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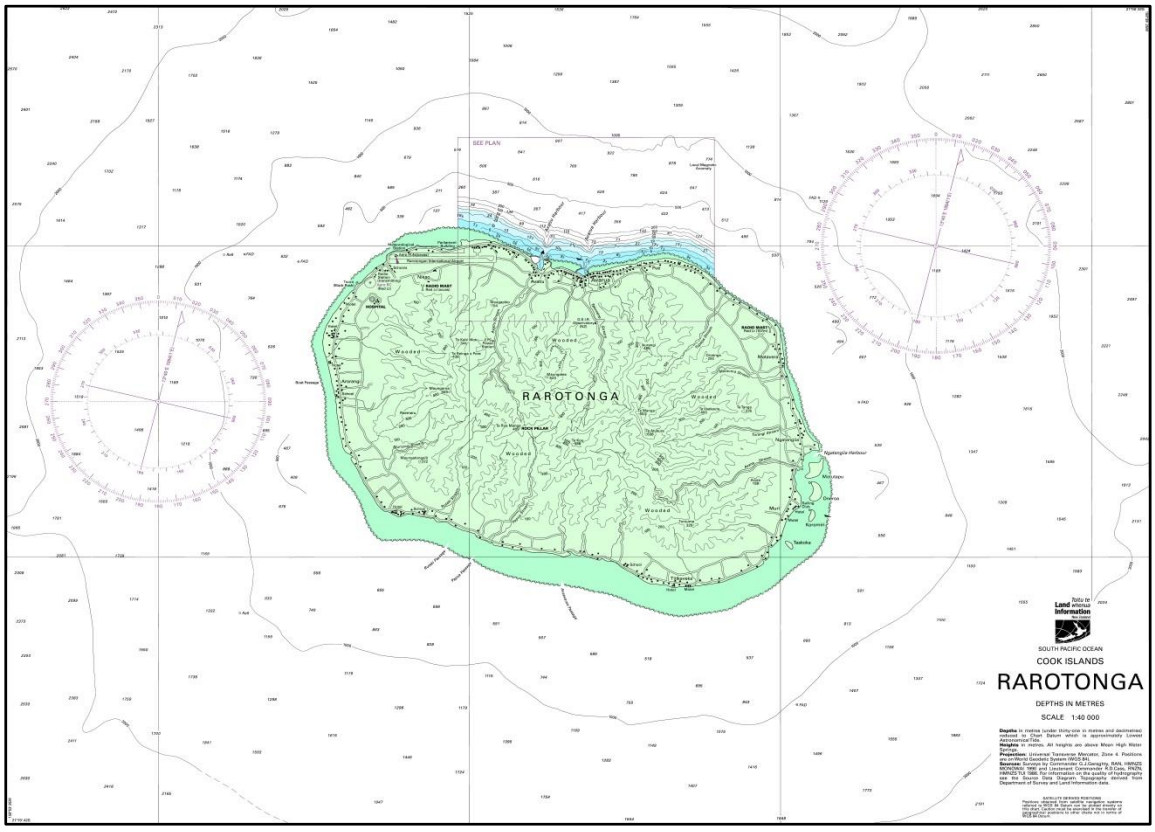
# SOUTH-WEST PACIFIC REGIONAL HYDROGRAPHY PROGRAMME

## COOK ISLANDS RISK ASSESSMENT - REPORT SYNOPSIS

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## MARICO MARINE NEW ZEALAND LTD

# SOUTH-WEST PACIFIC REGIONAL HYDROGRAPHY PROGRAMME

# COOK ISLANDS RISK ASSESSMENT - REPORT SYNOPSIS

| | |
|---|---|
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**The views expressed in this publication do not necessarily reflect those of the New Zealand Government.**

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**20th January 2015**

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## Annex A Benefits of Charting Upgrades for the Cook Islands

# 1 INTRODUCTION

This hydrographic risk assessment allows the Cook Islands Government, with the support of regional charting authorities, to come to a decision about the nature and scope of chart improvement surveys in the Cook Islands. It provides recommendations and conclusions to assist decision makers to prioritise hydrographic surveys throughout the Northern and Southern Cook Islands. These are based on the needs of contemporary shipping for the provision of accurate and adequate nautical charts.

The overall conclusion, based on a navigational safety perspective, is a need for improved charting in some areas of Cook Islands waters. The findings are supported on grounds of traffic risk and the potential for economic growth. The cost benefit analysis considers economic and safety advantages for international, as well as domestic coastal shipping in the Cook Islands.

## 1.1 SCOPE

The hydrographic risk model identifies shipping routes at risk, in relation to traffic type, size and density, against the consequence impact criteria. This study uses the same risk criteria as used in the Vanuatu hydrographic risk assessment, 2011. The model combines AIS datasets and non-AIS local trading routes, with navigational hazards and areas of cultural/environmental/economic value to produce a cumulative risk model. Potential environmental damage impacts feature strongly, such as the presence of pristine and abundant lagoons, turtle breeding grounds, and marine reserves, including the current designation of the Southern Cook Islands Marine Park.

The Exclusive Economic Zone (EEZ) of the Cook Islands was divided into cells of 20 kilometre squares in order to compare risk levels. For there to be hydrographic risk there must be a combination of traffic, likelihood criteria and consequence criteria. The traffic type, size and volume thus influences the risk levels in each cell associated with each of the criteria. Domestic coastal vessel trades and volumes were added as an overlay, by using Gross Tonnage (GT) as a measure of capacity on a route. The resulting risk matrix is shown in the main report.

The traffic analysis and risk model output are attached in full in the Annexes of the main report. A Cost Benefit Analysis result is presented in a spatial format within this synopsis (Figure 5), based on costs of singlebeam hydrographic survey and grounding risk reduction based on the existing chart quality already.

## 1.2 DATA SOURCES AND QUALITY

The risk approach is dependent on the quality of the input datasets. The satellite derived (S-AIS) data were augmented prior to use in the GIS modelling process. This was necessary because the S-AIS data are recorded at intervals when the satellite passes over the study area. The time period for the AIS update at the Cook Islands is currently between 6 and 8 hours.

The Cook Islands Port Authority provided a digital copy of port records for both international and domestic vessels calling at the port, together with hard copy of pilotage information. The datasets allowed an in-depth analysis of shipping trends, *seasonality* and size of vessels in comparison with freight volumes. Importantly, they were used to link S-AIS data to factual port calls. The identifiable vessels from port movements that were not in the AIS dataset could be manually routed-in, using known navigation patterns. The new database contained incorporated factual port data with S-AIS records.

### 1.2.1 Cost Benefit Data

For the Cost Benefit Analysis, hydrographic survey cost data, as published by different sources, was found to vary significantly. An average figure was used, with an additional task undertaken to test sensitivity by running the CBA model for different survey scenarios, to test for the change in Net Present Value for different types of survey technology. An assumption that singlebeam technology is deployed was used for costing purposes in the CBA model, which is cheaper to deploy than multibeam.

The CBA methodology was developed around other work suggesting a maximum benefit of 36% reduction in grounding frequency accrues from charting upgrades (source: Det Norske Veritas). This work was developed further to link a variable risk reduction percentage, to the ZOC[1] category (or chart quality). Table 1, below, shows the result of this development and the values used for the cost benefit work. Figure 2 presents the results of the CBA exercise.

[1] The ZOC category (Zone Of Confidence) is a charting standard based on depth accuracy and survey seafloor coverage. Technically, it is an MQUAL attribute available to the user to advise of charting standard. It is not used by all Hydrographic offices, but is used by LINZ

| Charting Upgrade Risk Reduction Available | |
|---|---|
| ZOC A | 2.5% |
| ZOC B | 5% |
| ZOC C | 10% |
| ZOC D | 20% |
| ZOC U | 30% |
| Fathom Charts | 45% |

**Table 1 : CBA Risk Reduction Relationship to ZOC Category**

## 1.3 VESSEL TRAFFIC OVERVIEW

The Cook Islands covers a vast area and therefore the majority of vessel movements within the EEZ are through-traffic, either between the Americas and South East Asia or Australasia or else traffic moving between other island groups. In particular, large numbers of vessels are tracked to the west of the Cook Islands, in Samoa and also to the east, near Tahiti.

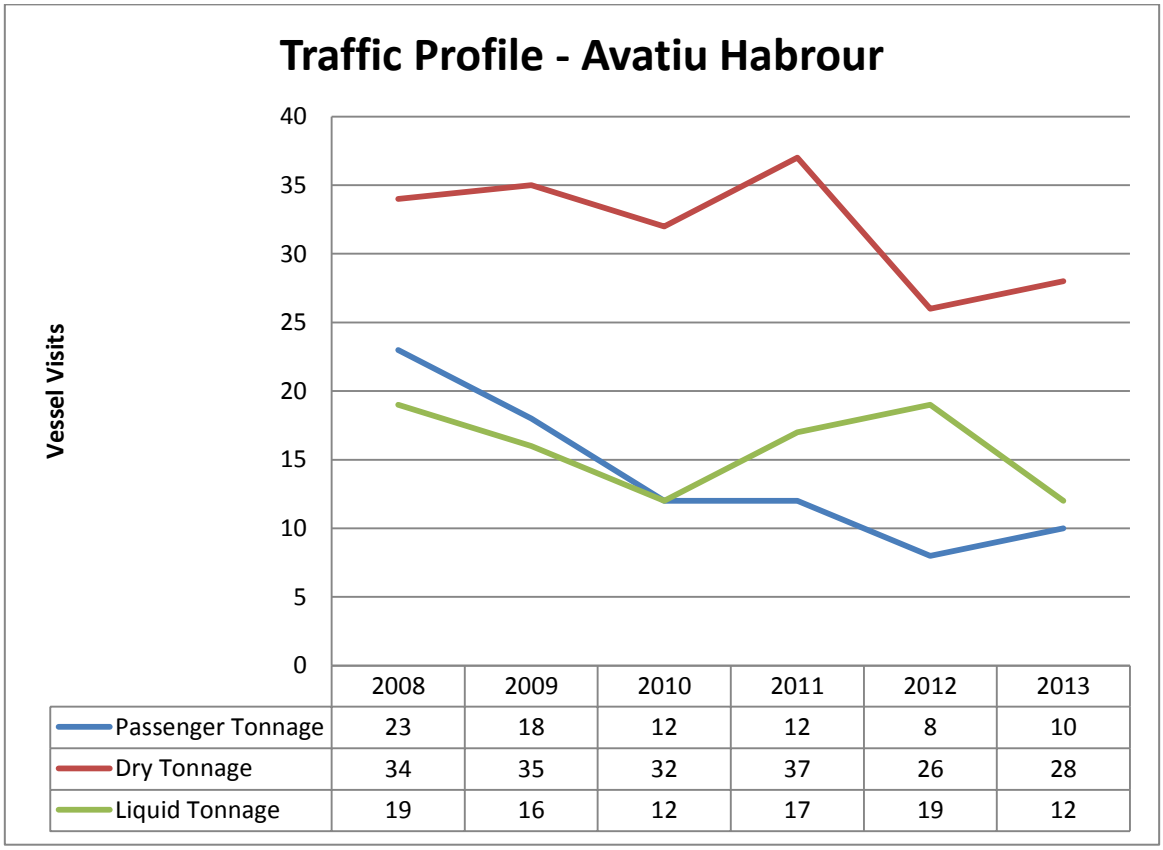
Dry cargo ships and domestic ferries consist of the largest contributors to the transit risk. Avatiu Harbour receives the largest ship-traffic volume of all the Cook Islands. The harbour is a feeder destination for the Oceania - Pacific route. The route connects New Zealand with the main South West Pacific ports.

Avarua is the main town of Rarotonga, and the seat of the Cook Island Government. Avarua is also a recreational harbour. The main commercial harbour of Rarotonga (and the Cook Islands) is at Avatiu, which attracts the overwhelming majority of SOLAS vessels, including dry cargo, cruise ships and yachts. It is also an additional harbour for the Oceania Pacific route, where cargo is worked.

The important cruise destinations for the Cooks are Rarotonga, Aitutaki and to a lesser extent, Atiu. Domestic coastal shipping services dominate the traffic volume for the Northern Cooks. Although the island group lacks berthing facilities, data gathering determined that cruise vessels do occasionally visit Atiu, but in low numbers. Interestingly, at Suwarrow, there is a significant volume of recreational craft in any one year, although this type of vessel makes a low risk contribution.

## 1.4 PORT TRAFFIC ANALYSIS

Overall, vessel visits at the Avatiu Harbour are steadily declining (Figure 1). This is based on port movement records taken over a five year period. In response to Pacific trade competition, the harbour has been the subject of development, upgrade funded by aid which was completed in 2013. The same year, dry cargo tonnage increased by 30%, which is likely to be the direct result of this port development.




| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| Passenger Tonnage | 23 | 18 | 12 | 12 | 8 | 10 |
| Dry Tonnage | 34 | 35 | 32 | 37 | 26 | 28 |
| Liquid Tonnage | 19 | 16 | 12 | 17 | 19 | 12 |

**Figure 1: Avatiu Harbour (Port of Rarotonga) - Traffic Profile**

Similarly, bulk liquid vessels visits are marginally declining; however, visiting vessel size has also increased.

The cruise sector is interesting in this part of the South West Pacific, with the market mostly being long distance cruising, with a small number of regular, but boutique vessels operating between Tahiti and the Cook Islands; data suggests cruising is either stagnant or in gradual decline during the period 2008-2013. There is a difficulty of landing passengers at Rarotonga during adverse weather conditions, as few cruise vessels can access Avatiu Harbour meaning the deployment of

passenger tenders for shore visits[2]. Regular aborted Rarotonga visits occur when cruise vessels cannot deploy tenders safely in the offshore (deep) waters. An alternative solution to this is the development of Arorangi jetty, an NZAid funded project, which facilitates a second landing option in an area of Rarotonga in more sheltered waters. This is expected to boost the cruise ship visit numbers for future years.

There is another quite important problem affecting any vessel with relatively high airdraft alongside Avatiu, which also affects cruise vessels. The final approach to Rarotonga airport runway aligns inbound aircraft with the port basin. When scheduled flights arrive, any vessel carrying hazardous cargos is obliged to move out to anchor, as is any vessel with an airdraft of above 28metres. This obviously affects most tonnage, but impacts *all* cruise vessel operators, who have a need for their vessel to be alongside for a day to provide services to passengers. The option of runway realignment is both difficult and expensive. As tanker operations are similarly affected, plans to place a SBM or jetty on the opposite side of Rarotonga (which is also in the lee of the prevailing swell direction) were under evaluation. It will be interesting to determine the number of cruise operations successfully using the new jetty at Arorangi, as this also alleviates this problem.

The island of Aitutaki has the second largest population in the Cook Islands (2011 census), making Arutanga Harbour also a port of economic importance to the Cook Islands. The harbour has ambitious development plans, which are in some measure justified as cruise operators have shown interest in future vessel calls. Like many of the Cook Islands, there is difficulty at Arutanga in facilitating berthing for modern cruise vessels that would allow direct gangway access ashore for passengers. Aitutaki cargo is mostly flown in from Rarotonga, but goods arriving by sea presently have to be offloaded offshore into a community barge. Development plans include the ability to berth modest sized vessels alongside, as well as facilities for visiting yachts.

There are clear signs of tourism and economic development potential for Aitutaki, but funding of the development provides challenge.

## 1.5 DOMESTIC COASTAL VESSELS

Inter-island domestic coastal shipping constitutes a significant economic activity in the Cook Islands. Domestic registered vessels tranship export goods from the outer islands to Avatiu Harbour. Similarly, goods imported at Rarotonga are transported to the other island groups by domestic vessels.

[2] Notwithstanding the narrow entrance channel, there is a 15 knot cross wind limit on entrance transit.

There are two main inter-island routes, Avatiu Harbour to the Northern Island Group and Avatiu Harbour to the Southern Island Group, with some domestic vessels carrying AIS transponders, but not all. Both routes appear to have scheduled services on a monthly basis. However, the frequency of service is, in realty, dependent on the cargo volume demands of each island. As the domestic cargo market size is really only suitable for one domestic operator, planned services are delayed until a commercially viable payload is confirmed. This is an important problem for the most distant northern islands, where the transit to, e.g., Penrhyn, can be about 5 days in each direction. This obviously affects both cargo and passenger movements by sea throughout the Cook Islands.

There have been some domestic vessel losses in service, which has brought about tonnage shortages, which is another factor in the infrequent cargo services that occur.

## 1.6 IHO CAPACITY BUILDING

The Cook Islands have already been the beneficiary of an IHO member funded visit (*IHO Technical Visit to the Cook Islands, February 2011*). The subsequent technical report made recommendations to the Cook Island Government for the development of a national Hydrographic Committee and areas for charting improvements.

# 2 REPORT CONCLUSIONS

The risk assessment results are shown pictorially in Section 7 of the main report, with Cost Benefit Results presented in Section 8. Key conclusions from the main report are presented below, followed by risk summaries.

## 2.1 ECONOMIC CONCLUSIONS

1) The Cost Benefit Analysis (CBA) for the Cook Islands is based on singlebeam survey costs. Even for (cost effective) hydrographic survey method, most of the Cook Islands will produce minimal NPV economic returns, because of low vessel traffic levels (Figure 5). Therefore, the safety *and* economic benefits of charting improvements would not outweigh the costs of survey. This is not a negative finding; it is the type of scenario on which a case is made for Aid funding to improve safety and efficiency.
2) Hydrographic surveys do, though, have the potential to deliver significant financial returns for the Cook Islands' cruise tourism sector, subject to the establishment of an accommodating fiscal regime.
3) The Cook Island's leading exports are black pearls and, to a lesser extent, copra and fresh produce. On average, import cargo volumes remain stable in terms of container numbers handled.
4) A potential benefit derived by practicable hydrographic surveys is the development of the deep mining industry in the Cook Islands.
5) A long-term cruise strategy could help to facilitate expansion of cruise calls to the Cook Islands. Rarotonga and Aitutaki do enjoy regular cruise calls, but occasional visits only occur at Atiu, Manihiki and Penrhyn. This is based on in-country records.
6) Regular and scheduled domestic shipping services are needed if economic trade between all of the remote islands is to be facilitated. Presently the more remote islands receive cargo services infrequently and sporadically. A domestic shipping strategy is needed to deliver scheduled freight services, as this will facilitate the development of domestic trade by providing routes to the markets of Rarotonga.

## 2.2 SOLAS VESSEL TRAFFIC ANALYSIS

7) Avatiu Harbour is the most significant port by ship traffic-volume. It has a relatively steady trade in containerised imports.

8) Two SOLAS general cargo vessels visit Avatiu Harbour, Rarotonga on a regular basis, including Arutanga Harbour, Aitutaki. These vessels represent the Pacific trade route connecting the Cook Islands with New Zealand, Australia, Tahiti and Samoa.

9) The Avatiu port development project is an important milestone for the Cook Islands shipping industry, completing 2013. The same year, dry cargo and liquid bulk tonnage increased, on average, by 30%. This growth is likely to be a positive result of the port development.

10) Cruise vessel visits have decreased over the last five years. Avatiu Harbour is small for modern cruise vessels and adverse weather conditions make entry transit dangerous. Cruise vessels mostly land passengers from offshore using their tenders. The development of Arorangi jetty provides a sheltered landing for cruise tenders. The jetty may also be an answer to an airdraft restriction at Avatiu Harbour for aircraft final landing approach which affects cruise vessels.

11) Arutanga, Aitutaki, also benefits cruise and dry cargo vessel calls, being the second Cook Island port in terms of SOLAS movements. Other Islands do occasionally experience cruise vessel calls, although these are one off visits by the smaller “boutique” section of the cruise market.

## 2.3 DOMESTIC COASTAL VESSELS

12) There are two key domestic trade routes in the Cook Islands (freight and domestic passengers); Rarotonga to the Northern Cooks Group, and Rarotonga to the Southern Cooks Group. A wider review of the trade, including routes, harbour facilities, as well as the option of a policy of development assistance to deliver regular scheduled services is required. Calls to the more remote Cook Islands are both sporadic and too infrequent; reliable shipping services are fundamental to the development of trade.

13) The Cook Islands domestic coastal fleet has a history of grounding losses. A review could secure potential improvement on the fleet, bearing in mind the successful example of the Aid assisted ferry service introduced into Tongan waters.

## 2.4 OFFICIAL NAUTICAL CHARTS

14) The risk assessment has determined areas where the accuracy and adequacy of charting should be reviewed against modern standards. The risk results for the Cook Islands are subdued, due to the low level of traffic overall and the rapid increases in ocean depth close to each island.

15) Improvements to charts, including improvements to charted island positions are needed as some islands are significantly out of position, when compared with modern satellite imagery on the WGS84 datum. For example Pukapuka is some 200m in error; Suwarrow and Nassau are some 300m in error and Aitutaki some 400m in error.

16) A number of islands have benefitted from substantial harbour enclosure developments, which remain uncharted. This hinders cruise penetration into the Cook Islands as voyage planners are unaware that potentially safe landing arrangements are present for their passengers; examples of these are Mauke and Mitiaro. Consideration needs to be given to adequacy of scale for use of harbour developments.

## 2.5 CONCLUSION BY REGION

### 2.5.1 Northern Cook Islands

17) Penrhyn presents heightened risk at the Taruia Pass into the lagoon, and moderate risk at Omoka Harbour. The key underlying influences are: the internationally recognised pristine and abundant nature of this atoll, which results in rapid coral growth as well as extensive turtle and rare species nesting areas. Negative to risk are the narrow lagoon entrance, uncertainty of depth and AtoNs of uncertain status. The wharf at Omoka is a critical location for the viability of the Northern Cooks fisheries patrol as it is *the* fuelling facility that provides patrols with the range necessary. There is potential for increased domestic vessel visits, as the present service levels are too low to encourage trading development. Penrhyn could be an attractive cruise destination. It is an important candidate for charting review on grounds of safety risk and guaranteeing the ongoing fisheries management missions.

18) Rakahanga shows a moderate risk at the west coastline of the island. This risk is mainly influenced by the high environmental and local economic importance of the island. Rakahanga is charted some 150 metres in error.

19) In Manihiki, the moderate risk level is scattered east and north of the island. Its economic and environmental importance, in combination with the moderate density of traffic, underlines this risk outcome.

20) Pukapuka presents a moderate risk result at the sea area east and west of the island. This arises from the domestic traffic coastal service and the SOLAS vessel transits, combined with a large numbers of marine reserves. The island is charted some 200m in error.

### 2.5.2 Southern Cook Islands

21) Palmerston shows a moderate level of risk, scattered north of the island. Large SOLAS vessels pass in the vicinity, which underpins this result influenced by the environmental importance of the island (turtle nesting sites).

22) At Aitutaki, there is a localised heightened risk which is concentrated at Arutanga Harbour and its approaches. The small harbour attracts SOLAS international ships, including containers and cruise ships. The heightened risk is generated from the key environmental importance of the marine reserves and breeding grounds. Passing SOLAS vessels extend the risk profile to south of the island. Aitutaki is charted some 400m in error.

23) Takutea shows isolated moderate risk at the eastern and western coast of the island, influenced by passing SOLAS vessels. It is uninhabited, but has an important Wildlife Sanctuary, of cultural importance to the islanders. A moderate number of yachts and day visits from Atiu have an effect on the risk results.

24) Atiu depicts a moderate risk level at the North West coast. An underlying factor is domestic vessel transits from Rarotonga, with community barge transits to Takutea Island. An uncharted berth is located at Taunganui landing, without recorded AtoNs. A review of charting and Aids to Navigation is justified by the risk result for mitigation effectiveness. Atiu is charted some 300m in error.

25) In Mauke, the moderate risk level is attributed to the domestic vessel visits in combination with the turtle breeding grounds located on the island. The island has an economic importance in the supply of domestic fresh produce exports to Rarotonga. It has an organised economy.

26) Rarotonga has an isolated area of significant risk at Avatiu Harbour which is surrounded by heightened risk. The island has both economic and environmental importance and attracts SOLAS international port calls for all types of vessels. The harbour is also the domestic coastal hub and therefore, a trade centre for the Cook Islands. The recent port development could possibly have improved tonnage capacity of the port, including larger tankers and dry cargo vessel port calls. These factors accumulate to deliver a localised significant risk result at the harbour entrance. However, it is exposed to heavy swell and weather limits for transit are low.

27) Cruise vessels mostly use their tenders to disembark passengers offshore and transit to a landing stage. Regular aborted visits occur due to conditions offshore. A second landing option in more sheltered waters (Arorangi Jetty) has recently opened, which may assist matters. This jetty also avoids air-draft restrictions if alongside Avatiu Harbour.

## 2.6 SUMMARY RISK TABLE

The following tables and risk model mapping provide an overview of the results of the comparative hydrographic risk assessment for the Cook Islands archipelago. It is a high level risk summary, which must be interpreted with care.

| COOK ISLANDS<br>Priority Areas for Safety Improvements<br>(Based on Comparative Risk Level) | | |
|---|---|---|
| **Island** | **Area** | **Comparative Risk Level** |
| **Rarotonga** | Avatiu Harbour Entrance and Approaches | **Significant** |
| **Penhryn** | Taruia Passage and North West Coast of Penhryn | **Heightened** |
| **Aitutaki** | Arutanga Harbour Entrance and Approaches | **Heightened** |
| **Rakahanga** | West Coast of Rakahanga | **Moderate** |
| **Manihiki** | Manihiki Anchorage, North Point and their Approaches. | **Moderate** |
| **Pukapuka** | Sea Area East and West of Pukapuka | **Moderate** |
| **Palmerston** | Lagoon and Sea Area North of Palmerston | **Moderate** |
| **Takutea** | West and East Coast of Takutea | **Moderate** |
| **Atiu** | North West Coast of Atiu | **Moderate** |
| **Mauke** | Mauke | **Moderate** |

**Table 2: Overall Comparative Risk Summary**

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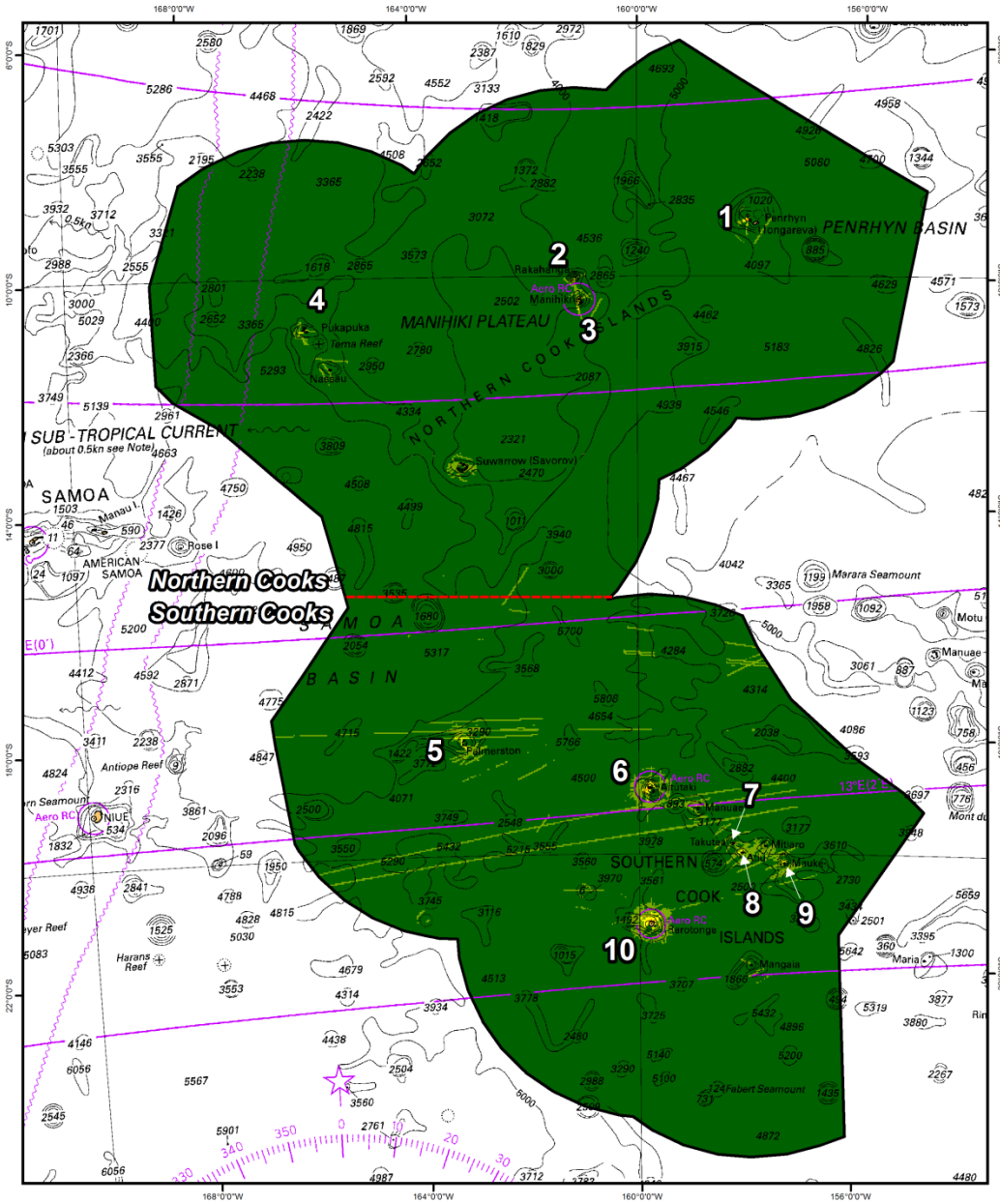
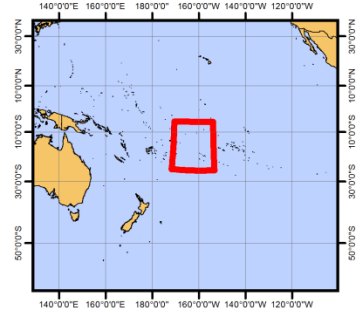



Figure Reference: 13NZ262_CookIsls_RiskModel17_01

| | |
|---|---|
| 1 | Taruia Passage and North West Coast of Penhryn |
| 2 | West Coast of Rakahanga |
| 3 | Manihiki Anchorage, North Point and their Approaches |
| 4 | Sea Area East and West of Pukapuka |
| 5 | Lagoon and Sea Area North of Palmerston |
| 6 | Arutanga Harbour Entrance and their Approaches |
| 7 | West and East Coast of Takutea |
| 8 | North West Coast of Atiu |
| 9 | Mauke |
| 10 | Avatiu Harbour Entrance and Approaches |

## Figure 2: Prioritised Risk Model Result Summary for Cook Islands



**Legend**

- Insignificant
- Heightened
- Low
- Significant
- Moderate

| Project No. | Date | Issue Number |
|---|---|---|
| 13NZ262 | 22/07/2014 | Issue 01 |
| **Author** | **Checked by** | **Scale at A3** |
| Andrew Rawson | John Riding | 1:8,000,000 |

**Data Source**
Satellite AIS (S-AIS) vessel track dataset recorded:
- January to March 2012
- July to October 2013
- December 2013 to January 2014

Chart 14061 courtesy of LINZ.
S-AIS supplied by: exactAIS

Coordinate System:
WGS 1984 UTM Zone 4S
Projection:
Transverse Mercator
Datum:
WGS 1984
Units:
Meter

0 50 100 200 300 N
Nautical Miles

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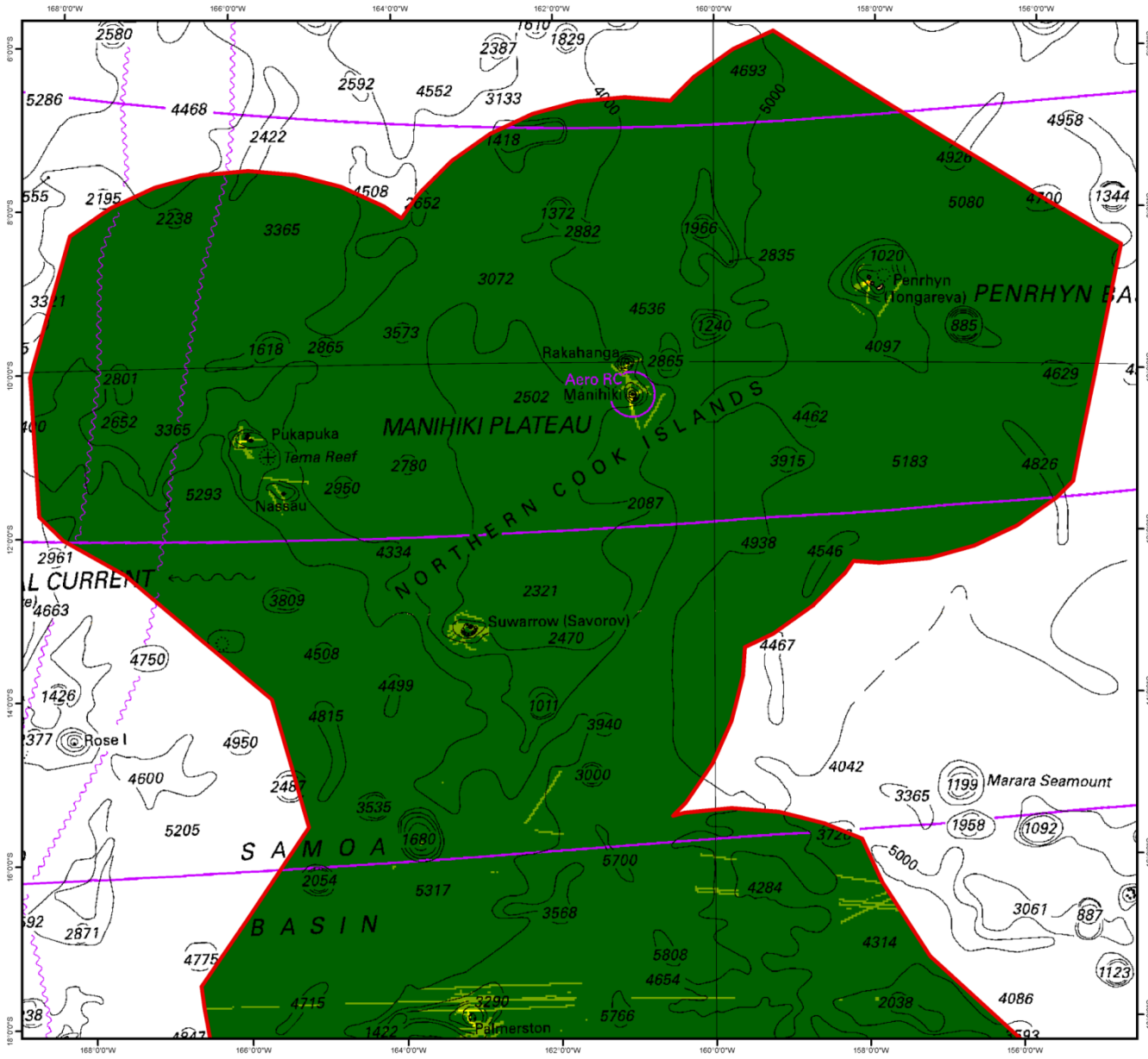
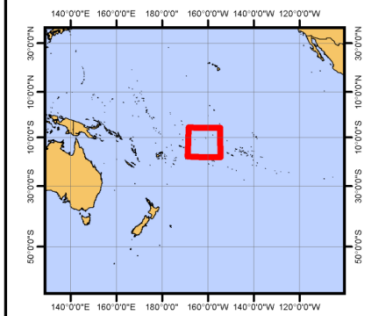



Figure Reference: 13NZ262_CookIsls_RiskModel7_01

**Figure 3: Northern Cooks Risk Model Results - Zoom**



**Legend**

- Insignificant
- Heightened
- Low
- Significant
- Moderate

| Project No. | Date | Issue Number |
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| **Author** | **Checked by** | **Scale at A3** |
| Andrew Rawson | John Riding | 1:5,000,000 |

**Data Source**
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Chart 14061 courtesy of LINZ.
S-AIS supplied by: exactAIS

Coordinate System: WGS 1984 UTM Zone 4S
Projection: Transverse Mercator
Datum: WGS 1984
Units: Meter

0 30 60 120 180 N
Nautical Miles

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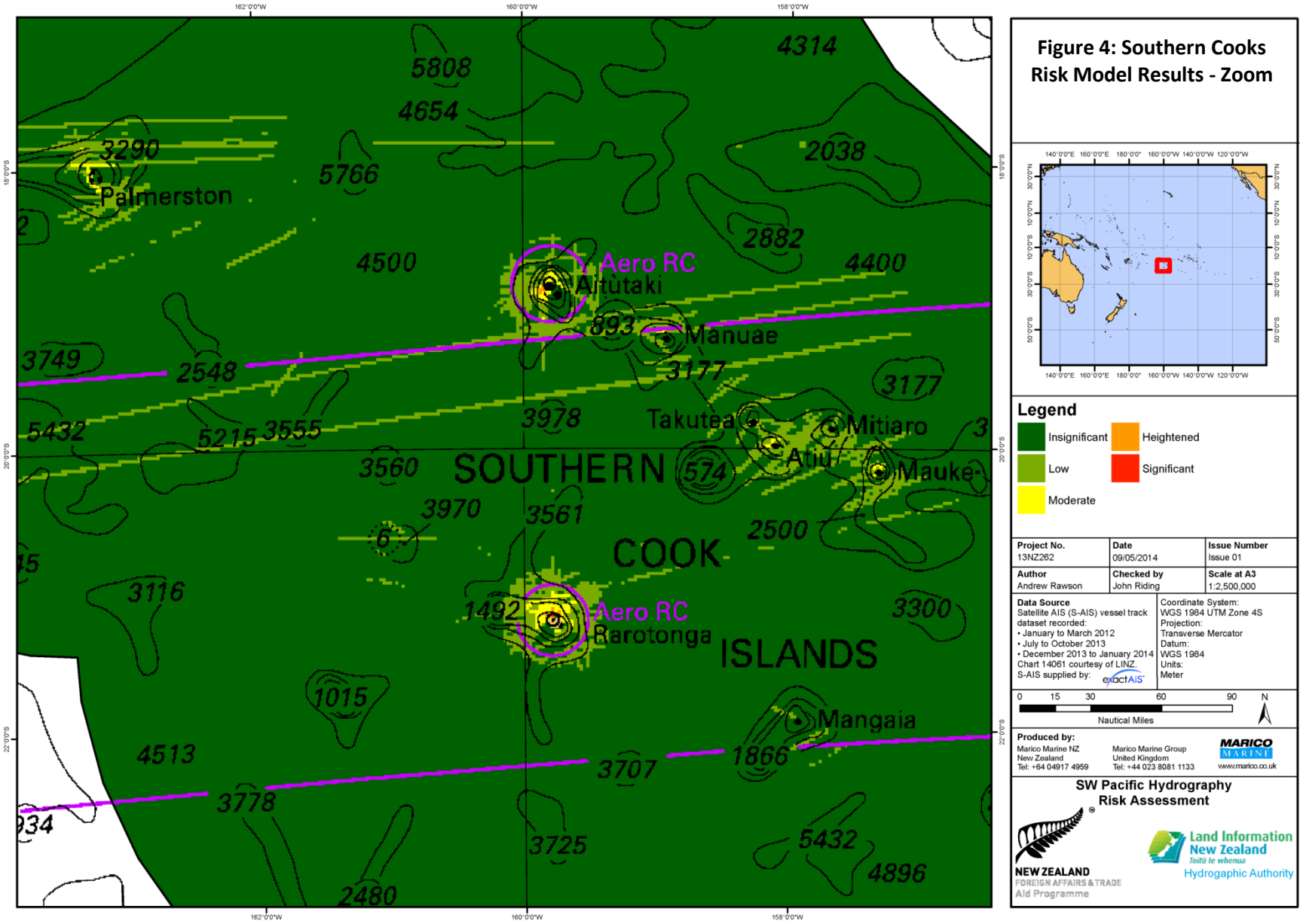


**Figure 4: Southern Cooks Risk Model Results - Zoom**

Figure Reference: 13NZ262_CookIsls_RiskModel1_02

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| Area by Island (N to S) | | Comparative Risk Level | | | Comments |
|---|---|---|---|---|---|
| | | Moderate | Heightened | Significant | |
| | | | | | **NORTHERN COOK ISLANDS** |
| 1 | Taruia Passage and North West Coast of Penhryn | ✓ | ✓ | | • A pristine and abundant lagoon of high environmental significance (internationally referenced).<br>• Heightened Risk concentrated in the harbour entrance due to close proximity to coral reefs and turtle nesting areas (including the endangered hawksbill sea turtle).<br>• Harbour entrance is narrow with rapid coral growth in lagoon.<br>• Fuel depot for Northern Cooks fisheries protection patrol is located at Omoka wharf (fuel transits lagoon entrance).<br>• Lagoon is accessible for yachts (20 per annum) and small domestic vessels.<br>• Proximity to a large number of charted and uncharted AtoNs which are either missing or with uncertain status.<br>• Exposed shoreline surrounded by deep seas where cargo is sometimes worked.<br>• Pearl farming of local economic importance (pipi pearl is natural and not seeded). |
| 2 | West Coast of Rakahanga | ✓ | | | • Some visiting yachts.<br>• Proximity to turtle nesting areas.<br>• Two marine reserves.<br>• A pristine and abundant lagoon of high environmental significance.<br>• High quality of fishing grounds.<br>• Some pearl farming. |
| 3 | Manihiki Anchorage, North Point and their Approaches | ✓ | | | • Scattered moderate risk north of island.<br>• Moderate risk concentrated in Manihiki anchorage and North Point.<br>• Exposed shoreline surrounded by deep seas where cargo is worked.<br>• An area of economic significance due to the black pearl aquaculture industry.<br>• Visiting yachts.<br>• Occasional cruise vessel visits.<br>• Proximity to turtle nesting sites.<br>• A national and a regional reserve.<br>• Domestic traffic transits South West of Manihiki Island.<br>• Significant tourism potential (only Northern Cook's island served by scheduled airline). |

| Area by Island (N to S) | | Comparative Risk Level | | | Comments |
|---|---|---|---|---|---|
| | | Moderate | Heightened | Significant | |
| 4 | Sea area East and West of Pukapuka | ✓ | | | • Two areas of moderate risk due to domestic vessels and transiting SOLAS traffic.<br>• Proximity to turtle nesting areas.<br>• Exposed shoreline surrounded by deep seas where cargo is worked.<br>• Large lagoon with villages on circumference.<br>• Several formal and informal marine reserves. |
| | | | | | **SOUTHERN COOK ISLANDS** |
| | Southern Cook Islands Overview | | | | • The Cook Islands Marine Park was established in 2012 and covers the entire Southern Cook Islands EEZ, affecting risk levels across the region. |
| 5 | Lagoon and Sea Area North of Palmerston | ✓ | | | • Scattered moderate risk north of island.<br>• Large vessels transiting (including tankers).<br>• Considerable density of visiting yachts (seasonal).<br>• Occasional cruise vessel visits (on an annual basis).<br>• Proximity to turtle nesting areas.<br>• Exposed shoreline surrounded by deep sea and swell, where cargo is worked. |
| 6 | Arutanga Harbour Entrance and Approaches | ✓ | ✓ | | • Localised heightened risk surrounded by an area of moderate risk.<br>• Heightened risk concentrated at reef passage.<br>• Large vessels transiting south of island.<br>• Small port handling containers with high density of yachts and domestic vessels.<br>• A premier destination for cruise vessels visiting the Cooks.<br>• Second largest tourism economy in Cook Islands.<br>• Several marine reserves.<br>• Proximity to turtle breeding areas.<br>• Exposed shoreline surrounded by deep seas where cargo is worked. |
| 7 | West and East Coast of Takutea | ✓ | | | • Visiting yachts.<br>• Risk affected by strong currents between islands.<br>• Proximity to turtle and bird (Formal Wildlife Sanctuary) nesting areas.<br>• Day visits from Atiu island (tourism potential). |

| Area by Island (N to S) | | Comparative Risk Level | | | Comments |
|---|---|---|---|---|---|
| | | Moderate | Heightened | Significant | |
| **8** | North West Coast of Atiu | ✓ | | | • Important turtle breeding areas.<br>• Bird sanctuary.<br>• Previous domestic vessel losses.<br>• Island with good soils, agricultural produce including the only source of coffee in the Cook Islands.<br>• Occasional cruise vessel visits.<br>• Moderate contribution of tourism to the economy.<br>• Some fresh produce exports. |
| **9** | Mauke | ✓ | | | • Risk mostly localised influenced by passing vessels offshore.<br>• Proximity to turtle breeding areas.<br>• Organised local economy of economic significance (some produce exports to Rarotonga).<br>• Moderate contribution of tourism to the economy.<br>• Previous domestic vessel losses. |
| **10** | Avatiu Harbour Entrance and Approaches | ✓ | ✓ | ✓ | • Localised significant risk surrounded by areas of moderate risk.<br>• Relative concentration of ship traffic both for international SOLAS and domestic vessels.<br>• Avatiu is a harbour of high economic value to Cook Islands.<br>• Harbour entrance transit exposed to prevailing conditions and times of heavy swell.<br>• A premier destination for cruise vessels visiting the Cooks.<br>• Premier tourism destination and a major contribution to Cook Island's economy.<br>• Proximity to turtle breeding areas.<br>• Several Marine Reserves.<br>• Some produce exports (to NZ). |

**Table 3: Comparative Hydrographic Risk Level by Region for the Cook Islands**

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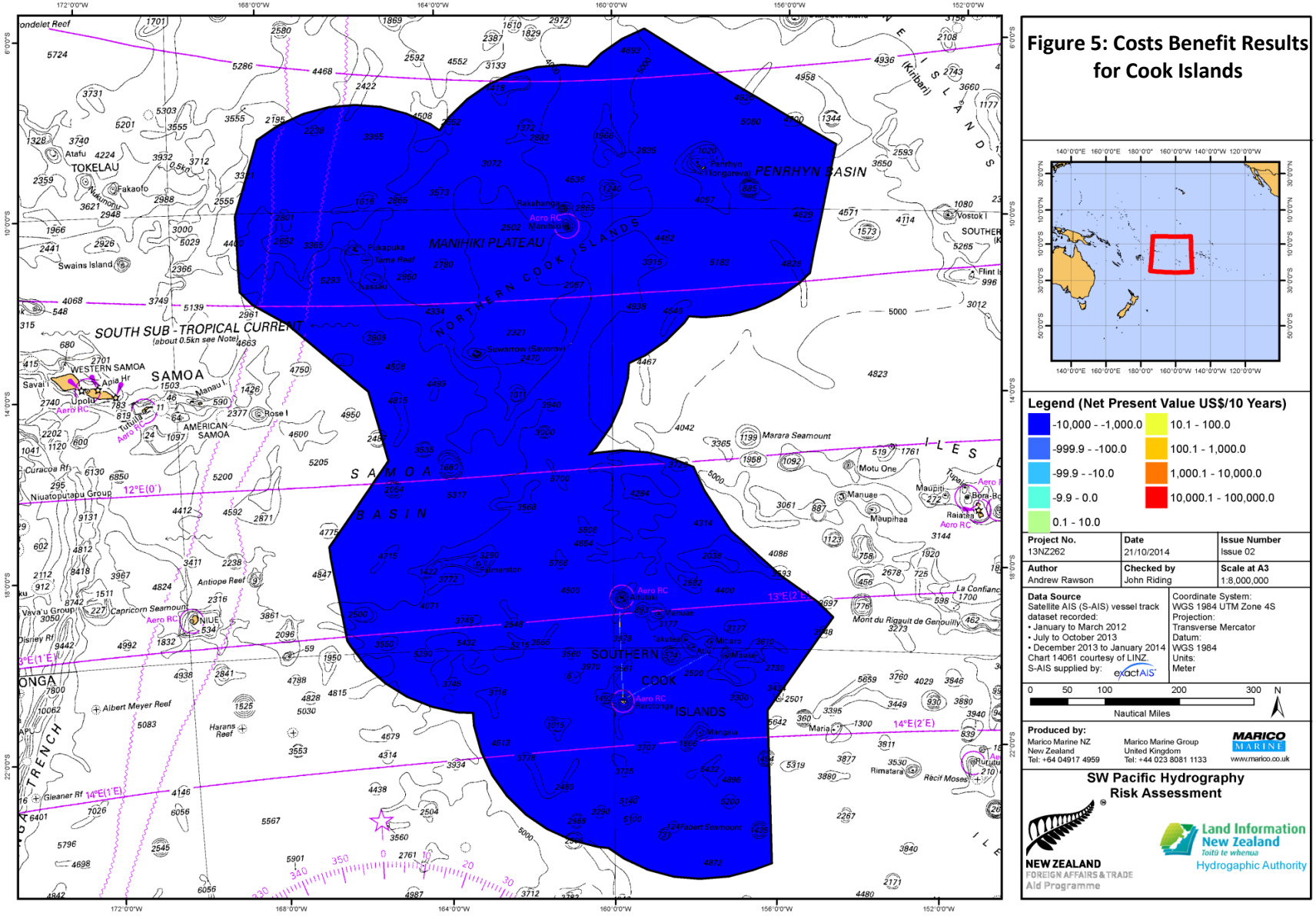


Figure Reference: 13NZ262_CookIsls_CostBenefit1_02

## Figure 5: Costs Benefit Results for Cook Islands




**Legend (Net Present Value US$/10 Years)**

| | |
|---|---|
| -10,000 - -1,000.0 | 10.1 - 100.0 |
| -999.9 - -100.0 | 100.1 - 1,000.0 |
| -99.9 - -10.0 | 1,000.1 - 10,000.0 |
| -9.9 - 0.0 | 10,000.1 - 100,000.0 |
| 0.1 - 10.0 | |

| Project No. | Date | Issue Number |
|---|---|---|
| 13NZ262 | 21/10/2014 | Issue 02 |
| **Author** | **Checked by** | **Scale at A3** |
| Andrew Rawson | John Riding | 1:8,000,000 |

**Data Source**
Satellite AIS (S-AIS) vessel track dataset recorded:
- January to March 2012
- July to October 2013
- December 2013 to January 2014

Chart 14061 courtesy of LINZ.
S-AIS supplied by: exactAIS

Coordinate System: WGS 1984 UTM Zone 4S
Projection: Transverse Mercator
Datum: WGS 1984
Units: Meter

0 50 100 200 300 N
Nautical Miles

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**SW Pacific Hydrography Risk Assessment**

NEW ZEALAND
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Aid Programme

Land Information New Zealand
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Hydrographic Authority

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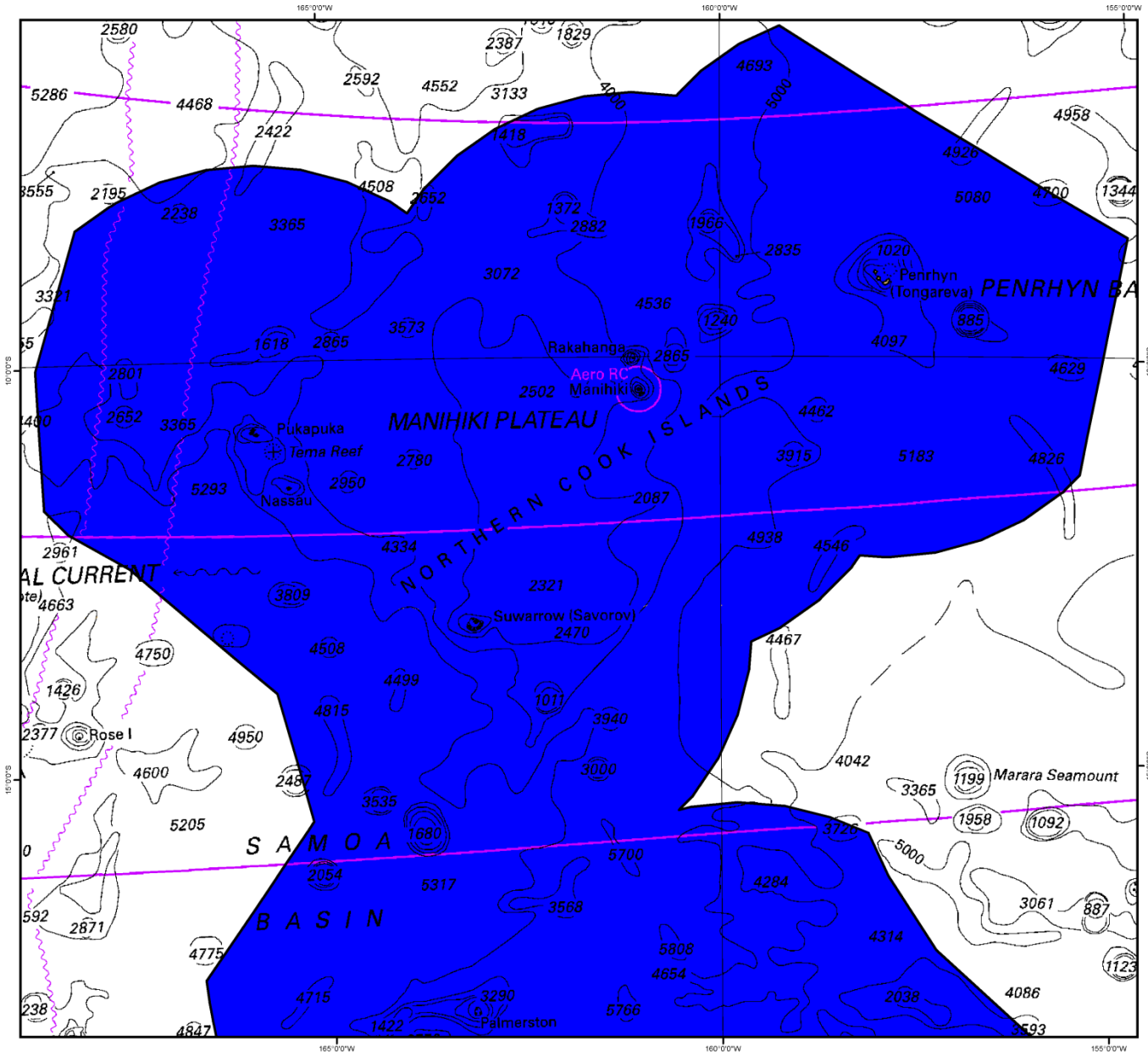
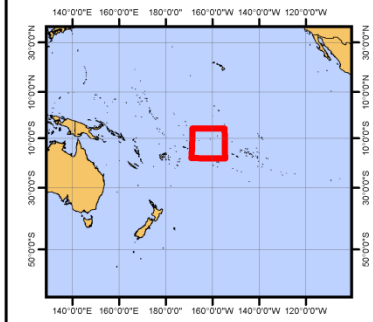



## Figure 6: Northern Cooks CBA Results



**Legend (Net Present Value US$/10 Years)**

- -10,000 - -1,000.0
- -999.9 - -100.0
- -99.9 - -10.0
- -9.9 - 0.0
- 0.1 - 10.0
- 10.1 - 100.0
- 100.1 - 1,000.0
- 1,000.1 - 10,000.0
- 10,000.1 - 100,000.0

| Project No. | Date | Issue Number |
|---|---|---|
| 13NZ262 | 21/10/2014 | Issue 02 |
| **Author** | **Checked by** | **Scale at A3** |
| Andrew Rawson | John Riding | 1:5,000,000 |

**Data Source**
Satellite AIS (S-AIS) vessel track dataset recorded:
- January to March 2012
- July to October 2013
- December 2013 to January 2014

Chart 14061 courtesy of LINZ.
S-AIS supplied by: exactAIS

Coordinate System:
WGS 1984 UTM Zone 4S
Projection:
Transverse Mercator
Datum:
WGS 1984
Units:
Meter

0 30 60 120 180 N
Nautical Miles

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Hydrographic Authority

Figure Reference: 13NZ262_CookIsls_CostBenefit4_02

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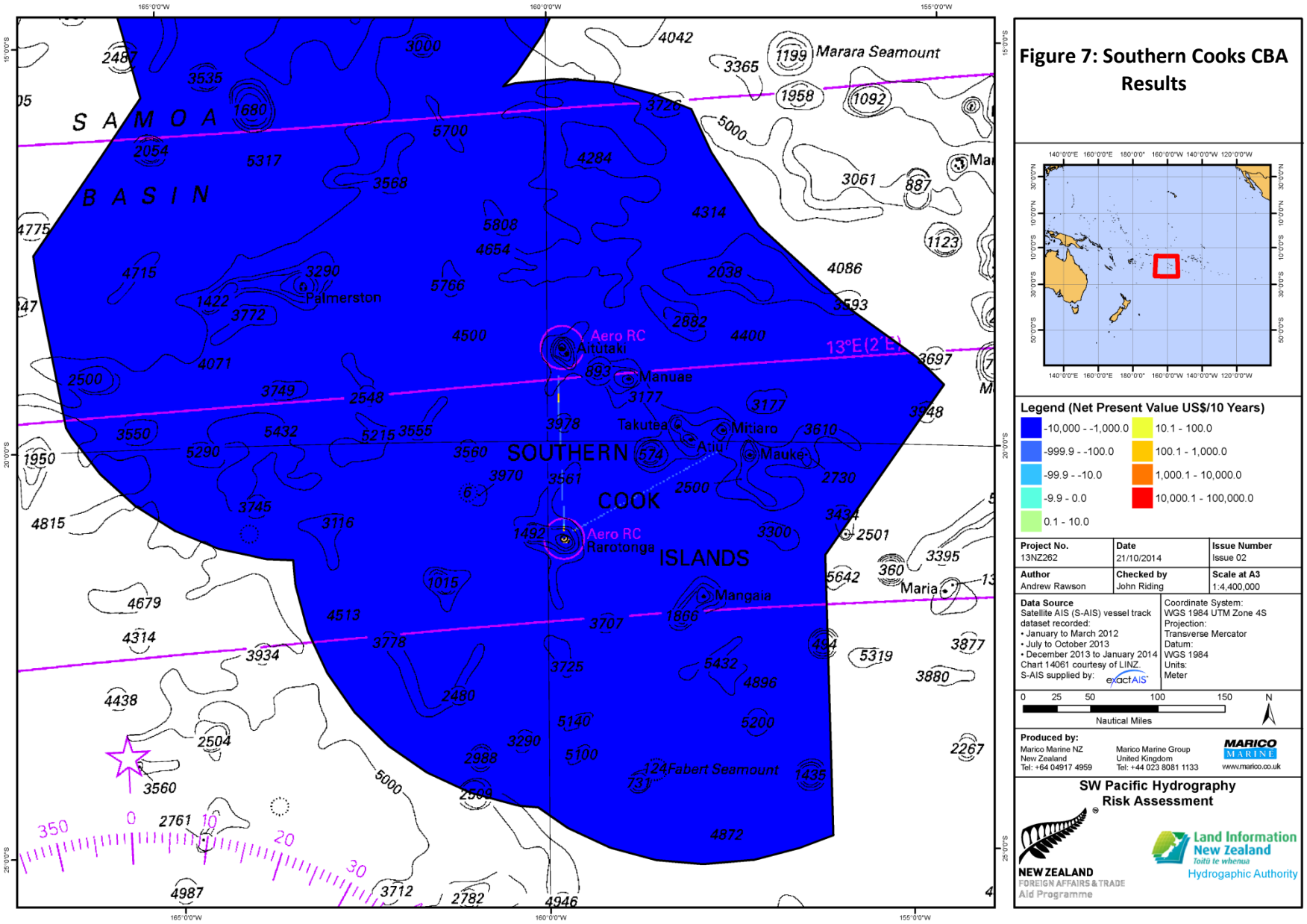


**Figure 7: Southern Cooks CBA Results**

Figure Reference: 13NZ262_CookIsls_CostBenefit3_02

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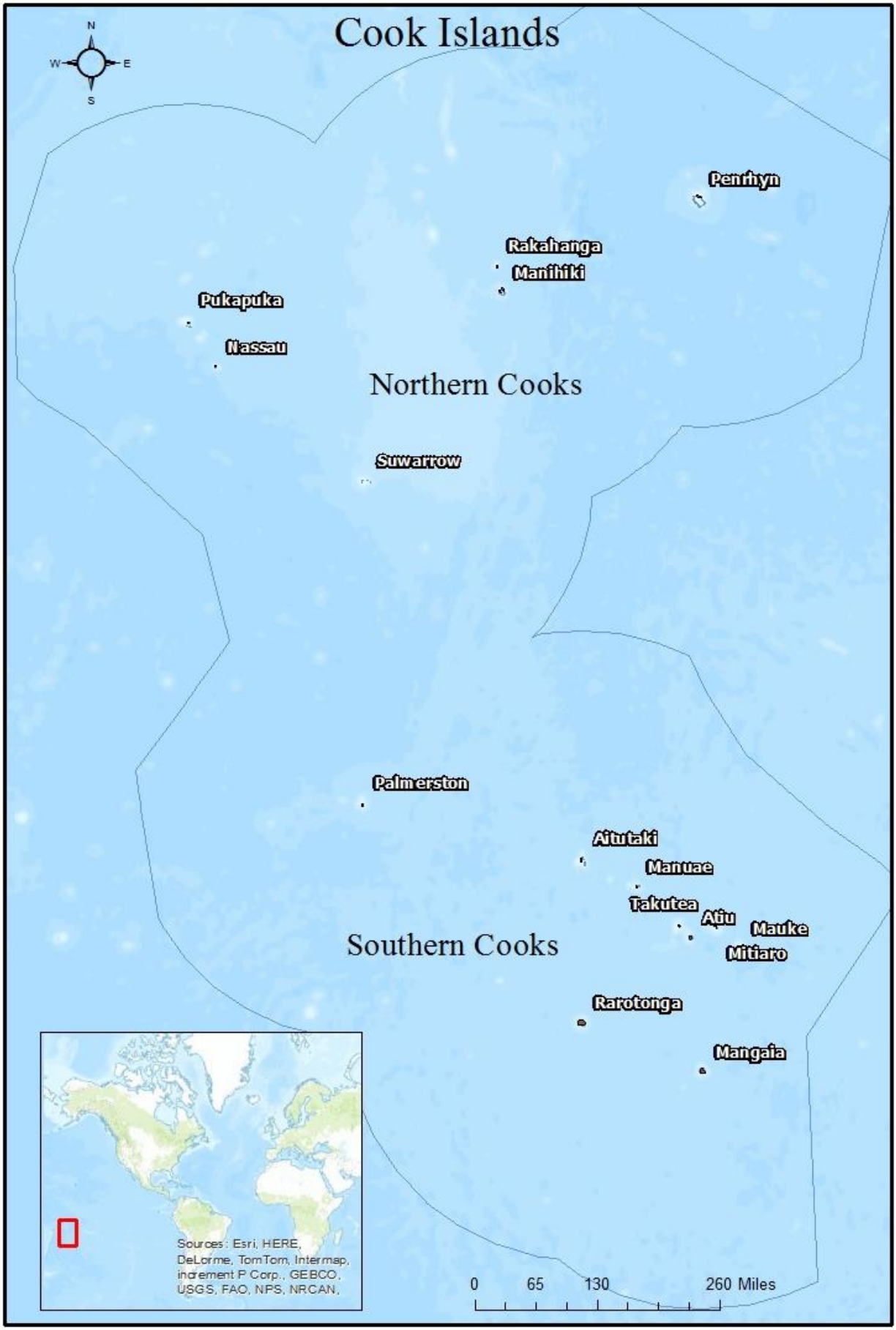


**Figure 8: Map of the Cook Islands**

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# Annex A

# Benefits of Charting Upgrades for the Cook Islands

# 1 BENEFITS OF HYDROGRAPHIC SURVEYS FOR THE COOK ISLANDS

Hydrographic survey data is a facilitator. Classically the data is integrated into ships' charts as a navigational aid; to provide the wherewithal for the ship to safely plan and undertake a voyage avoiding such hazards as dangerous shoals. The quality of hydrographic data determines the extent to which investors are prepared to undertake 'the shipping adventure', and insurers to underwrite the risk, to supply essential transportation services to nations such as the Cook Islands. If the hydrographic data and, in the modern context, the relevant ENCs are of high quality, there is an increased likelihood the service will be of high quality as well, with competition ensuring no excess freight rates. Conversely, poor quality data brings with it the risk of substandard shipping.

However, particularly with the advent of Geographical Information Systems (GIS) underpinned by powerful computer processing, and integration with satellite and other remote sensing technologies, hydrographic data delivers a wide range of additional benefits to multiple marine stakeholders, notably planning and development. It is now widely accepted that these benefits of hydrographic survey data, which are mostly unquantifiable in financial terms, outweigh those derived from its classic application, hence the common assessment that hydrographic data should be viewed as a public rather than private good.

Across the three shipping sectors, hydrographic survey data delivers benefits in different ways. For the international shipping of freight, the principal benefit is assessed to be the maintenance of market stability with the opportunity to lever significant reductions in transportation costs. For domestic shipping, with a poor record historically – and recently – improvements in safety will flow from hydrographic data. Finally, for cruise tourism, hydrographic data provides planners with the information they require to identify suitable sites for future development, to access in particular the burgeoning Australian/New Zealand cruise market[3]. For any or each of the aforementioned applications, for the Cook Islands, the benefits of hydrographic survey are considered to outweigh the costs.

[3] In 2014, New Zealanders are expected to represent approximately 20% of the cruise market after a period of significant growth.

Commercial shipping relies on current hydrographic survey data. A hydrographic survey undertaken to the latest International Hydrographic Organization (IHO) standards[4] provides the following benefits:

- Accurate and reliable full bottom coverage allows for more flexible route planning, more precise navigation and more flexibility to utilise the increased loading of ships, thus increasing the economic efficiency of shipping.
- Critical new shallows or water depth, less than previously charted, may be identified and appropriate action taken.
- Facilitate revisions of fairways or routes, and planning of modified or new Traffic Separation Schemes.
- Enabling changed practices in navigation with new ECDIS functionality (e.g. 3D navigation with real time dynamic water level in formation, precise warnings), with consequential reduction in environmental harm and insurance premiums.
- Provision of quality information for training purposes.

These factors have been identified as causal to shipping companies using less efficient or less capable vessels that are more likely to be involved in a maritime accident in areas with poor hydrographic data. Further, the International Convention for the Safety of Life at Sea (SOLAS) requires signatory states to facilitate the production of current electronic navigation charts (ENCs) for ships navigating their coastal waters[5]. Should a member state not fulfil this obligation, insurers have the option to decline cover, or charge an additional risk premium, to vessels wishing to navigate its coastal waters, including ports.

All ENC's are based on the World Geodetic System 84 (WGS84 datum) and are organized in so called Cells. The cells are allocated to defined scale ranges with a different degree of generalization or usage bands. To comply with IMO requirements, a member state should develop accurate and adequate ENCs for all its waterways, including ports.

Beyond shipping, reflecting its 'public good' nature[6], hydrographic survey data delivers a wide range of additional benefits to maritime stakeholders.

Indeed, the largest users of hydrographic data are typically developers, notably port developers, and planners. The specific benefits of charting improvements to shipping in the Cook Islands are summarised below in the table within this Annex.

[4] IHO S-44 Standards for Hydrographic Survey

[5] Regulation 9 of SOLAS Chapter 5

[6] 'Public good' are services in the public interest which would not be supplied at optimal levels by market forces alone

In summary, hydrographic data is a facilitator and should be considered as vital infrastructure, servicing exactly the same purpose as a mapped highway on land.

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| Port Infrastructure | 1 | The Avatiu Harbour Development Project was completed in 2013. The project has expanded the harbour's capacity to handle larger SOLAS vessels. | Improvements in charting standards for Avatiu Harbour create shipping confidence and the potential for new trade opportunities.<br>Cheaper transport costs encourage the growth of Cook Islands exporting companies. | Port and channel maintenance discontinues and international shipping reduces calls to Avatiu Harbour. There is no viable option to increase productivity as port movements decline.<br>Transportation costs and port/customs charges increase disproportionately over time. |
| | 2 | Some domestic harbours are uncharted and of uncertain depth, experiencing, in many cases, rapid coral growth. Examples are the harbours of Penrhyn and Manihiki. | Clarity of lagoon transit and approaches to the remote harbours of the Cook Islands reduce the grounding risk for domestic vessels. Changes in harbour infrastructure status circulate more rapidly. Further improvements to entrance channel capacities become more likely. | The grounding risk increases, despite low vessel visit numbers and any resulting oil spills have disastrous consequences to the marine environment and the local economy. The Oil Spill Emergency Response team experiences delays while navigating the difficult approaches to the remote harbours. Uncertainty continues to exist with regards to depth. |
| | 3 | Charting in Penrhyn needs updating and chart corrections are required for AtoNs and channel locations. Omoka Harbour, a port of international entry to the Cook Islands, is a domestic port with sheltered waters. | Lagoon transit channel capacity becomes clearer, allowing cargo and vessel operators to understand options. Omoka Harbour has a development plan to improve its port facilities and continues to improve the entrance and channel approaches. | Charts are no longer updated and navigational safety becomes an ongoing issue. Omoka Harbour, Penrhyn, is no longer served by scheduled shipping and used only by locals. Cargo transportation depends solely on costly flights. |

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| | 4 | Surveys are anticipated to show the need for further channel deepening. | The need for deepening of domestic harbours is accurately identified as depth restrictions are accurately recorded. The planning of ongoing hydrographic work and its scope is improved. Safety benefits accrue as more reliable information allows vessels to access ports with minimal risk.<br>Port infrastructure in the Cook Islands other than Rarotonga has the potential to grow. Local employment options improve in the long term and the decline in population is reduced. | Deep draught vessels navigate in shallow waters with difficulty as manoeuvring is restricted. Safety and environmental concerns increase.<br><br>Inter-island freight distribution diminishes due to ineffective port operations. Poor port maintenance increases unwillingness to invest in an agile supply chain system. |
| | 5 | The majority of Aids to Navigation are either not marked or their status is incorrectly promulgated on charts or by Notices to Mariners. Examples are the AtoNs located at the pristine lagoons of Penrhyn and at uncharted harbour basins at a number of islands. | The status of leads and other Aids to Navigation (AToNs) improves as information for chart corrections becomes more readily available. This information is added to the charts on a regular basis.<br>A functioning system with regular Notices to Mariners improves the confidence of shipping interests in the Cook Islands and increases the Cook's value as a trading destination. | During cyclone season, a majority of AToN's become defective and there is no proper maintenance. Thus, the probability of a grounding accident increases during this period. Such an accident would result in a major economic impact to the local economy. |

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| International Cargo Shipping Sector | 6 | International trade to the Cook Islands waters is presently focussed around Avatiu Harbour. With the exception, in part, of fuel transhipments, only occasional calls occur to Aitutaki, whose deliveries rely on transhipment or air. | Charting improvements allow shipping operators to reduce the grounding risk of vessels providing existing services. Options for discharge at other international port destinations in the Cook Islands become viable, as flexibility improves along with the potential for cost efficiencies derived from direct calls. The economic benefits of reduced freight costs lead to an increase in cargo shipments in and out of the Cook Islands overall. | No further charting improvements lead to a higher risk of maritime accidents. There are no alternative trade routes for vessels which now provide shipping services in the Cook Islands. It is difficult for shippers to achieve economies of scale. Freight rates remain high as transportation costs increase for South Pacific container services in the Cook Islands. |
| | 7 | The Cook Islands Hydrographic Committee has not yet been established with clarity of roles. | Confidence in the charting system increases as the flow of navigational safety information from operators to the Cook Islands Hydrographic Committee is introduced and communication of information is maintained. | The charting system is inefficient as it fails to respond to maritime safety standards and hydrographic best practices. As a result, the Notice to Mariners is not reliable. Commercial vessels do not receive nautical chart and publication updates. The probability of an accident is high, and is certain to increase over time; therefore commercial shipping is increasingly likely to withdraw operations at a future date. |
| Cruise Tourism | 8 | There is pressure from cruise interests for the Cook Islands to open up more cruise destinations which, in turn, increase the number of cruise visits to the islands. | The development of accurate and appropriate scale charts into the Northern Cooks and the Southern Cooks, as well as certain isolated islands, result in increased cruise vessel penetration. Port calls other than Rarotonga become viable, which result in the increased popularity of the Cook Islands as a cruise destination. The increased number of passenger visits brings income into the local economy. | The cruise sector shrinks because nautical charts are not reliable. Cruise shipping operators are reluctant to send their vessels to remote or isolated islands. Cruise port calls decrease and economic development stagnates. The recent grounding of the WORLD DISCOVERER, a cruise ship that struck an uncharted reef at Sandfly Passage, Solomon Islands, serves as an example of the possible consequences. |

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| | 9 | At present, the number of visitors to the Cook Islands arriving on cruise ships is on the decline, with a by cruise drop in the number of visitors to Rarotonga and Aitutaki. | An increase in cruise line passengers results in more tourists choosing to return to the Cook Islands by air for longer stays, thereby increasing the demand for hotel and home-stay accommodations. Companies catering to large numbers of tourists, such as diving and whale watching tours, enjoy increased revenues. | Currently, tourism contributes to almost 60% of the gross domestic product of the Cook Islands. This figure is likely to drop substantially in the years to come as the number of cruise passengers declines. Accommodation suffers high vacancy rates, holiday market rates fall and international tourism revenues suffer, leading to an increase in the rate of unemployment. |
| | 10 | During 2012/2013, the number of cruise vessels visiting Avatiu Harbour decreased (mostly due to adverse weather conditions). An alternative destination located at Arorangi provides safe disembarkation of cruise passengers. | Improved charting provides cruise ship operators with the confidence that Cook Islands destinations other than Rarotonga are able to accommodate cruise vessels of increasing size.<br>Infrastructure and economic development is driven by the need to accommodate larger vessels and trade as well as larger passenger numbers. | There is no return on investment from cruise vessel visits because navigational charts do not provide accurate and updated hazard information.<br><br>Although aid donors provide substantial funding, it may not be targeted and infrastructure projects are likely to be abandoned in the long-term. |
| Domestic Shipping Service and Training | 11 | Demand for cargo transportation – Aquaculture products from the Northern Cook Islands. | Charting improvements facilitate the growth of domestic trade to export ports (including airports) as well as increase the availability of gourmet fish and marine based produce. | Export and domestic trade remain static or go into decline. An aged fleet is used to transport local products in order to cut costs further. |

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| | 12 | Coastal navigation depends on the master's knowledge of local features, rather than on nautical charts. | Ongoing advances in awareness and confidence in navigational safety together with improvements in chart-related practices, such as passage planning and positional monitoring, reduce the risk of vessel groundings and other marine accidents in the Cook Islands waters.<br>The quality standard of the domestic fleet improves as safety awareness grows and owners gain confidence in the new navigational systems being put into place. | Current maritime charts are inaccurate, therefore they are, and continue to be, a poor tool for use as a preventative measure to avoid an accidental oil spill or similar incident. Discrepancies in mapping also hinder emergency response teams or search and rescue operations in the event of grounding. The Cook Islands have a total of 15 islands with a plethora of corals and shallow depths which increase the risk of accidents. |
| ENCs | 13 | The geographic location of electronic charts in the Cook Islands is not aligned with the actual position of the islands. As a result, ENCs depicting the Cook Islands are unreliable. | Further amendments and updates to ENCs for the Cook Islands have a positive impact both on SOLAS and domestic coastal shipping. | Though flag states enforce the SOLAS amendment for all vessels to carry ECDIS on-board, the Cook Islands ENCs remain unreliable. SOLAS vessels, especially liner shipping, reduce or withdraw their operations from the Cook Islands. |
| Cook Islands Hydrographic Committee | 14 | The Cook Islands has not formed a National Hydrographic Committee. Under the IMO Convention SOLAS V/9, the Government of the Cook Islands has an obligation to collect hydrographic data and keep it up-to-date with all the nautical information necessary for safe navigation. | The Cook Islands Hydrographic Committee is established and they become a member state of the IHO. The Committee becomes more effective and the Cook Islands interests are better represented in the work of the IHO. New options for further grant funding accrue. | The Cook Islands does not appear to meet its international treaty obligations to ensure that appropriate hydrographic services are in place. This has a negative safety and financial impact, both for domestic and international shipping. |

| Cook Islands | | | | |
|---|---|---|---|---|
| **Table of Benefits Associated with Charting and Hydrographic Services Upgrades** | | | | |
| **Economic Analysis Sector** | **No.** | **Status Quo** | **Benefits of Charting Improvements** | **No Improvements to Charts** |
| | 15 | The Cook Islands has only a limited government agency mandate to undertake hydrographic activities. | Hydrographic services and surveys are performed on a regular basis. New nautical charts are produced and are kept up–to-date. | The current state of nautical charting and the lack of coherent Maritime Safety Information (MSI) services are likely to have a significant adverse impact on the economy of the Cook Islands. This negative result puts the safety of life at sea and protection of the marine environment at risk. |
| Chart and ENC Distribution Services | 16 | The distribution of new or replacement charts in the Cook Islands is fragmented. Published ENCs difficult to obtain within the Cooks. | An effective Chart distribution service with ENC updates for ECDIS/ECS systems using Cook Island waters is established as part of port infrastructure development. Cook Islands' agents are established outside of Rarotonga, improving usage and promulgation to users. Improved charting extends into the recreational and visiting yacht markets. Employment and benefits accrue. | The fragmented replacement chart system in the Cook Island remains fragmented. Interest in charting by navigational stakeholders and usage declines. |