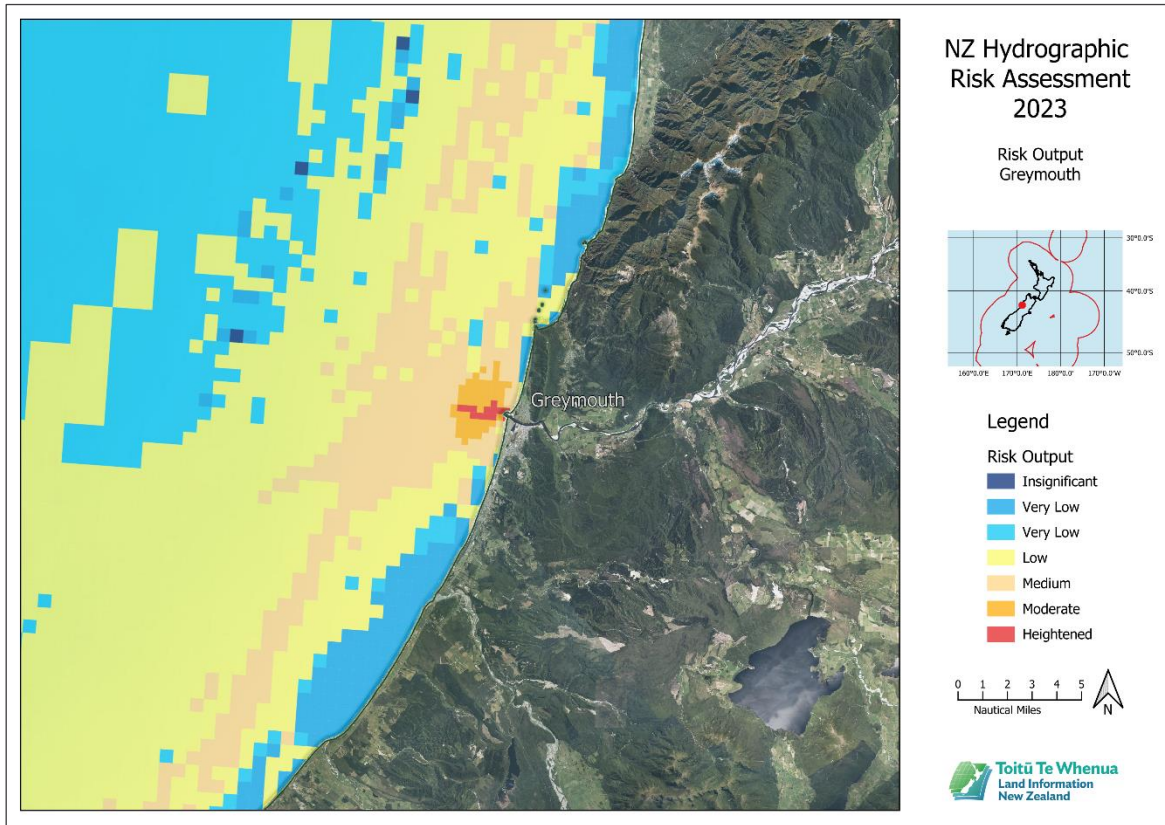


Figure 27 - 2024 Risk Output in Greymouth area

A small pocket of heightened risk is concentrated on the leading line to the port which is a result of the high concentration of traffic through the narrow port entrance. A small amount of moderate/medium risk can be seen on the approaches.

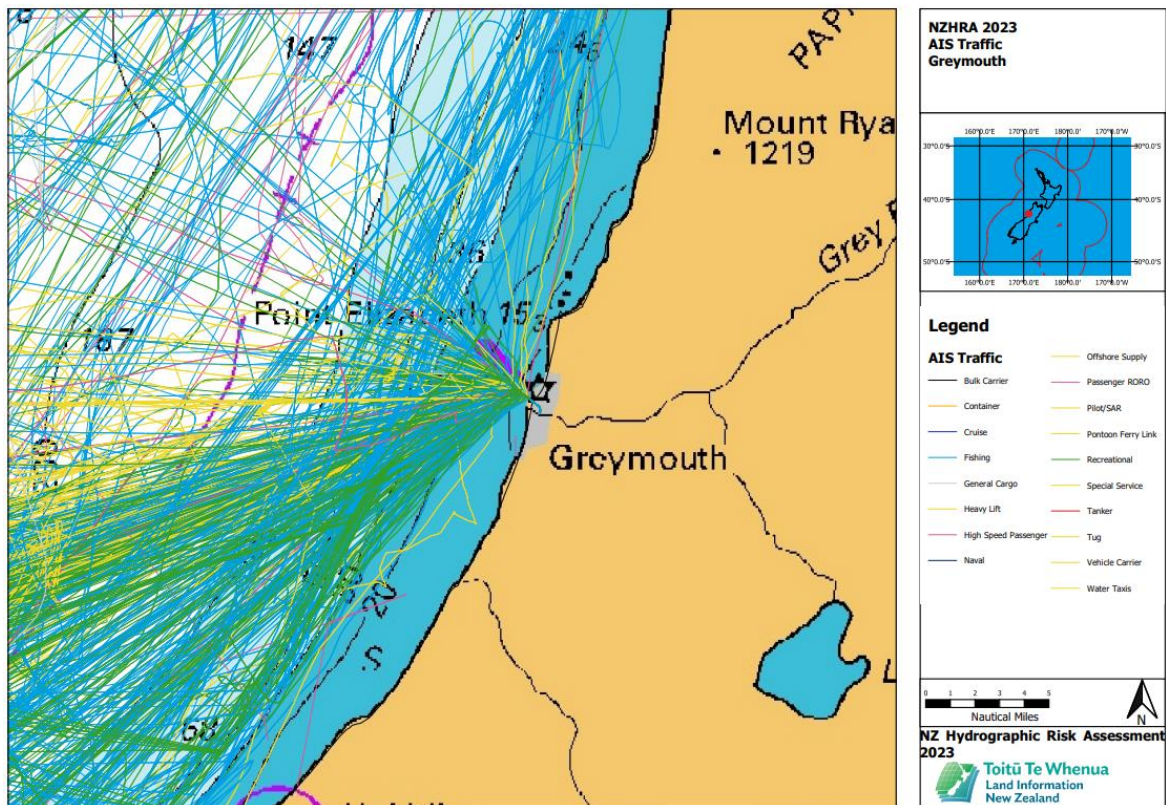


Figure 28 - 2018/2019 AIS traffic in vicinity of Greymouth

Greymouth traffic is dominated by fishing vessel traffic.

Much like Westport, Greymouth is included in the future plans for developing infrastructure along the west coast. As with Westport it is worth looking at the inherent risk to see the impact on future traffic. As expected, the inherent risk is in the medium/moderate range as can be seen in Figure 29.

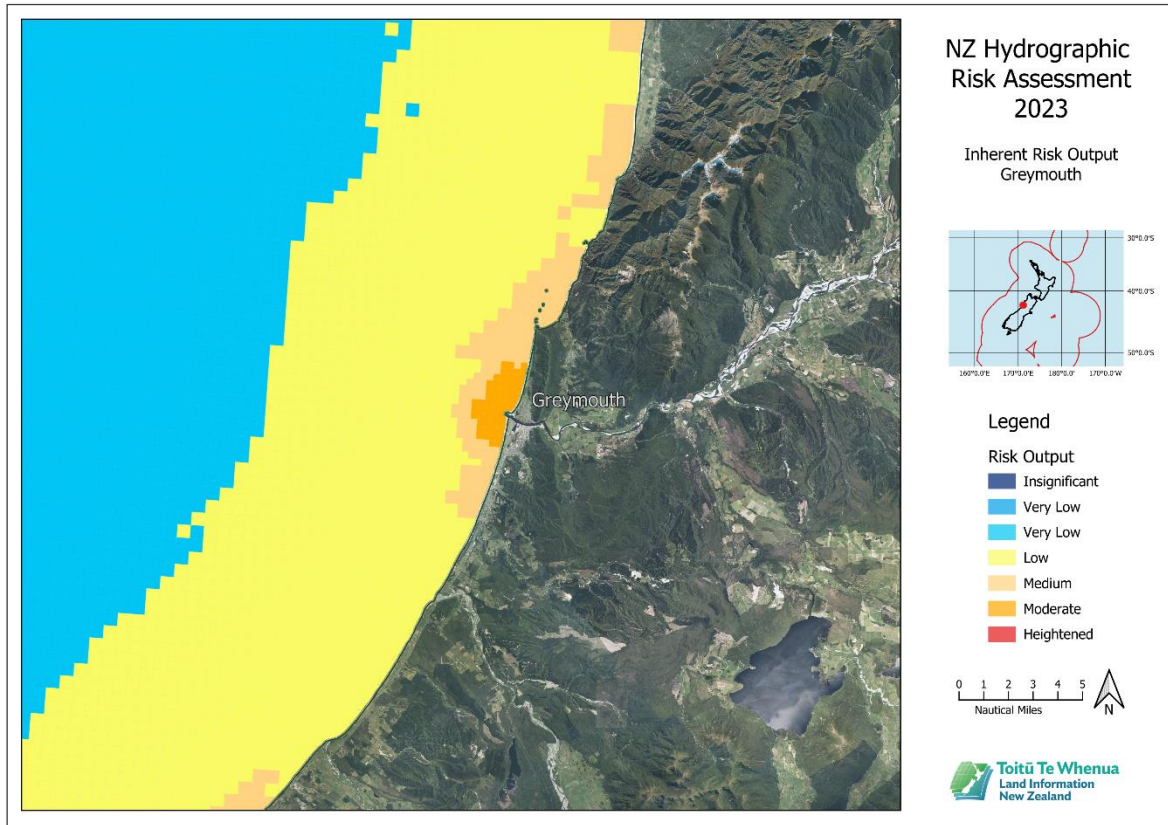


Figure 29 - Inherent risk calculation in Greymouth

Marlborough Sounds

The Marlborough Sounds sit at the top of the South Island and comprises 20 percent of New Zealand’s coastline. The area is navigated by a variety of users from high-volume passenger services, a growing aquaculture industry and high levels of recreational users. The Sounds are home to nearly 600 marine farms, growing mussels, oysters, salmon, paua, and seaweed⁹.

The risk profile for Marlborough Sounds can be seen in Figure 30.

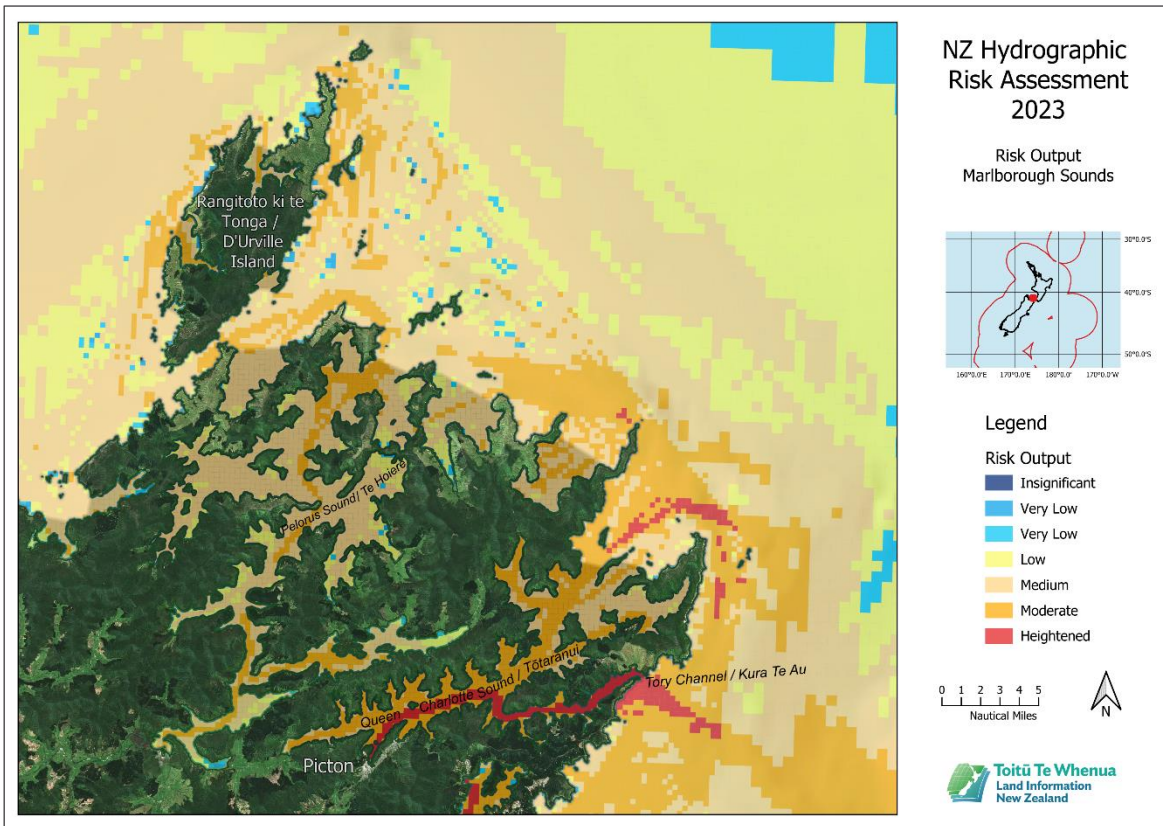


Figure 30 - 2024 Risk Output in Marlborough Sounds area

The Marlborough Sounds region was identified as an area of heightened risk in the 2016 risk assessment and the region has been the focus of hydrographic surveys since then. Even so, several pockets of heightened risk remain and reflects the volume and type of vessels navigating the area. Outside the areas of modern MBES coverage there are small pockets of heightened risk north and south of Tory Channel /Kura Te Au entrance as well as on the western side of Queen Charlotte Sound/Tōtaranui. This risk looks to be caused by the volume and type of traffic and the age of the underlying survey data. Of note, at the western entrance of Queen Charlotte Sound/Tōtaranui the AIS shows a dry bulk

⁹ <https://www.marlborough.govt.nz/environment/coastal/marine-farming#:~:text=Industry%20pioneers%20recognised%20this%20nearly,%2C%20salmon%2C%20paua%20and%20seaweed.>

carrier passing around into Pelorus Sound / Te Hoiere and the last survey done in many of the areas outside the Sounds is in the 1950s.

The Port Underwood area shows a pocket of heightened risk as well as moderate risk. Heightened risk is due to the volume of fishing traffic going into the main port in Oyster Bay. The rest of the Port Underwood's risk is due to a mixture of mussel farming supply vessels and recreational vessels. The last time Port Underwood was surveyed was in 1985 with singlebeam.

Areas of moderate to medium risk can be seen at the entrances to both Pelorus Sound/ Te Hoiere and Queen Charlotte Sound/Tōtaranui as well as around D'Urville Island. Much of the moderate risk is generated by the sheer volume of traffic combined with the age of survey.

The high volume of recreational traffic can be seen in the AIS data. Some smaller passenger vessels can be seen navigating between Queen Charlotte Sound/Tōtaranui as well as fishing boat traffic potentially part of the aquaculture industry servicing the many marine farms in the region. Large volumes of traffic can be seen moving in the corridors around the Sounds and major islands. Most large vessel traffic can be seen entering Queen Charlotte Sound/Tōtaranui at the main entrance with only the inter-island ferry utilising Tory Channel/Kura Te Au. Some small cruise/passenger vessels can be seen entering Port Gore, Port Forsyth and Catherine Cove to anchor.

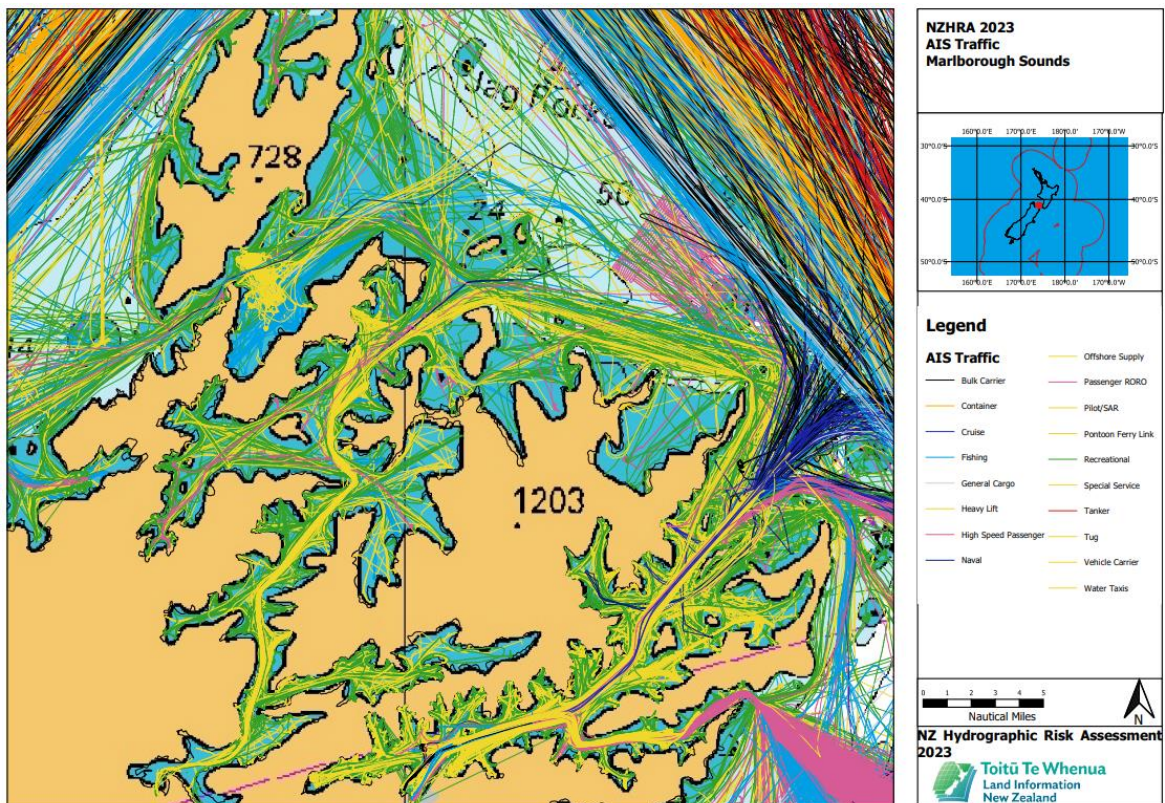


Figure 31 - 2018/2019 AIS traffic in vicinity of Marlborough Sounds

Port Marlborough were one of the few respondents to the data gathering exercise asking for numbers of arrivals. In their response they provided an overview of vessel arrivals which closely matched the AIS traffic data. They also noted that they see hydrographic risk as quite low in piloted areas of the Sounds.

The inherent risk picture provides a very simplistic view of hydrographic risk. The inherent risk can be seen in Figure 32.

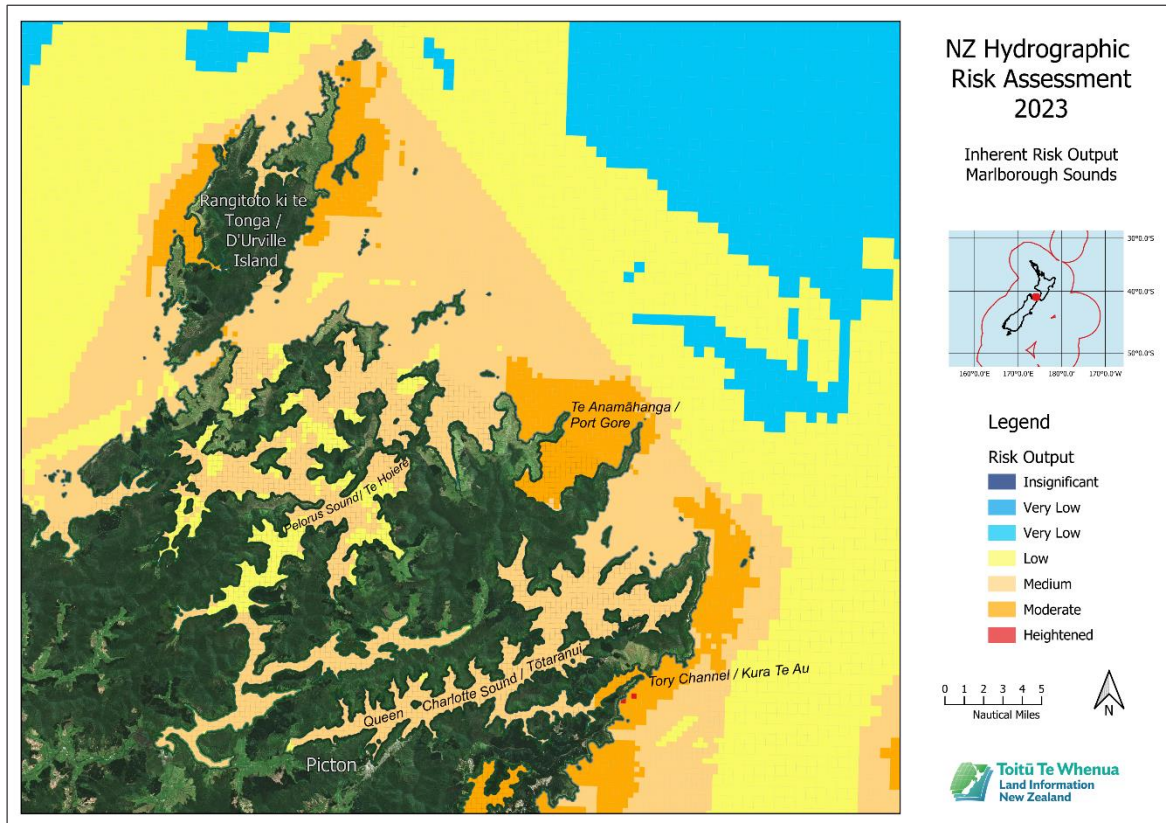


Figure 32 - Inherent risk calculation in Marlborough Sounds

The inherent risk shows highest risk located in Te Anamāhanga / Port Gore and around the Tory Channel/Kura Te Au entrance. The reason Te Anamāhanga / Port Gore and areas around Rangitoto ki te Tonga / D'Urville Island receive a higher moderate risk is due to the age of survey compared to surrounding areas. The areas north and south of Tory Channel/Kura Te Au look to be a combination of age of survey and proximity to the tidal streams at Tory Channel (a variable in the risk model).

Stewart Island / Rakiura

Stewart Island / Rakiura sits approximately 30km south of the South Island of New Zealand. The island hosts a small fishing industry which is supported by the interisland ferry service for its freight. This service is owned by Real Journeys and transports passengers and freight to Bluff on the New Zealand mainland from the main settlement Halfmoon Bay / Oban on Stewart Island / Rakiura. Stewart Island / Rakiura is a key domestic tourist destination with most of the island classified as a National Park. In conjunction to the domestic tourism the island also hosts large cruise vessels which anchor in Paterson Inlet/Whaka a Te Wera and ferry people ashore to local wildlife attractions. Big Glory Bay, which is accessed by a passage through Paterson Inlet/Whaka a Te Wera, hosts a number of marine farms, mostly farming salmon.

The risk output for Stewart Island / Rakiura can be seen in Figure 33.

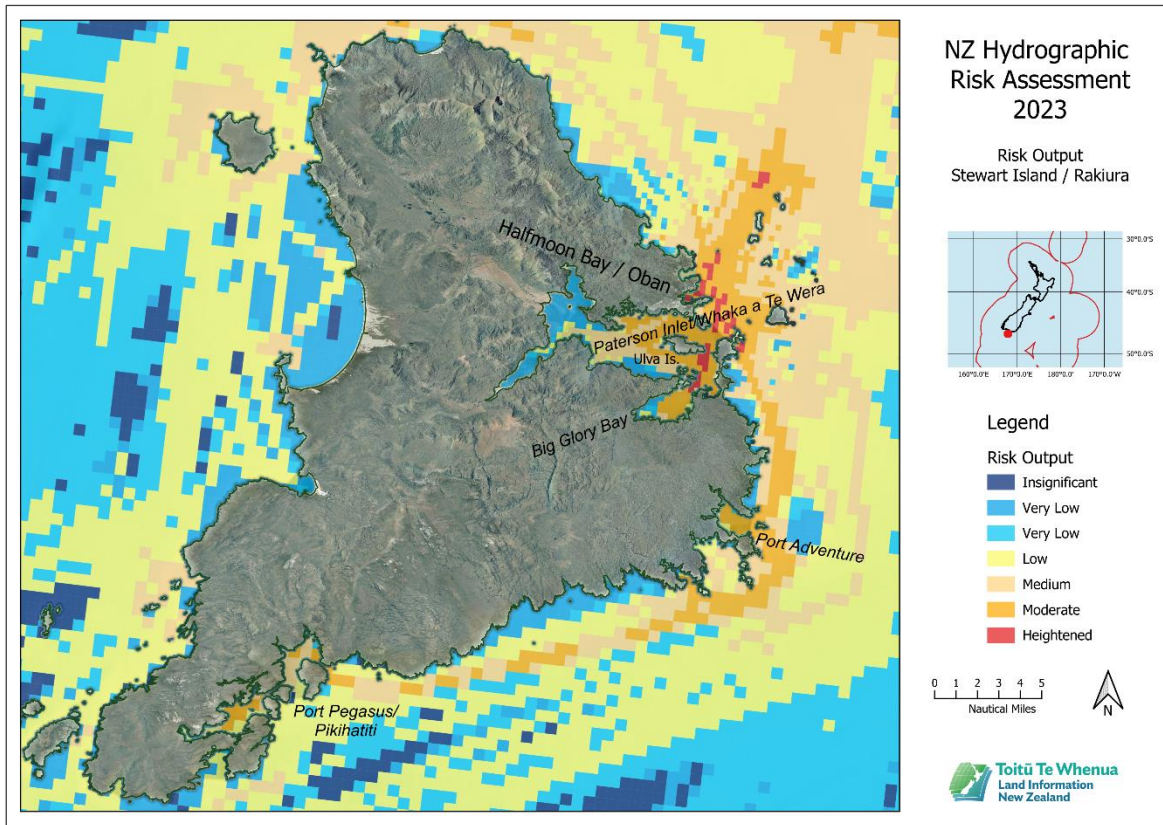


Figure 33 - 2024 Risk Output in Stewart Island / Rakiura area

Pockets of heightened/moderate risk can be seen on approaches to Halfmoon Bay / Oban and Paterson Inlet/Whaka a Te Wera. Areas within Paterson Inlet/Whaka a Te Wera are reasonably well surveyed with modern MBES north of Ulva Island where most cruise ship traffic generally anchor. The rest of the inlet is surveyed with modern SBES. It is worth pointing out the most risk in Big Glory Bay is generated by the interisland ferry assisting

in aquaculture operations/freight. Of more pressing concern are the areas at the entrance to Paterson Inlet/Whaka a Te Wera which were last surveyed in their entirety in the 1980s. However, parts of this area were surveyed by the Royal Australian Navy Laser Airborne Depth Sounder (LADs) division in 2019 which covers a significant part of the approach to Paterson Inlet/Whaka a Te Wera.

A corridor of moderate risk extends from Paterson Inlet/Whaka a Te Wera around to Port Adventure and Port Pegasus/Pikihaiti. The moderate risk is mostly created by the passenger vessel Milford Wanderer which is operated by Real Journeys and does small cruises to remote locations. All surveys done in this area were pre-2000s with some approaches to Port Adventure and Pegasus/Pikihaiti swept by SSS.

The risk on approach to Halfmoon Bay / Oban and the northern coast of the island is mitigated by recent hydrographic survey HS69 (2021/22). Hydrographic survey can do no more to reduce risk in this area.

The AIS traffic can be seen in Figure 34.

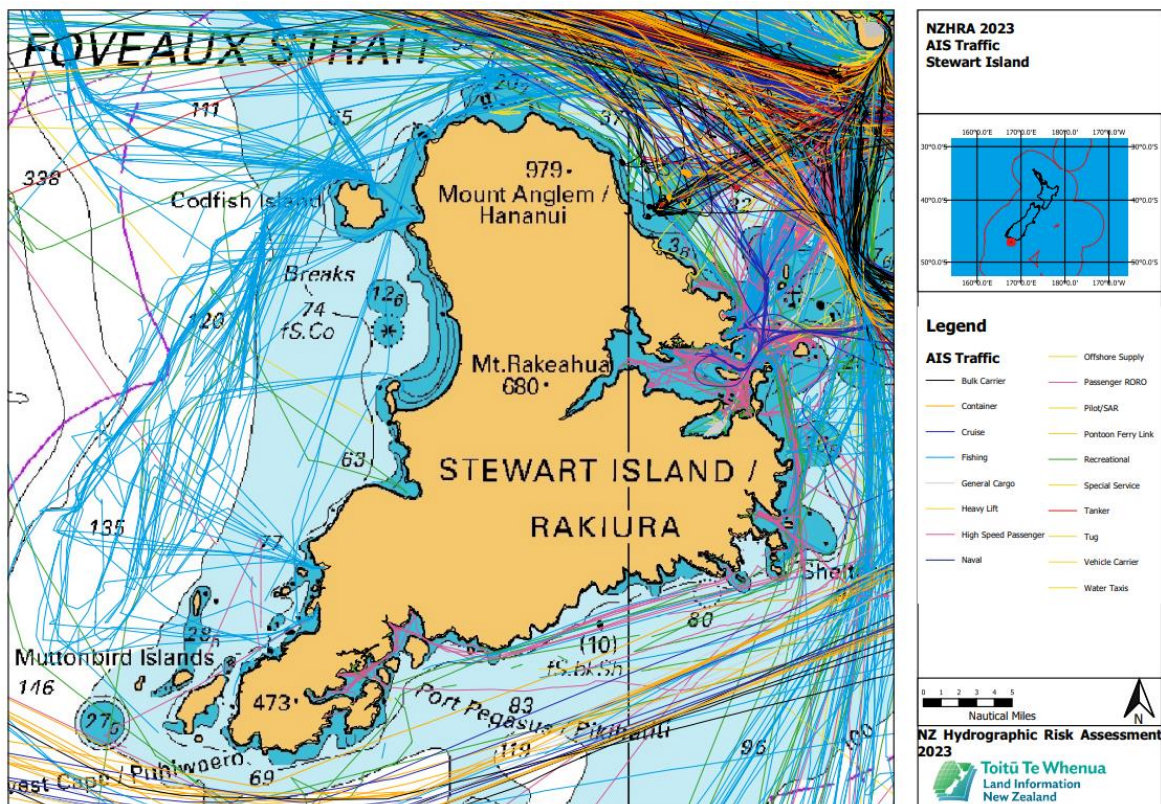


Figure 34 - 2018/2019 AIS traffic in vicinity of Stewart Island / Rakiura

The traffic shows a high number of fishing traffic operating in the waters around the island and anchoring in many locations around the coast. The aforementioned inter-island ferry can be seen navigating between the South Island and Halfmoon Bay with

many trips to Big Glory Bay. A number of cruise/passenger vessels are seen navigating in and around Paterson Inlet/Whaka a Te Wera, Port Adventure and Port Pegasus/Pikihati. These include the *Milford Wanderer* (operated by Real Journeys) and larger cruise vessels. Most large vessel/container traffic either passes through Foveaux Strait or south of South Cape/Whiore.

Conclusions

Aside from a select few areas, the risk output was largely the same as that of the 2016 risk assessment. Due to the risk model's high weighting towards vessel traffic hydrographic surveying over the past 7 years has done little to reduce risk outputs in high traffic areas. Further, the addition of Class B traffic to the model has done little to add to the risk, showing the relatively high weighting of Class A traffic on the model result. The other main changes since the last risk assessment, such as the inclusion of recreational amenities and the expanding of marine reserves/coastal resource areas, have also done little to increase risk in the model.

There are small pockets of heightened and moderate risk which remain as highlighted in the sections above. It is recommended that these areas form the basis of a new survey programme. The fact that they are classified as moderate as opposed to heightened should not necessarily mean there is no risk to mitigate in these areas. If all heightened areas were removed and assumed surveyed then the Jenks natural classification would designate a majority of moderate areas as "heightened". Suggested survey areas are included in Appendix D.

When reviewing the risk model, it is necessary to consider it is just a model and there are factors that introduce risk in some areas more than others. The select areas reviewed in this report highlight the pockets of remaining risk and some of the reasons for them.

There is a compelling reason to change the risk assessment thinking away from being so traffic dependent. Inherent risk has highlighted risk pockets where vessels could potentially transit through even though they may not have done so already. This may happen through planned changes or through unplanned transits. From a resilience standpoint larger freight vessels may wish to pass through an area to provide aid post a natural event. A vessel may be forced into an area of higher risk to avoid collision or be forced into an area by a loss of power. Furthermore, surveying in some waters may open up ways for navigation through areas rather than around them and result in less carbon emissions.

Improvements and Future Risk Assessments

AIS Traffic Data

The main difficulty in conducting the risk assessment calculation lies in the handling of AIS traffic. The 39 variables which make up the primary risk calculation are very simple to update and require a basic level of GIS knowledge to handle. The risk calculation without the traffic variables is possible without even the use of SQL and can be done using simple field/table calculations available in most GIS software. AIS traffic from its raw data format requires a lot more data handling and room for error. By nature, the AIS formats are fragmented and not suitable for the risk model, requiring a lot of work to get them usable. Furthermore, the information on vessels particulars such as vessel type and size is not readily available and multiple sources are required to get that information. The combination of AIS formats and lack of vessel information introduces a high possibility of error into the risk model. An improvement in the handling of AIS traffic would significantly help in doing future risk assessment calculations. It is suggested that for future risk assessments another path is taken for AIS traffic. Through the risk assessment exercise, it became clear that other government agencies handle AIS traffic data for their various uses but are bound by data licencing agreements or privacy concerns before releasing. It is therefore worth investigating if the AIS data can be made available to LINZ in a more usable format. This may involve paying into the "all of government" contract or paying a supplier to provide the information in a more usable and authoritative format.

Another possibility is to use the Global Maritime Traffic Density Service (GMTDS) outputs. This dataset is provided by the United States National Geospatial Intelligence Agency (NGA) and the website states the main goal is to enhance maritime safety. The service portrays AIS traffic density in raster formats into 1km². The largest downside to this approach is the fact that the current risk model counts transit segments based on distance and the GMTDS output sum ups the time segments in each cell. A conversion factor will need to be applied to convert time to distance to incorporate the GMTDS input into the risk calculation. A further downside is that the current risk model grid is not the same as the GDMSS grid (the current risk model is an arbitrary grid that is irregular whereas the GMTDS grid is a standard 1km² grid size). One could amalgamate and then join the grids with spatial join operations to bridge the gap but that involves the handling of vast volumes of data in a very inefficient way. There is also the lack of granularity in the GMTDS output in that there are only 8 classifications of vessel and unlike the current risk model there is no distinction made for vessels over a certain size. It is worthwhile conducting a small trial to reverse-engineer the same solution as the 2024 output using the GMTDS data. At the time of writing this report there was uncertainty as the future of this data service with NGA looking to discontinue the service at the end of 2024. It would be prudent to check the service has a future before progressing any investigations into how this could be incorporated into in the risk assessment model.



Figure 35 - GMTDS AIS density output for December 2018

CATZOC degradation

It should also be investigated how CATZOC A1 and A2 surveys degrade with time. Other hydrographic offices such as the Australian Hydrographic Office (AHO) automatically downgrade CATZOCs based on time since the survey. Downgrading is merited as the seabed can change over time with sediment build up and possibility of obstructions brought about by significant storms. The new S-100 standard does allow for "temporal variance" in its encoding of Quality of Bathymetric Data, which replaces S-57 CATZOC encoding. However, little thought is given as to how surveying an area can inform the risk picture around temporal variance. The risk model does consider Age of Survey however this has about 1/3 of the weight of CATZOC in the risk calculation.

Appendix A – Risk Weightings

		0	1	2	3	4	5	Rating	Category Weighting	Model Weighting	Overall Weighting	
		CONTINUOUS SCALES										
Traffic	Potential Loss of Life		Insignificant	Low	Moderate	High	Catastrophic		42.0%		25%	
	Potential Oil Outflow		Insignificant	Low	Moderate	High	Catastrophic		38.0%			
	Vessel Damage + Salvage Costs		Insignificant	Low	Moderate	High	Catastrophic		5.0%			
	Economic Costs		Insignificant	Low	Moderate	High	Catastrophic		15.0%			
		LIKELIHOOD SCALES										
Causation Risk Criteria	Charting	Chart Quality	A	B	C	D	U	3		15.00%	25%	
		Survey Age	<5 years	5-10 years	10-20 years	20-30 years	>30 years	1	30.0%	5.00%		
		Chart Scale and Extents	Excellent	Good	Moderate	Poor	Unacceptable	2		10.00%		
	Route Characteristics	Navigational Complexity	>10nm	Open Sea >10nm	Offshore Navigation (5-10nm)	Coastal Navigation (1-5nm)	Port Approaches	Constrained Navigation (<1nm)	3	17.5%		8.75%
		Depth of Water 15m Contour	>10nm	5-10nm	2.5-5nm	1.5-2.5nm	1-1.5nm	Within 1nm	2			5.83%
		Traffic Density		Insignificant	Low	Moderate	High	Catastrophic	1			2.92%
	MetOcean	Prevailing Wave/Wind		Sheltered at Most Times	Mainly Sheltered	Moderate Exposure	Mainly Exposed	Exposed on Most Days	3			5.83%
		Tides/Current	Open Sea	1-2kts	2-3kts	3-4kts	4-5kts	>5kts	3	17.5%		5.83%
		Longwave/Surge		Very Unlikely	Unlikely	Occasional	Often Poor	Frequent	2			3.89%
		Poor Visibility		Very Unlikely	Unlikely	Occasional	Often Poor	Frequent	1			1.94%
	Navigational Hazards	Sea Mounts	>10nm	5-10nm	2.5-5nm	1.5-2.5nm	1-1.5nm	Within 1nm	1			2.19%
		Isolated Dangers - Rocks/Wrecks/etc.	>2.5nm	2.5-2nm	1.5-2	1-1.5nm	500m-1nm	<500m	2	17.5%		4.38%
		Charted Tidal Hazards	>2.5nm	2.5-2nm	1.5-2	1-1.5nm	500m-1nm	<500m	2			4.38%
		Breaking Reefs	>10nm	5-10nm	2.5-5nm	1.5-2.5nm	1-1.5nm	Within 1nm	3			6.56%
	Mitigation	Harbour Risk Mitigation Resources		Available				Absent	2	10.0%		4.00%
		Pilotage		Pilotage				No Pilotage	3			6.00%
	Bathymetry	Dynamic Seabed - Estuarial		Insignificant	Low	Moderate	High	Significant	3			4.50%
		Seismic/Volcanic Factors	>10nm	5-10nm	2.5-5nm	1.5-2.5nm	1-1.5nm	Within 1nm	2	7.5%		3.00%
		CONSEQUENCE SCALES										
Consequence Risk Criteria	Loss of Life		100.0%	102.5%	105.0%	107.5%	110%	N/A	N/A		50%	
	Property		100.0%	102.5%	105.0%	107.5%	110%	N/A	N/A			
	Environmental Impact	Formal Reserves - World Heritage	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	3			17.65%
		Marine Reserves	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2.5			14.71%
		Coastal (Sensitive Resources)	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2			11.76%
		Wetland Resources	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	1.5			8.82%
		Aquaculture/Fishing Grounds/Shellfish Harvest Sites	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2	N/A		11.76%
		Tourism	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2			11.76%
		Cultural (Iwi)/Treaty History Sites	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2			11.76%
	Recreational/Social Amenity	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2		11.76%		
	Economic Impact	Port Access Channels	>2.5nm	2.5-2nm	1.5-2nm	1 to 1.5nm	500m to 1nm	<500m	3			24.00%
		Critical Infrastructure (Berths) - Economic Contribution	Absent	Very Low	Low	Moderate	High	Critical	1			8.00%
		Proximity to Sites of High Economic Contribution	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2			16.00%
		Proximity to Sites of Moderate Economic Contribution	>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	1	N/A		8.00%
Proximity to Sites of Low Economic Contribution		>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	0.5		4.00%		
Cruise Ship Stops		>20nm	10-20nm	5-10nm	2.5-5nm	1-2.5nm	<1nm	2		16.00%		
Pipelines/Cables		>10nm	5-10nm	2.5-5nm	1.5-2.5nm	1-1.5nm	Within 1nm	3		24.00%		

Appendix B – Risk Calculation

```

Add R_Caus
(( [L_CQual]*0.15)+( [L_CAge]*0.05)+( [L_CAdeq]*0.1)+( [L_Nav]*0.0875)+( [L_Depth]*
0.0583333)+
( [L_TDen]*0.02916666)+( [L_Prev]*0.0583333)+( [L_Tides]*0.0583333)+( [L_LWave]*0.0388888
)+
( [L_Vis]*0.0194444)+( [L_Mounts]*0.021875)+( [L_ISOD]*0.04375)+( [L_TidHaz]*0.04375)+
( [L_Reefs]*0.065625)+( [L_Mitig]*0.04)+( [L_Pilot]*0.06)+( [L_Dynamic]*0.045)+( [L_Seis]*
0.03)
    
```

not calculating x 100%

```

Add R_Env
( [C_WHerit]*0.1764706)+( [C_MarRes]*0.1470588)+( [C_CoaRes]*0.1176471)+( [C_Wetl]*
0.0882353)+
( [C_Fishing]*0.1176471)+( [C_Tourism]*0.1176471)+( [C_Cult] *0.1176471)+( [C_Rec]*
0.1176471)
    
```

```

Add R_Econ
([C_PortAcc]*0.25)+( [C_CritInf]*0.0833333)+( [C_HiEcon]*0.1666666)+
( [C_ModEcon]*0.0833333)+( [C_Cruise]*0.1666666)+( [C_PipCab]*0.25)
    
```

```

Add Risk_Pol
(((( [T_Oil]* [R_Caus])/5)* [R_Env])/5)*0.38

Add Risk_PPl
(((( [T_Lol]* [R_Caus])/5)* [C_Resp])/1.1)*0.42

Add Risk_Sal
(((( [T_Costs]* [R_Caus])/5)* [C_Salv])/1.1)*0.05

Add Risk_Econ
(((( [T_Econ]* [R_Caus])/5)* [R_Econ])/5)*0.15
    
```

T_o = traffic

Traffic inputs

6 9

```

Risk Score
[Risk_PPl]+ [Risk_Pol]+ [Risk_Sal]+ [Risk_Econ]
    
```

sum-consq x risk-caus

Appendix C – Stakeholder Engagement Form

NZ Hydrographic Risk Assessment 2022

Background

The New Zealand Hydrographic Authority (NZHA), as part of Land Information New Zealand (LINZ), is responsible for the provision of hydrographic services to meet New Zealand's international obligations under SOLAS Chapter V and is embarking on a New Zealand Hydrography Risk Assessment. A risk assessment was last done in 2016 and has informed the LINZ hydrographic survey program over the last six years. Now that program of work is coming to a close another risk assessment is being conducted to identify any remaining areas of risk and inform survey and charting efforts in coming years.

The NZ Hydrography Risk Assessment will be a systematic process that is evidence based, founded on risk and employs spatial analysis techniques to identify and prioritise areas of risk to help prioritise hydrographic surveys to improve maritime safety in New Zealand.

The risk model is created in a GIS and utilises a multitude of different datasets. Shipping traffic using actual vessel positions from Automatic Identification Systems (AIS) data make up one of a number of layers of location information. The use of GIS to display areas of risk spatially over an area provides an easily interpreted output for this type of risk assessment. The final result is a simple heat map showing areas of comparative risk which is easily understood by a wide audience.

Data Gathering

A key component of the risk assessment is the gathering of location information and data to support the identification of areas of risk and prioritise future hydrographic surveys. This will ensure the nautical charts are adequate and accurate to meet the needs of contemporary shipping, maritime safety and the protection of the environment. The quality of the data gathering achieved will directly influence the quality of the output.

An overview of the type of data and information required at this stage is provided below, followed by a section where the information can be collated.

The period years of the data and information acquired is ranging from 2016 to 2022.

Shipping and Port Systems

- Types of vessels and characteristics (including LOA and GRT)
- Harbour characteristics, Infrastructure, AtoNs
- Harbour Ferry and Coastal Ferry Routes, Movements and Passenger Volumes
- Coastal Shipping Routes, Cargo Types and Volumes
- Passenger Volumes (port throughput) (Local Operators (numbers or estimate))

- Vessel Incidents and Statistics
- Oil Spill Incidents and Volumes/Statistics
- Berths Key to the Port Operations
 - Berths with high passenger volume

Environment

- The availability of Geospatial data layers which would include:
 - Marine reserves (DOC or Regional Council)
 - Coastal Reserves of importance.
 - Identified Breeding Grounds (Coastal)
 - Reef, Mangroves or other type of Wetlands
 - Coastal Recreational areas
 - Culturally sensitive areas (regional, local)

Tourism

- Tourism focus areas including number of visitors or data
- The Regional Value Estimate of the Coastal Tourism market
- Local tourist vessels destinations (current or proposed)
- Cruise Ship Stops or Destinations (current or proposed)
- Past and Future Cruise Schedule
- Local Vessel routes and passenger volumes.

Local Economic Information

- Coastal centres of highest economic contribution in the Region
- Coastal locations with businesses sensitive to shipping incident involving pollution.
- Regional GDP data
- Regional Tourism data.

Local Contacts

- Fishing Operators (representative organisations)
- Recreational Clubs (representation)
- Local Iwi consultation links.
- Local Commercial Operators (passenger/Charter - Sea)
- Tourism Offices – Statistics.
- Organisations with Coastal Interest of relevance to Charting

General Information
Name/Organisation:
Team/Unit:
Contact details:
Geographical area(s) of interest:
Hydrographic interest(s) (i.e. fishing, conservation):
Are you able to provide a GIS layer showing your area(s) of interest (i.e. shape file)?

Geospatial Data
The existence of geospatial data i.e. marine reserves, protected areas, environmental or cultural areas of importance?
If YES, please describe:
Is this data available for use outside your organisation? YES / NO
If YES, please detail:
<ul style="list-style-type: none"> • Data format i.e. shape file
<ul style="list-style-type: none"> • Licensing requirements
<ul style="list-style-type: none"> • How can it be accessed?

Vessel, Passenger and Cargo Data

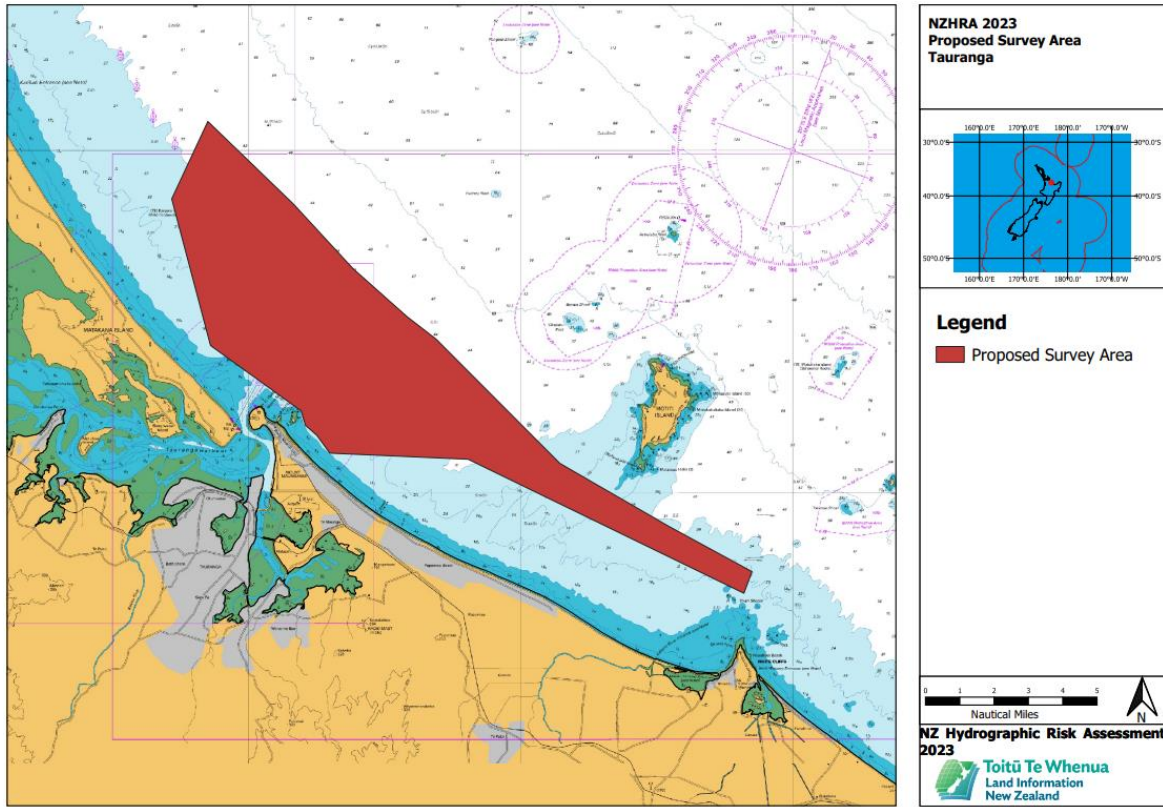
The availability of movement statistics/movement records for SOLAS Vessels
 The availability of movement statistics/movement records for Domestic Vessels
 Would the port company be able to provide analysis of this traffic (Spreadsheet output).

Type	No. of Port visits/yr	Min/Max/Distribution by month				
		Length (m)	Draught (m)	Size (GT)	Passenger/ crew complement	Cargo Volume
SOLAS vessels (TOTAL)						
Cruise vessels						
Container Vessels						
RO/RO						
General cargo						
Bulk carriers (inc. timber)						
Tankers (OIL)						
Chemical Tankers (Annex II)						
Reefers						

Coastal Shipping (Total)						
Type	No. of visits/yr	Min/Max/Distribution by month				
		Length (m)	Draught (m)	Size (GT)	Passenger/crew complement	Cargo Volume
Containers						
General cargo						
RO/RO (Cargo)						
Ferry						
Bulk carriers (inc. timber)						
Tankers Oil						
Chemical Tankers (Annex II)						
Reefers						

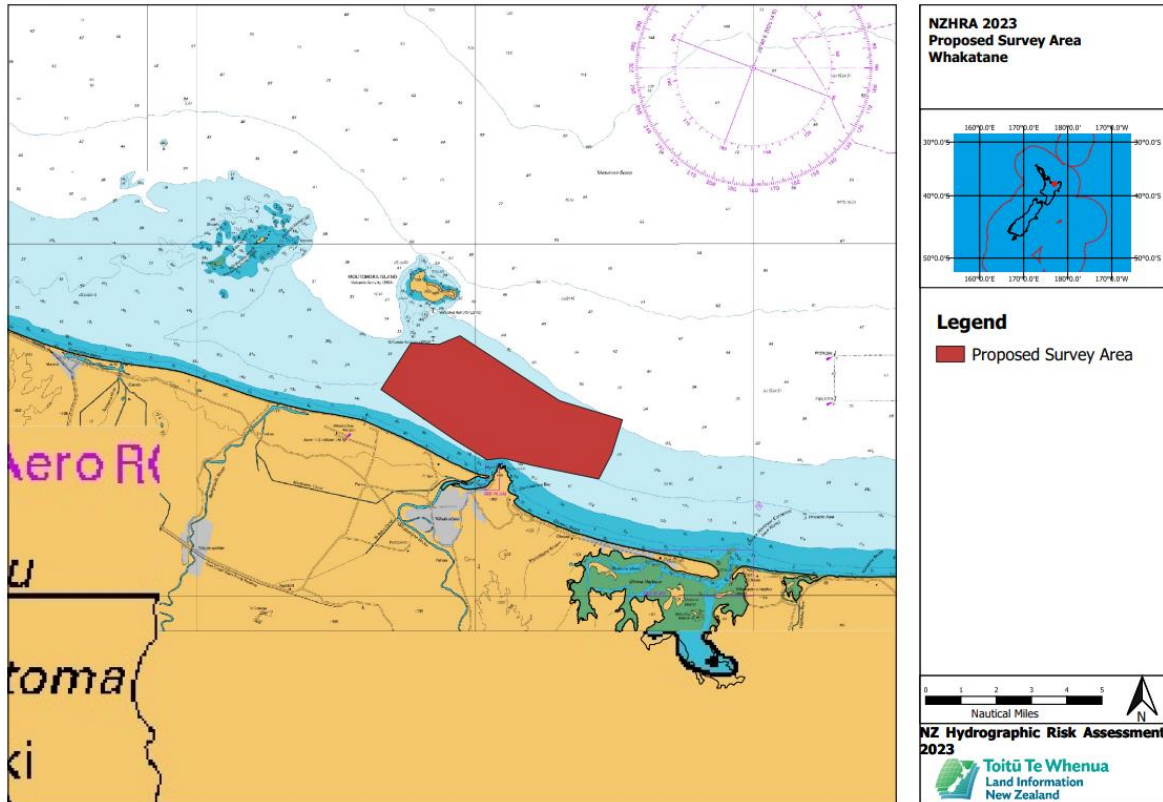
Domestic vessels operating locally (TOTAL)						
Type	No. of visits/yr	Min/Max/Distribution by month				
		Length (m)	Draught (m)	Size (GT)	Passenger/ crew complement	Cargo Volume
Harbour Ferries						
Passenger charter vessels (local)						
Fishing Vessels						
Cruising yachts						
Recreational Craft	Craft Numbers by Harbour					

Appendix D – Proposed Survey Areas

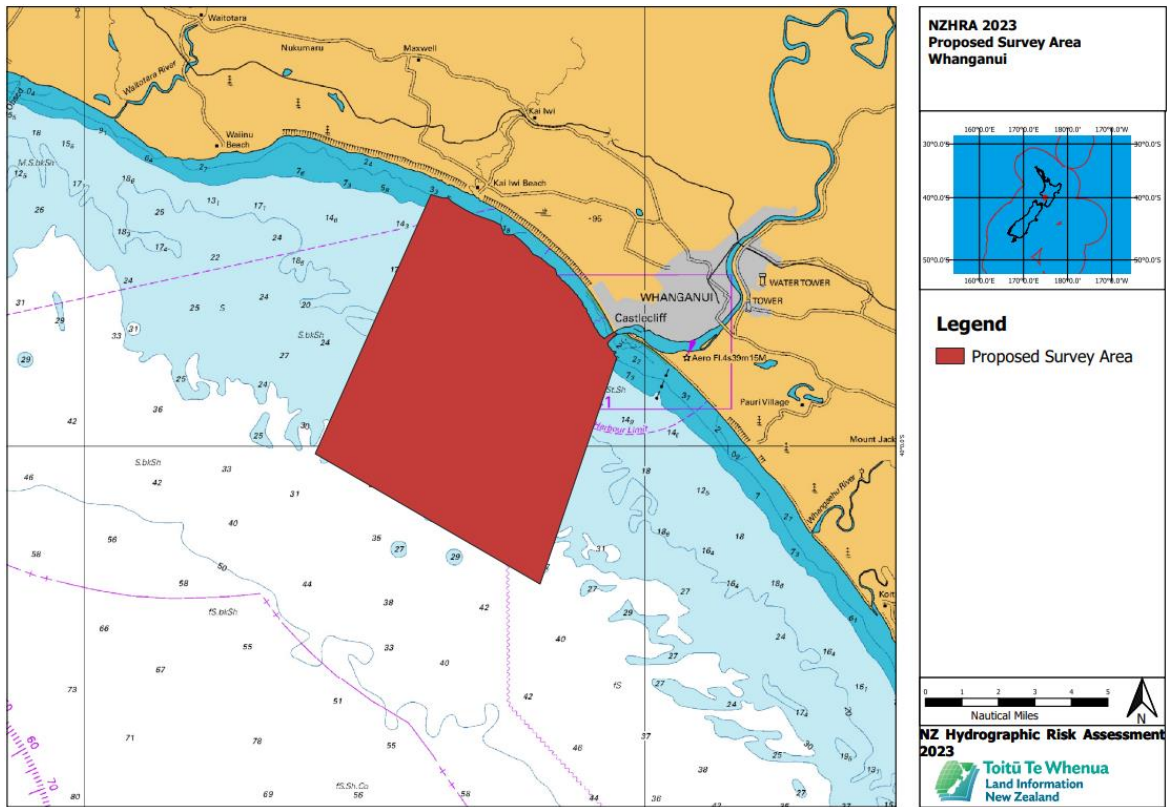


Recommended Tauranga survey area

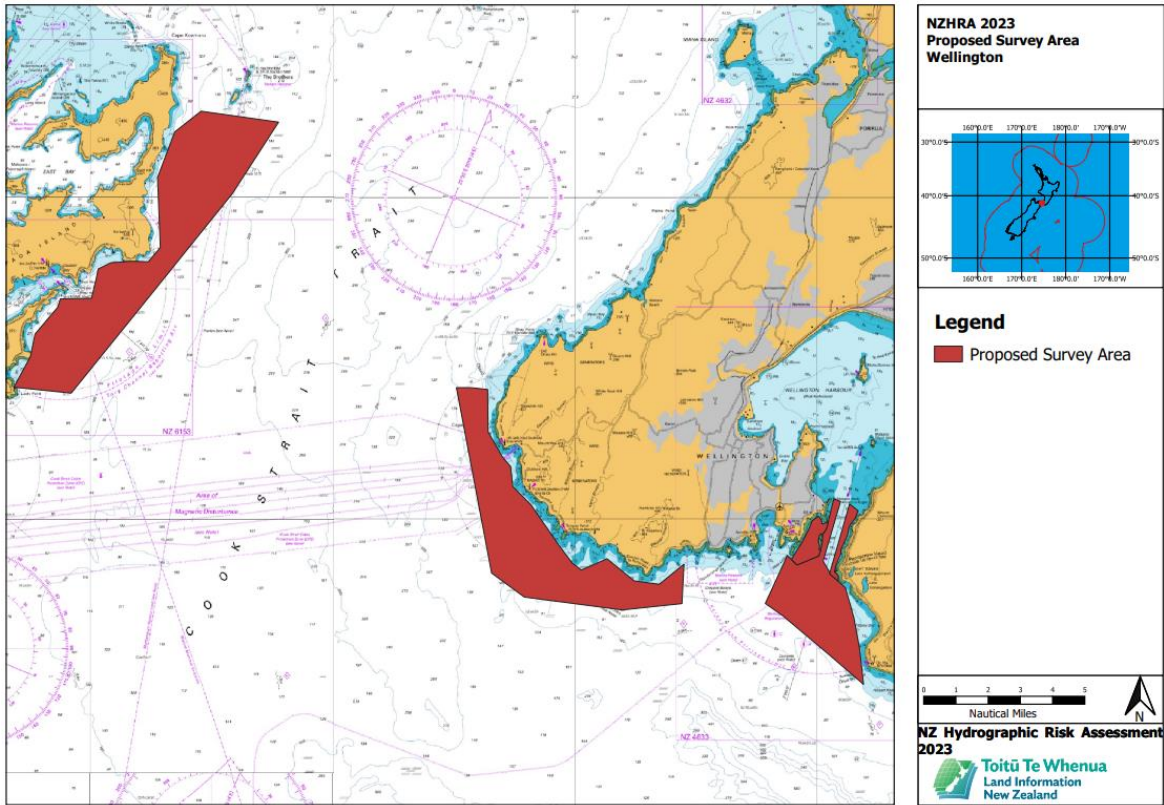
Through discussions with the BOPRC, the harbourmaster's team advised of the intention to anchor this season's cruise ships south of Moutohorā Island and transfer passengers to the Whakatāne marina. This is to take the strain off the Port of Tauranga and provide access to tours of inland areas such as Rotorua. These inputs from the harbourmaster add to the justification for surveying in the proposed areas shown in the figure below.



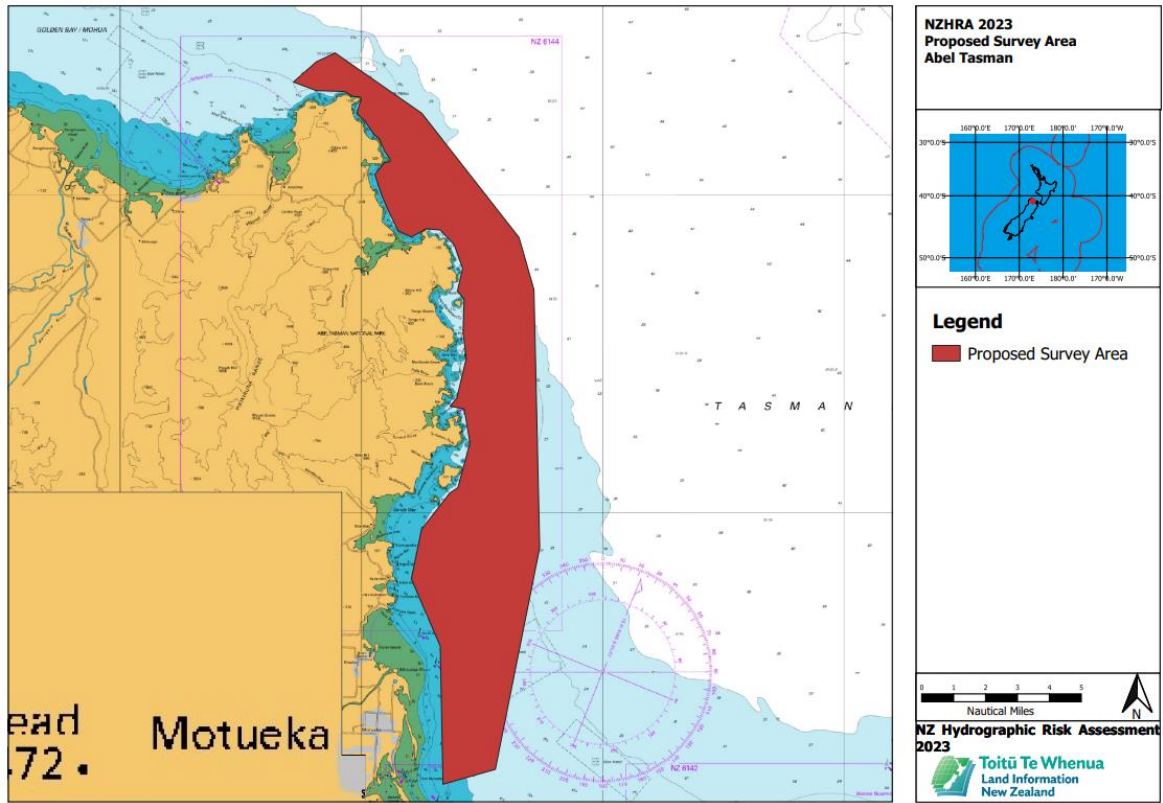
Recommended Whakatāne survey area



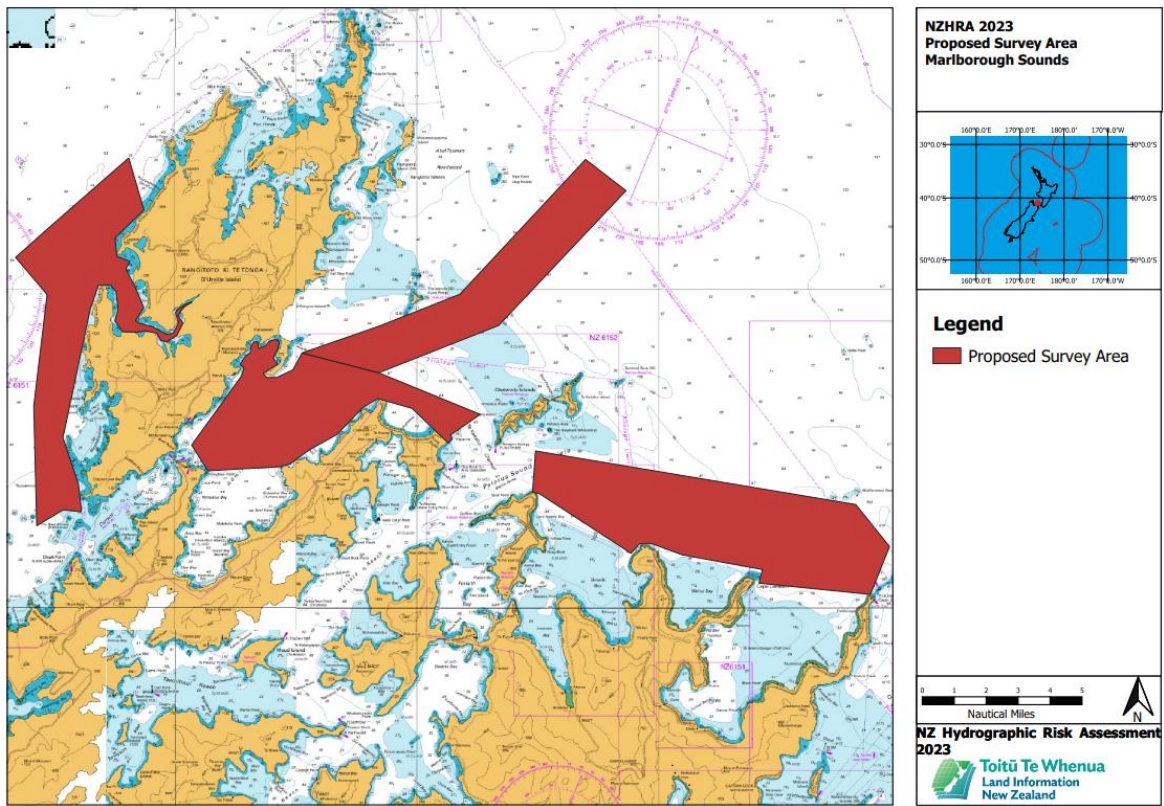
Recommended Whanganui survey area



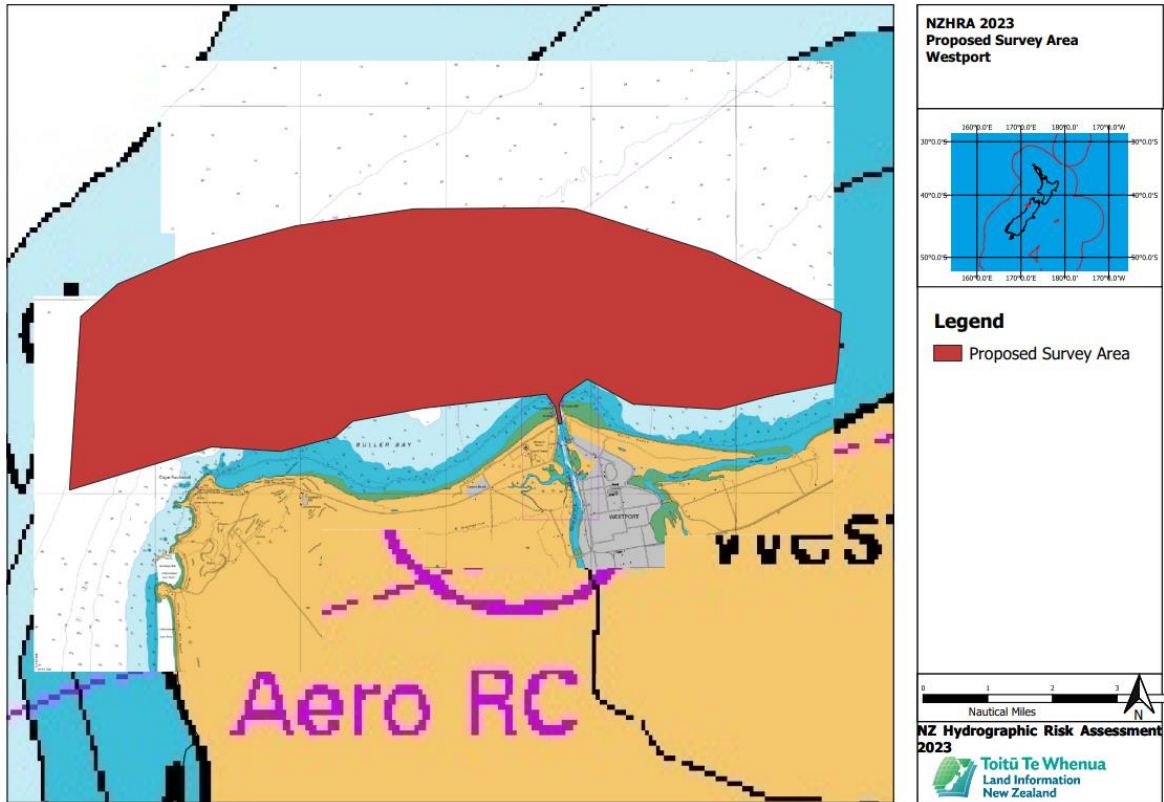
Recommended Wellington survey area



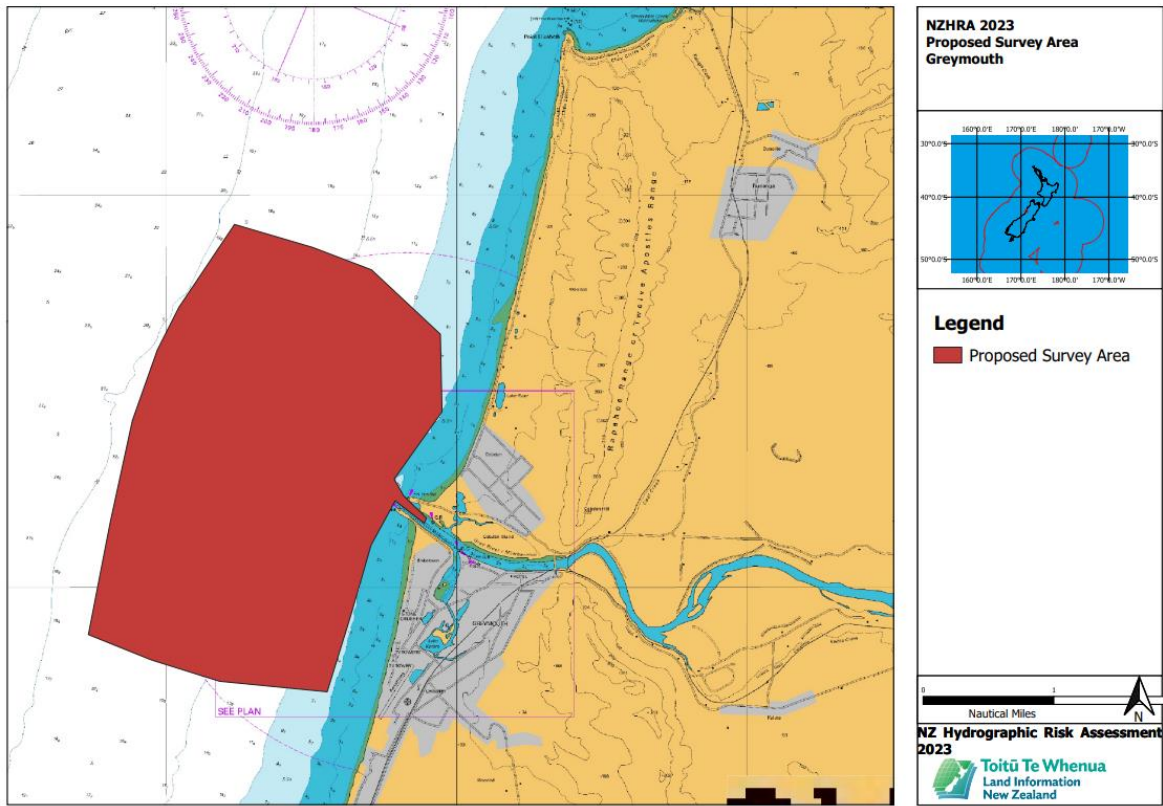
Recommended Abel Tasman survey area



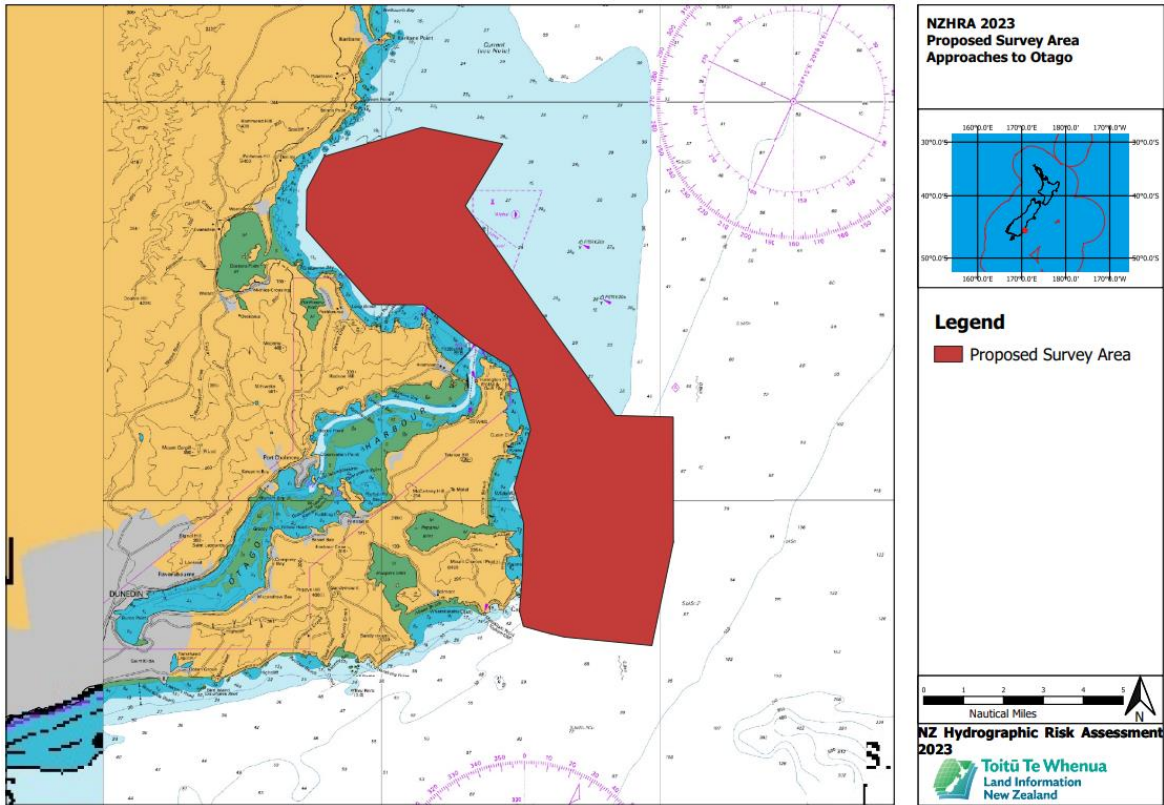
Recommended Marlborough Sounds survey area



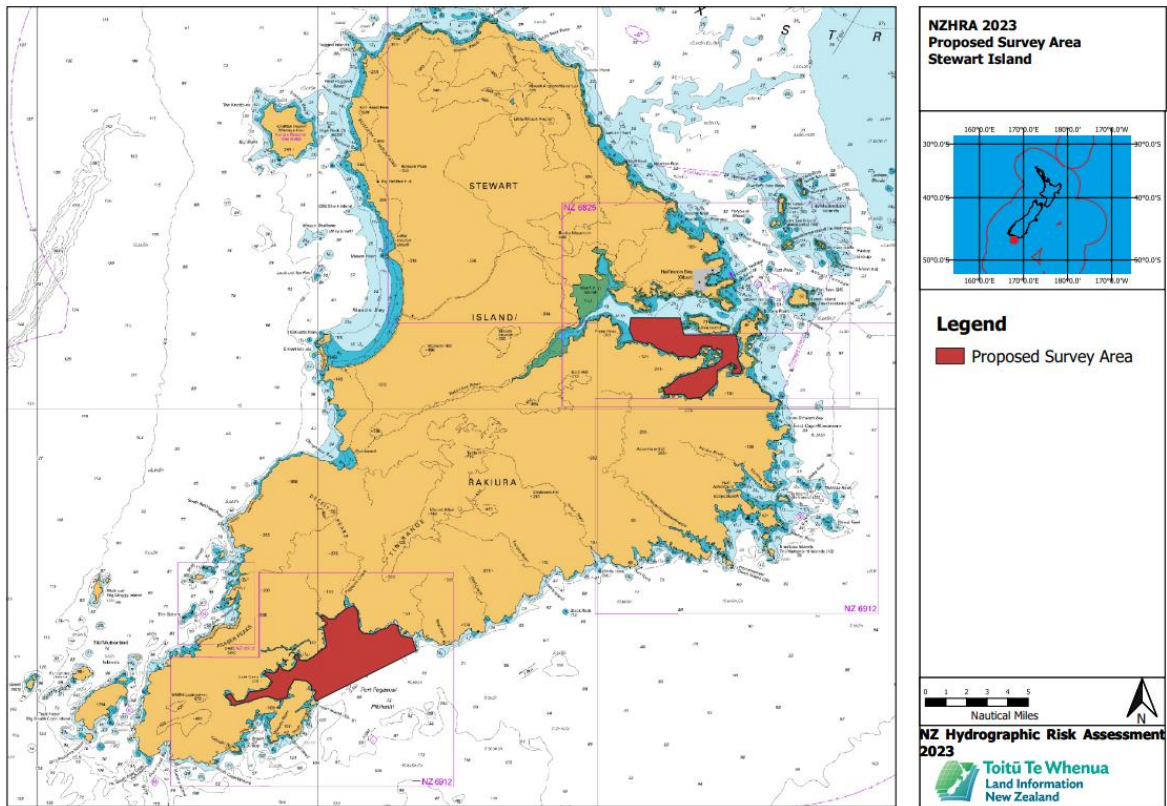
Recommended Westport survey area



Recommended Greymouth survey area



Recommended Otago survey area



Recommended Stewart Island/Rakiura survey area