Tourism, biosecurity and pathways into New Zealand: identifying risk and mitigation strategies

Report on visitor hotspot data mapping

Jude Wilson

Crile Doscher

David Simmons

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Contents

Introduction

This report describes the mapping and analysis of tourist itinerary data to identify visitor hotspots on nights/days one to seven of visits to New Zealand. Two data sets – describing sample data collected via the International Visitor Survey (IVS) from the 2012-2013 year (YE June) and cruise schedules from the 2017-2018 year (YE August) – are mapped. If viewed in sequence the maps presented provide an indication of visitor flow around New Zealand, but the data displayed is aggregate only. As such, it more accurately represents visitor hotspots over sequential night (and days) while in New Zealand. Together these data identify the most common locations visited by tourists arriving both by air (overnight visit hotspots) and sea (day visit hotspots). The research forms part of a four-year programme investigating the use of tourist movement data to visualise tourist flows through the country to determine points of intersection and aggregation in respect of biosecurity risk. Mapping these data has potential to improve tasking and prioritising of biosecurity surveillance programmes. It also contributes to a better understanding of the biosecurity risk presented by tourism.

Background

Biosecurity and the management of associated risks are critical for both primary production and tourism to sustain economic benefits and social welfare, and to protect biodiversity. Together, agriculture (4.6%) and tourism (5.9 %) directly account for 10.5 percent of New Zealand's GDP[1]. Biosecurity failures can have a significant impact on the tourism industry itself as was shown during the foot and mouth outbreak in the UK (Blake et al., 2003). In addition to the curtailment of tourists' activities in the country, and a reduction in the value of the country's image to prospective tourists, it has also been suggested that such a biosecurity failure has potential to reduce the number of visitors.

In the year ended March 2018 there were 3.82 million international visitor arrivals to New Zealand. In addition to arrivals by air, there were 259,000 unique[2] cruise passenger visits to New Zealand in the year ended June 2018 (an increase of 17% on the previous year). It is estimated that approximately three quarters of these cruise passengers are not captured in the travel and immigration statistics as they are transit passengers (i.e., they arrive and depart New Zealand by ship and do not complete border clearance). Additionally, for every 100 cruise passengers visiting New Zealand, another 42 visited as crew in the June 2018 year (StatsNZ, 2018). International tourists represented 56 percent of all passenger arrivals by air (YE Mar 2018), and 87 percent of passenger cruise arrivals (YE June 2018).

Tourists have been shown to have an inherent mobility (Forer, 2005; Worboys & Gadek, 2004) that can lead to the unintentional internal transfer of pests or disease (Parliamentary Commissioner for the Environment, 2000; Hall, 2005). The recent rapid growth of tourism

[1] Tourism (https://www.stats.govt.nz/information-releases/tourism-satellite-account-2017 ; Table 1); Agriculture (Comprising Horticulture and fruit growing; Sheep, beef cattle and grain farming; Dairy cattle farming; Poultry, deer and other livestock farming) (https://www.stats.govt.nz/information-releases/national-accounts-industry-production-and-investment-year-ended-march-2017 ; Table 2)

[2] The 'unique passengers' total is a count of each cruise ship passenger once only over the year, based on unique passport number. This reflects that a passenger can appear as an arrival, a departure, or both, and ensures a cruise ship passenger is counted only once over the year.

arrivals, coupled with changes in visitor origin (Wilson & Simmons, 2016), present a significant and growing pathway for the introduction of new pests and diseases with recognised biosecurity risks. While biosecurity monitoring at arrival points is well-established, little is known with respect to subsequent pathways along which tourists travel. For example, tourist flow potentially differs across a range of factors including the tourist's ethnic origin, length of stay, transport mode and travel interests. As such, understanding the links between international tourist flows, and the potential biosecurity risks these visitors represent, is a new and important area of research.

Data sources

The data mapping was based on two key datasets: The International Visitor Survey (IVS) and cruise schedules available from the New Zealand Cruise Association.

IVS

The International Visitor Survey (IVS) measures the expenditure, characteristics and behaviours of international visitors to New Zealand. Since it was started in 1984 the IVS has been undertaken by a number of contracted market research companies and by government (e.g., Ministry of Tourism). Responsibility for the IVS passed on to the Ministry of Business Innovation and Employment (MBIE) when it was formed on 1 July 2012. Problems highlighted in the IVS methodology led to the introduction of a number of significant changes to the IVS in July 2013. These included: an increased sample size (from 5,200 to 8,900 per year); the collection of online data (rather than face-to-face interviews); the addition of Queenstown airport as a departure point (for sampling); and, changes to many of the questionnaire components (MBIE, 2018a). As a result of these questionnaire component changes, itinerary data were no longer collected (see Box 1).

Box 1 International Visitor Survey revision 2013 – Itinerary data changes

Itinerary – places stayed

Information on locations where the respondents stayed at least one night continues to be captured; however, the number of locations has been limited to 483 compared to the 2,547 previously. The order of places stayed is no longer captured. If a location is not available for selection, respondents are asked to identify the closest town or city.

The series of questions that built up a detailed itinerary in the previous survey was the main contributor to the unsustainable length of the questionnaire and has been removed. For each location, these questions collected information on transport used, accommodation, activities, day trips from each location, and places visited for more than an hour on the way to or from the location. Information about activities, transport and accommodation is now collected separately and no longer associated with locations stayed. Locations visited but not stayed at are no longer captured.

Historical information on locations stayed at least one night will be mapped to the new location list. Where a previously stayed location is not listed, it will be mapped to the next closest location.

(MBIE, 2013) https://www.mbie.govt.nz/info-services/sectors-industries/tourism/tourism-research-data/ivs/documents-image-library/IVS-revision-20132013information-paper.pdf

Both the historical and the redesigned versions of the IVS questionnaire and methodology were run simultaneously over a six-month period, ending on the 30 June 2013. Consequently, data collected until 30 June 2013 represents the most recent data able to be mapped according to itinerary sequencing. The IVS maps contained in this report are based on the IVS sample of visitors interviewed between 26 June 2012 and 26 June 2013 and describe travel

itinerary data for 2,561 travel groups representing a total of 16,590 individuals. The lower number of travel groups sampled during this period (i.e., 2,561 compared with the 5,700 reported above) possibly reflects the transition in methodology noted above.

The IVS methodology applies a weighting to the sample to represent the total number of visitors to New Zealand. This weighting is based on data reported on arrival cards completed by all international arrivals and for international arrivals is published as IVA (International Visitor Arrivals). While no weighting has been applied to the data shown in these maps, a larger number of visitors than the IVS sample is reported as a result of data collected describing each sampled visitor's travel party size. Travel party size was no longer collected after the 2013 IVS revision.

Cruise schedules

Cruise data for the period 1 September 2017 to 31 August 2018 were sourced from the New Zealand Cruise Association. These data (collated on an Excel spreadsheet) described each individual cruise ship visit by the ship name, port visited, ground handler, arrival date and time, departure date and time. The data were electronically sorted by vessel, and then by date of arrival and, from this, individual cruises (and itineraries) were identified. Cruises beginning in Auckland were excluded from the itinerary dataset, although these were not always easy to clearly identify for the following reasons:

- The function of Auckland as an exchange port (where individual cruises begin and end)
- The fact that some voyages incorporate several itineraries (i.e., new passengers join an extant cruise itinerary – usually in Auckland). However, this was deemed to be not particularly significant in respect of the mapping as often these ships had visited multiple New Zealand ports (prior to Auckland) and were included accordingly, while new passengers would not be mapped as they are ex-Auckland

The timing of the research (mid-way through the period covered by the cruise schedule data) also presented a challenge as it was difficult to check itinerary data for cruises that had already been completed. The following data sources provided additional itinerary information:

- Crew website http://crew-center.com/
- Clean Cruising http://www.cleancruising.com.au/
- Cruise Timetables https://www.cruisetimetables.com/
- Individual cruise line/ship websites
- Individual port schedules http://www.poal.co.nz/operations/schedules/cruise

Examples of the data available from each of these sources can be found in the Appendix. However, it should be noted that in some instances, these data contradicted that available via the cruise schedule dataset. Also, the cruise schedule data did not allow for weather-induced or other unexpected schedule changes.

A new spreadsheet was prepared with a single line entry for each individual cruise itinerary. A total of 115 cruises (undertaken by 35 cruise ships) were described by vessel name, number of passengers, number of crew, previous port (to arrival in New Zealand) and the day (in sequence from day one to day seven) and date of each port visited. The passenger and crew

data carried on each vessel were sourced from the New Zealand Cruise Association (http://newzealandcruiseassociation.com/ships-visiting-new-zealand/) with the exception of that pertaining to the Seabourn Encore and the Ovation of the Seas. Data for these two vessels was added from additional sources:

- Ovation of the Seas https://www.royalcaribbeanpresscenter.com/fact-sheet/28/ovation-of-the-seas/
- Seabourn Encore https://www.logitravel.co.uk/cruises/seabourn/technical-details-seabourn-encore-16058566.html

While it is known that a small number of cruises disembark passengers in Fiordland (to allow land travel to Dunedin), no Fiordland visits were included as a day one visit in the mapping exercise. The majority of cruises do not disembark passengers during Fiordland visits. The maps show only port days on which embarkation occurs.

For methodological clarity, the full passenger and crew numbers carried on each ship are mapped. It is, however, estimated that around 90 percent of passenger will go ashore during port visits with the percentage disembarking dependent on a number of factors, including:

- The port being visited – attractions, previous visits, tender port, etc
- How long the ship has been at sea with more passengers thought to disembark after a ship has been at sea for several days
- Weather conditions

In the case of crew, it is estimated that between 50 percent and 80 percent may disembark at any given port – over five consecutive port visit days the percentage disembarking is likely to be 50-60 percent. Crew disembarkation is dependent on:

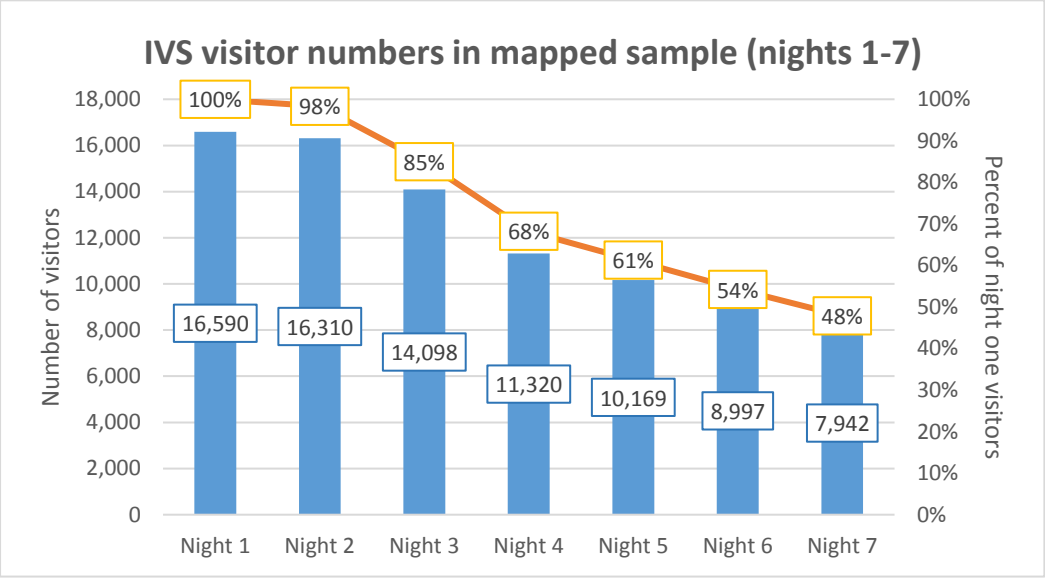
- The port being visited – shopping ports are more popular (Dunedin, Wellington, Auckland, Tauranga), tender ports are less popular
- The length of time spent in port and crew rosters are also contributing factors
- A crew shore industry has developed over time as services catering to crew cater to different interests than those catering to passengers. In addition to shopping, the availability of Wifi (enabling contact with home) is particularly important for crew.

Mapping methodology

IVS mapping

The IVS map data show where the sample surveyed (and their travel groups) stayed overnight (for nights 1 to 7) while in New Zealand. As Figure 1 shows, however, more than half of these visitors had left the country before night seven.

Figure 1 IVS visitor numbers in mapped sample



The raw IVS data were acquired as an SPSS dataset. For exploratory purposes, data from interviews collected between 26 June 2012 and 26 June 2013 were extracted for mapping. A Python script was written that collated and transferred the number of visitors to 2,248[3] mapped locations visited in the 2012-2013 data sample on nights one to seven of their New Zealand visit. ArcGIS 10.6 was used for mapping.

The mapped data represent the itineraries of 16,590 visitors as this was the maximum number for whom data were available via the IVS sampling. No weighting has been applied (i.e., in order to reflect these visitors' representativeness according to origin, age, travel purpose etc) and the mapped itinerary data are not able to be extrapolated to represent particular types of visitors.

Cruise mapping

The cruise maps show the total number of visitors (both passengers and crew) who visited New Zealand on a cruise ship between 1 Sep 2017 and 31 August 2018. The analysis did not include any ships which started their cruise itinerary in New Zealand as passengers on these cruises would have either arrived in New Zealand by air or were already resident in New Zealand. Altogether, the 115 cruises involved 232,728 passengers and 95,371 crew. As noted above, however, it is unknown how many go ashore (from either group). It is also unknown what they do whilst onshore.

[3] The smaller number of overnight locations reported by these data than those described in Box 1 (i.e., 2,248 compared with 2,547) possibly relates to the transition period in which dual methodology was employed.

Domestic passengers are included in these data – during the winter months some cruise companies use Auckland as an exchange port (i.e., cruises both begin and end there). These cruises primarily visit the Pacific and, with many of the returning passengers being domestic, would potentially have greater disembarkation dispersal than is the case with international cruise passengers who visit only small number of ports (and their more immediate surrounds).

The cruise dataset also includes each ship's last port of call (prior to New Zealand), which may be of interest in respect of biosecurity concerns. Of the 115 cruises, three quarters (*n*=77, 67%) originated in Australia and a third (*n*=38, 33%) originated in the Pacific. The most common Australian departure port was Sydney (*n*=40, 52%) followed by Tasmania and Melbourne (Figure 2); slightly under a third (*n*=12, 32%) of the 38 cruises arriving from the Pacific came from Fiji (Figure 3).

Figure 2 Cruise arrivals from Australia, by embarkation port

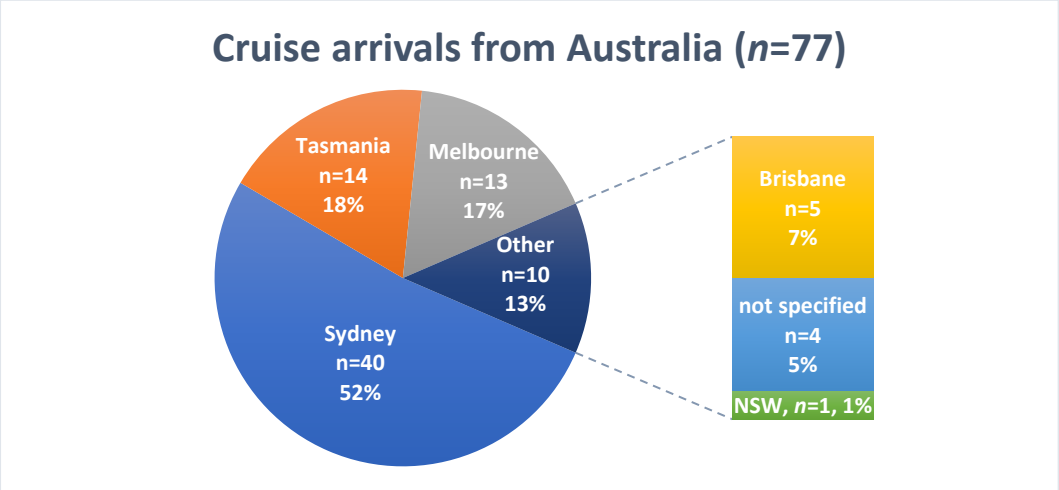


Figure 3 Cruise arrivals from the Pacific, by embarkation port

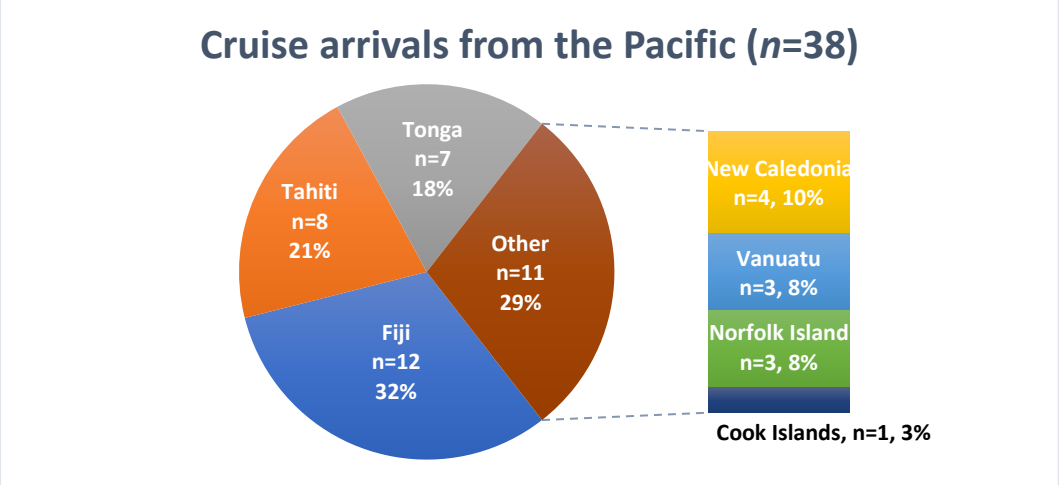


Table 1 shows first port of call for ships from Australia and the Pacific. For ships departing Australia, the most common first port of call in New Zealand was Fiordland although, as noted, the majority of ships do not disembark any passengers or crew here: instead the first port of call for these 57 cruises was either Port Chalmers, Stewart Island or Lyttelton (as indicated

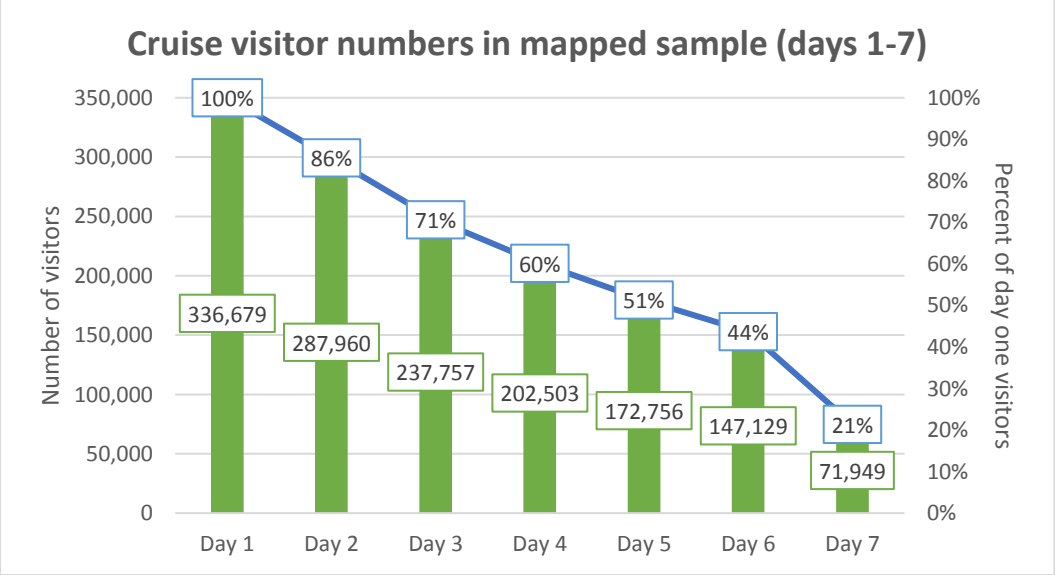
the ‘F’ in brackets). Port Chalmers was the first port of call for 51 cruises (44% of the total). The most common first port of call for ships from the Pacific was Auckland, with an additional six ships visiting Auckland from Australia. Together, the ports of Auckland and the Bay of Islands were the first port of call for 50 cruises.

Table 1 First port of call of cruises from Australia and the Pacific

	From Australia	From the Pacific	Total
Port Chalmers (F)	51	-	**51**
Auckland	6	27	**33**
Bay of Islands	9	8	**17**
Stewart Island (F)	5	-	**5**
Wellington	2	2	**4**
Picton	2	-	**2**
Tauranga	1	1	**2**
Lyttelton (F)	1	-	**1**
	77	**38**	**115**

Similar to the IVS itinerary sequencing, there was a reduction in cruise visitor numbers over the seven days, as a result of cruises visiting fewer than seven ports in New Zealand. For example, 20 of the 33 cruises which reported Auckland as their first port of disembarkation (Table 1) only visited Auckland. As Figure 4 shows, by day four only 60 percent of the day one total cruise visitors (passengers and crew) remained in New Zealand, while by day seven this had fallen to 21 percent. There were also some ships whose itineraries included an ‘at sea’ day between disembarkation ports (e.g., between Akaroa and Auckland, Tauranga and Port Chalmers). These sea days are not shown on the cruise map (Figure 8).

Figure 4 Cruise visitors in mapped sample



For mapping, the cruise data were compiled in an Excel spreadsheet and pivot tables were derived to sum up the total number of passengers and crew visiting each port on days one through seven. These counts were transferred to a GIS layer of port locations in ArcGIS 10.6 for map creation. As noted, only ports at which disembarkation occurred were included in the mapping. The cruise with Fiordland recorded as their first itinerary port were mapped with either Port Chalmers (*n*=51), Stewart Island (*n*=5) or Lyttelton (*n*=1) as day one (as this was

the first day on which passengers and crew disembarked the ship); these ship's subsequent port visits were shifted accordingly.

The mapped data only shows those cruise ships which arrive in New Zealand from an overseas port and, as a consequence, do not portray the full extent of visitation at each port. The most common itinerary scheduling in the busier summer cruise season, for example, describes cruises which depart Australia for Fiordland, cruise north to Auckland and then repeat this itinerary in the opposite direction. These Auckland to Australia cruises are not included in the mapping.

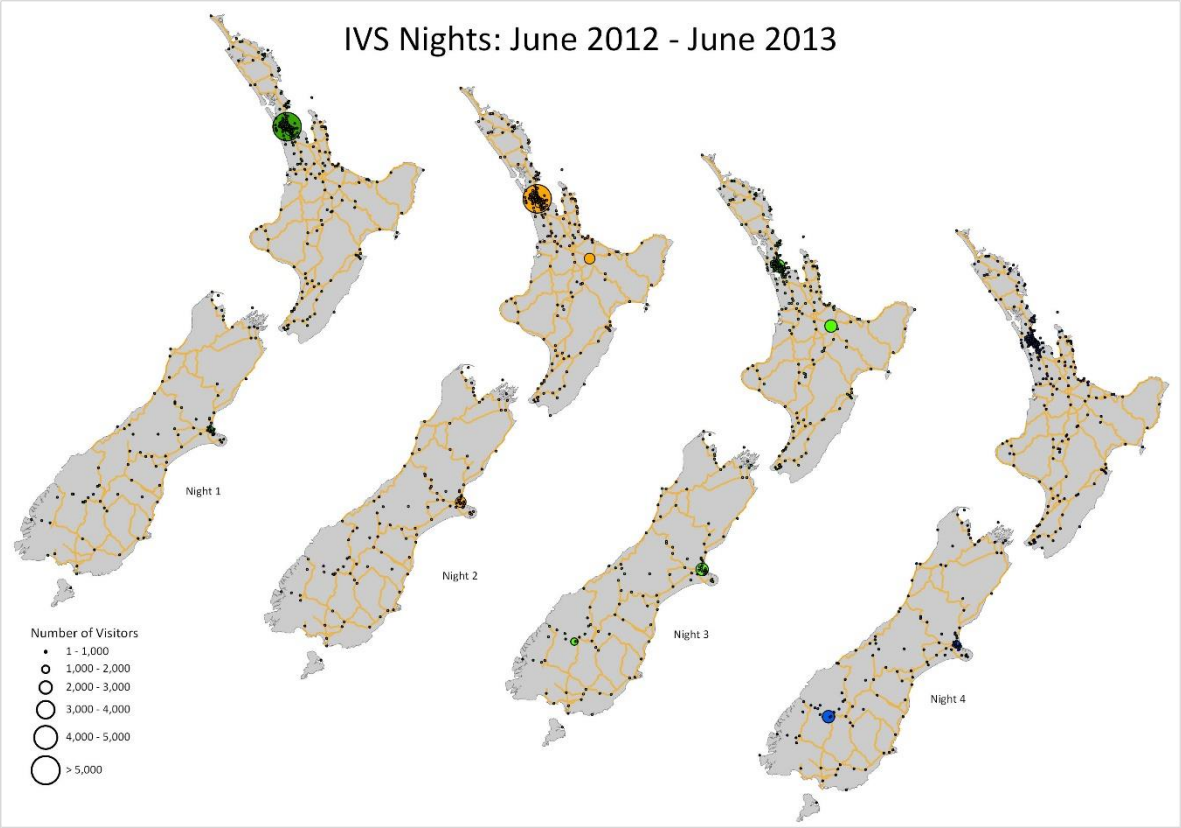
Visitor hotspot maps

A series of visitor hotspot maps were created to display the overnight locations visited by international tourists who arrive by air (IVS visitor maps) and the day locations visited by both the passengers and crew who arrive in New Zealand by cruise ship (Cruise visitor maps).

IVS visitor maps

Figure 5 presents the results of the IVS mapping for nights one, two, three and four. Patterns following night four were very similar to that night and are not shown.

Figure 5 Overnight visitor locations (nights 1-4) for IVS sample and travel groups



As expected, the highest number of nights are initially spent in Auckland with Christchurch being the next significant stay, though much lower in magnitude. The larger coloured circles indicating visitors in Auckland on nights one and two relate to those who reported staying in the Auckland CBD or central city areas. By nights three and four many of these visitors had dispersed to other parts of New Zealand although a significant number remained in the Auckland surrounds. Both Rotorua and Christchurch had visitor peaks on nights two and three, while the Queenstown peak was on night four (Figure 5).

The night one map in Figure 5 shows that visitor' dispersal is rapid with a significant number staying overnight at locations quite distant from their airport of arrival into New Zealand. This is potentially facilitated by the uptake of domestic flights on the day of arrival in New Zealand, particularly in respect of the number of Auckland arrivals who spend their first night in the South Island. Altogether, 75 percent of the visitor population included in the mapping arrived at Auckland Airport and almost 25 percent arrived at Christchurch airport. A small number

only were recorded as having arrived at other airports. Overall, the Figure 5 maps present a more robust picture of dispersal (and the speed of that dispersal) than of actual visitor numbers, as the smallest category used in the scale of visitor numbers was 1 – 1,000 visitors. The falloff in visitor numbers over the seven-day period also impacts on the total number of visitors represented on these maps as, for example, by night four, only 68 percent of the night one visitors remained in New Zealand (see Figure 1).

Further analysis was undertaken to show these data by airport of arrival (i.e., Auckland arrivals and Christchurch arrivals). Figure 6 shows where Auckland arrivals stayed overnight on nights one to four; Figure 7 shows the same data for Christchurch arrivals. These maps show more clearly the concentration of Auckland arrivals in North Island locations on nights one to four, while the number of Auckland arrivals who stay overnight on night one in the South Island confirms the uptake of domestic air travel immediately after arrival in New Zealand (Figure 6).

The maps in Figure 7 show a relatively high concentration of visitors in, and around, Christchurch on night one, with movement to Queenstown for night two (and subsequent nights). The Christchurch arrivals maps also show some visitor dispersal prior to reaching their overnight location for night one, with the travel distances involved suggesting that some of these visitors also take domestic flights on arrival. This is particularly the case for those who are located in the far south on night one, although some may have arrived from overseas into Queenstown. As noted, Queenstown was only added as a sampling airport after the 2013 IVS revisions. Overall, the Christchurch arrivals were more widely dispersed by night four. By night three some of the Christchurch arrivals had relocated to the central and upper North Island (Figure 7).

The IVS visitors are mapped according to their overnight stay locations and do not provide any further detail on travel mode, routes taken, or activities and locations visited between each overnight stop. These details may be of considerable concern in respect of the biosecurity risks associated with international tourists and their pathways around New Zealand. In respect of better border biosecurity, however, it is perhaps of more interest to know the locations from which visitors arrive in New Zealand. Currently, flight arrival data is captured by international arrival cards and only asks the port of last embarkation. A visitor may have departed their home country and flown directly to New Zealand, but their last embarkation (i.e., their final flight) could have been Australia. Likewise, visitors from the UK will not be recorded as having departed from the UK and could have arrived in New Zealand via a wide range of routes and travel itineraries. For example, they may have taken a number of flights constituting a ‘direct flight’, flights with a short stopover en route, or they may be visiting New Zealand as part of a multi-destination trip having visited other countries prior.

Figure 6 Overnight visitor locations (nights 1-4) for IVS sample and travel groups: Auckland arrivals

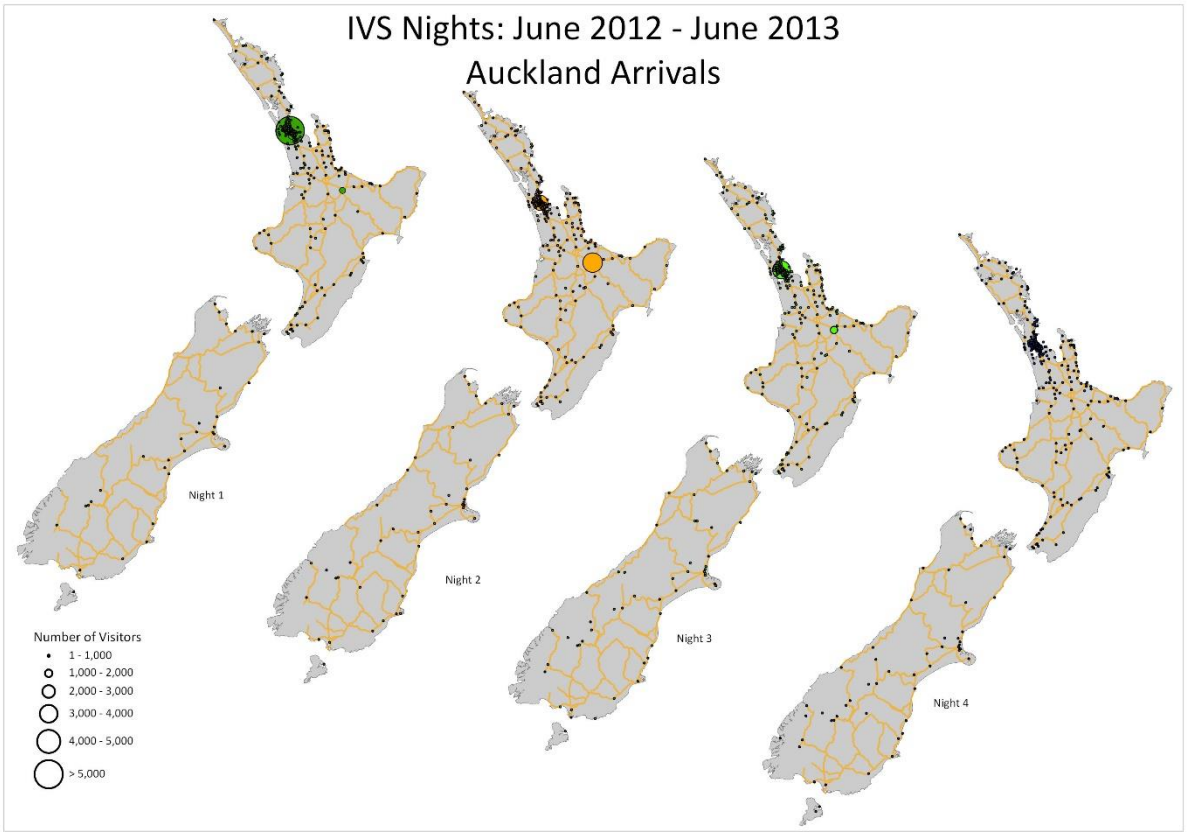
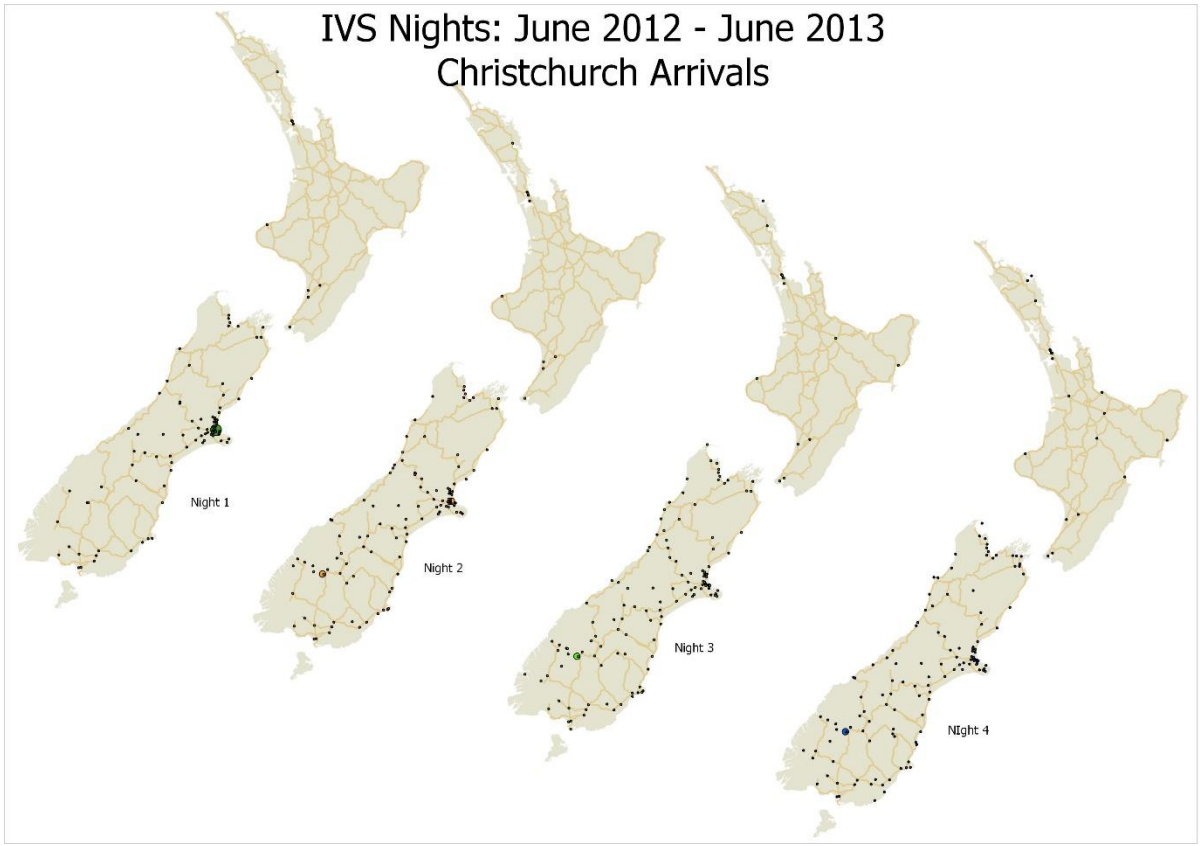


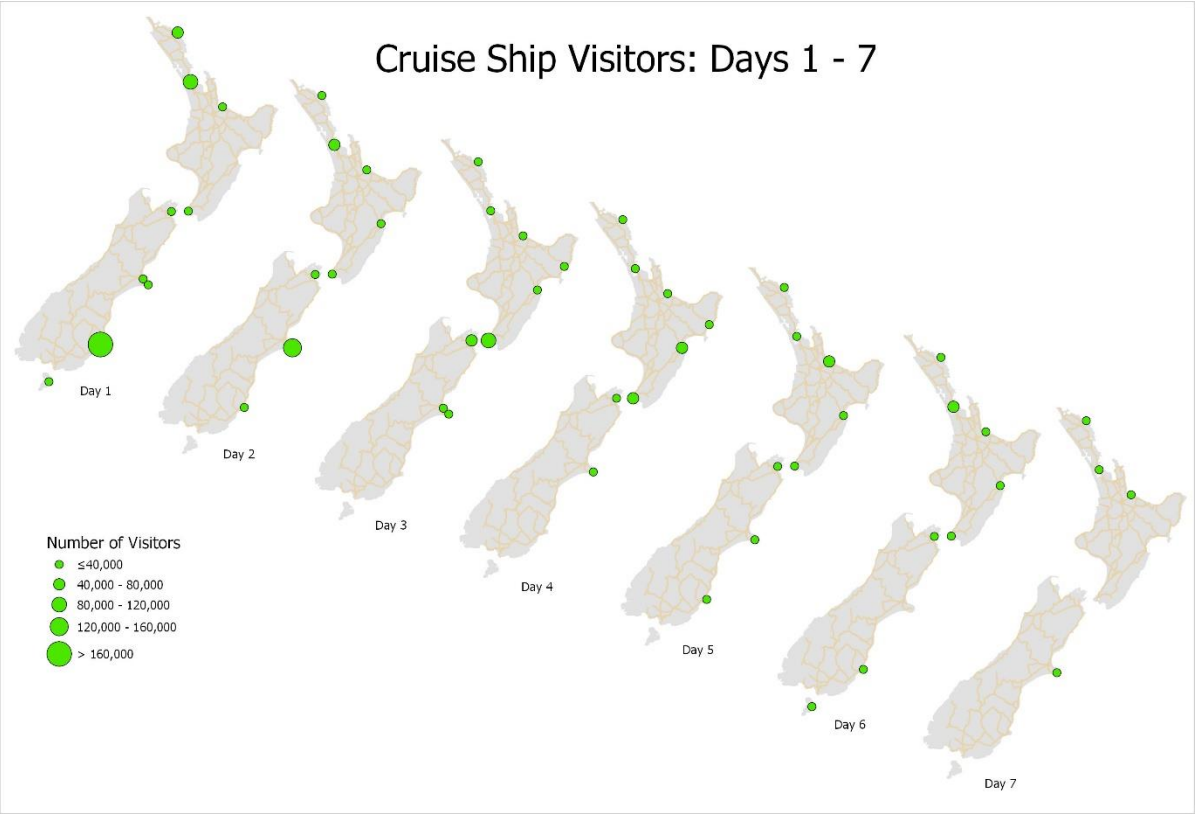
Figure 7 Overnight visitor locations (nights 1-4) for IVS sample and travel groups: Christchurch arrivals



Cruise visitor maps

Figure 8 shows the ports visited on days one to seven of the New Zealand cruise itineraries. As noted, these data represent the total possible number of visitors (both passengers and crew) who might disembark at each port.

Figure 8 Day visitor locations (days 1-7) for cruise visitors



Port Chalmers is the most significant port of call on day one although all of these cruise visitors have already visited Fiordland. As noted, for the majority of these ships, Port Chalmers is their first landfall and is the first port of disembarkation. These cruise ships tend to proceed northwards from Port Chalmers to Auckland, although some only travel as far north as Wellington or Picton before departing New Zealand. Arrivals to Auckland encompass passengers for whom Auckland is their disembarkation point (from Pacific cruises), though some cruises do arrive in either the Bay of Islands or Auckland and then follow a southbound itinerary around New Zealand. As noted, the cruise ships which depart Australia for New Zealand ports commonly repeat the same itinerary in the opposite direction (i.e., Auckland to Australia) but are not mapped as their embarkation port is Auckland.

The north- and southbound cruises tend to meet in the middle of the country (Picton and Wellington), most significantly around days three and four. As noted, however, almost 80 percent of cruise ships have departed New Zealand by day seven (see Figure 4).

The smallest circles on Figure 8 represent up to 40,000 visitors – the number of passengers and crew which could be on between one and 13 cruise ships. Passenger numbers on the 35 ships included in the mapping ranged from 224 to 4,180 (average 2,024); crew numbers ranged from 140 to 1,500 (average 829). Cruise visitors visit a smaller and more discrete

number of locations within New Zealand than do those visitors recorded by the IVS. The 115 cruises mapped made calls to only 11 ports (compared to 2,248 overnight locations mapped from the IVS data). As noted, however, it is known how many disembark the ship and no further details are available describing the activities they undertake while ashore. Useful details – in respect of biosecurity risk – might include both the distances travelled from the embarkation port and the type of environments visited.

The cruise data provides a clearer record (than for air arrivals) of where these visitors either boarded, or previously disembarked the ship. With cruise visitors, however, there may be some time decay on risk (e.g., it takes multiple days to reach New Zealand from Australia and the Pacific by sea). Ships arriving into New Zealand from Australia can be at sea for two or three days (e.g., 2 days from Sydney and Tasmanian ports, 2 days Melbourne to Fiordland, 3 days from Brisbane and Melbourne to Auckland). In addition, those cruises with Fiordland scheduled as their first port of call will have an additional day (2 days if going to Lyttelton) at sea prior to their New Zealand landfall. Ships arriving in New Zealand from the Pacific can be at sea for between two and four days, dependent on their departure port and arrival port in New Zealand (e.g., generally, 2 days if arriving in Bay of Islands, 3 days if arriving in Auckland).

Data limitations

This report and mapping exercise represents an attempt to depict the key arrival points and subsequent movement (itineraries) of visitors to New Zealand who arrive by both air and sea. The maps were prepared from IVS data collected in 2013 (the last time these data were collected by the IVS) and cruise schedule data from 2017-2018. Overall, the IVS maps show the considerable (and rapid) dispersal of a sample of international visitors who arrived in New Zealand by air in 2012-2013. While the cruise data presented are current, they do not provide any visit detail beyond the embarkation ports visited by each ship. Generating more granular biosecurity risk assessments would require additional data on disembarkation rates (which potentially vary by vessel and cruise type) and on-shore activities.

Although based on a dated dataset, the dispersal of visitors over the seven night period (shown only to night 4 in the maps) is likely to be broadly similar today especially as the maps depict such a large number of overnight locations visited. Many of the locations reported in the IVS dataset were generic (e.g., Auckland) and there was considerable overlap between individual locations (e.g., some of those surveyed reported staying in Auckland, while others reported staying in the Auckland CBD, North Shore, in specific Auckland accommodation premises, and so on). Should itinerary data be recorded in the future, and mapping undertaken, it is suggested that these are collated to represent fewer data points. Possible rationale for collation include statistical area units (which represent recognised urban settlements), or by either an environmental (e.g., built areas, urban parks, native forests and reserves, coastal environments, etc) or land use (e.g., dwellings, farmed land, production forest, protected areas etc) classification.

A number of broad changes – occurring since 2013 – in international visitor numbers and travel patterns should be noted, however. The growth of flights into Queenstown airport, for example, may have substantively changed visitor movement around the South Island. Queenstown airport data were included in an 'other' airport category in 2013 (along with Wellington, Dunedin and Hamilton) and, as noted, no IVS sampling was undertaken at Queenstown airport. In 2018 (YE Sept), the 277,248 international arrivals at Queenstown airport represented seven percent of all international arrivals (up from 5% in 2013). Over the same period, Auckland arrivals fell from 72 percent (2013) to 71 percent (2018), while Christchurch airport maintained a 15 percent share of international arrivals.

International tourism arrivals have grown and evolved considerably since 2013. Overall, international visitor arrivals increased from 2,670,048 in 2013 (YE Sept) to 3,808,605 (YE Sept), an increase of 43 percent. Over the same period, international arrivals from China increased by 92 percent (from 236,336 to 452,944). The travel patterns of Chinese visitors are reported to be diversifying quickly to more independent forms of travel which may also encompass more extensive itineraries than represented by organised coach tours.

Concerns are also raised about the sample size and weighting mechanisms used in IVS analysis. As noted, the data mapped here represent a sample population (along with that sample's travel companions) and, while these provided a sufficient number of visitors for mapping purposes, there are some concerns around how representative the itineraries of these visitors are in respect of all international visitors. The review of the IVS also highlighted concerns around visitors' recall of places visited and location accuracy.

We are aware of additional national conversations on the need to measure and understand tourist flow data. These are occurring in a number of venues including within the National Science Challenges (e.g., Resilience to Nature's Challenges, Building Better Homes Towns and Cities), NZTA, LGNZ and RTOs (regional tourism organisations). Recently Statistics NZ has been working with the three major TelCos to take a government centric approach to explore the development of population densities (hot spots) and travel patterns in New Zealand. This project and MPI have been engaged in these discussions. Various data requirement have emerged alongside the need to separate point (time) and flow data at differing levels of spatial granularity. A recently published NZTA review of South Island visitor flows largely focused on forecasting future roading infrastructure needs with the authors noting that, while "data exists to provide a reasonable estimate of international visitors to the South Island and their port of entry … a fuller description of visitor flows also requires measures of route and mode use between regions and of flows between accommodation and attractions within regions" (Byett et al., 2018, p.7). The 'investigation of regional tourism flows and volumes' was also one of the key initiatives proposed in the 2018 tourism data domain plan (MBIE, 2018b).

Conclusion

In respect of better border biosecurity, the maps are potentially most valuable in respect of the night one/day one data, as this presents as the visitors' first point of contact in New Zealand. The subsequent nights/days depicted in the map indicate pathways around New Zealand although, as noted, they represent 'hotspots' at which visitors collect (either overnight for the IVS sample, or by day for cruise visitors) rather than representing visitor flow. Tourism flow data is not currently collected, but new data sources (such as cell phone tracking records) may in the future provide a more useful, informative and accurate dataset of tourist flow and activity than was able to be measured in the past.

In order to contribute to understanding biosecurity risk associated with tourism, and in terms of better border biosecurity, these data would also need to be mapped alongside known and potential risk vectors, locations, environments, types of visitor (e.g., origin, arrival routes, their activities), and so on. Biosecurity risk assessment would be enhanced by the measurement of more granular data describing activity and environmental settings associated with visitors to New Zealand. These include, for example, greater understanding of water and land based activity (including the use of camping and other outdoor equipment) and the types of environments visited (including urban, parkland, marine, riverine, riparian, wetlands, forest, agricultural, conservation land, etc.). The current national level instruments do not attend to this level of granularity. Risk profile 'maps' might also benefit from refinements in respect of each visitor's country of origin or country of embarkation. These could be informed by current MPI airport and cruise port assessment data.

Within the broader biosecurity assessment framework, specific vectors thought to have some association with tourism activity could also be refined (e.g., seed, spore, insect etc.) along with descriptions of the potential source of each. Improved understanding and greater clarification of the nature of the biosecurity risks would also determine the need to focus on either 'better border biosecurity', or on the risk pathways found within New Zealand. For the

present, a seven night / seven day window has been examined and this time period might be extended or reduced according to particular risk attributes and research foci. The visitor hotspots mapped herein present a first broad attempt at understanding the potential impact of tourism (and tourist flows) on biosecurity risk locations.

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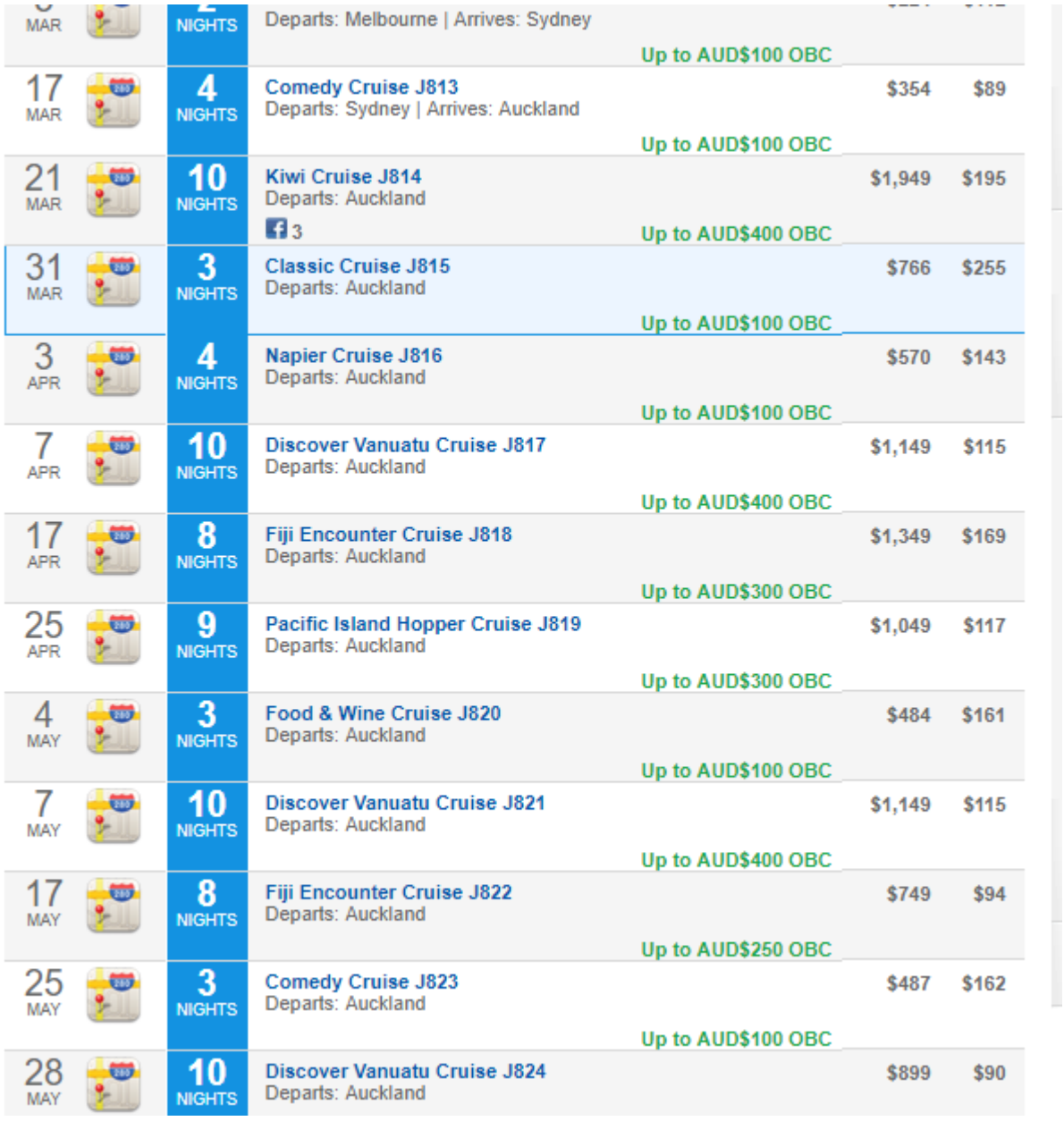
Appendix

Clean Cruising

The Clean Cruising website allows a search for all cruise lines and ships and lists departures for individual cruises. Can select specific departure ports – Auckland is one option available. The data were only for current (from February 2018) and future departures however (i.e., no past data were available)

Image below shows a sample for the Pacific Jewel.



MAR	NIGHTS	Departs: Melbourne | Arrives: Sydney	Up to AUD$100 OBC		
17 MAR	4 NIGHTS	Comedy Cruise J813 Departs: Sydney | Arrives: Auckland	Up to AUD$100 OBC	$354	$89
21 MAR	10 NIGHTS	Kiwi Cruise J814 Departs: Auckland 3	Up to AUD$400 OBC	$1,949	$195
31 MAR	3 NIGHTS	Classic Cruise J815 Departs: Auckland	Up to AUD$100 OBC	$766	$255
3 APR	4 NIGHTS	Napier Cruise J816 Departs: Auckland	Up to AUD$100 OBC	$570	$143
7 APR	10 NIGHTS	Discover Vanuatu Cruise J817 Departs: Auckland	Up to AUD$400 OBC	$1,149	$115
17 APR	8 NIGHTS	Fiji Encounter Cruise J818 Departs: Auckland	Up to AUD$300 OBC	$1,349	$169
25 APR	9 NIGHTS	Pacific Island Hopper Cruise J819 Departs: Auckland	Up to AUD$300 OBC	$1,049	$117
4 MAY	3 NIGHTS	Food & Wine Cruise J820 Departs: Auckland	Up to AUD$100 OBC	$484	$161
7 MAY	10 NIGHTS	Discover Vanuatu Cruise J821 Departs: Auckland	Up to AUD$400 OBC	$1,149	$115
17 MAY	8 NIGHTS	Fiji Encounter Cruise J822 Departs: Auckland	Up to AUD$250 OBC	$749	$94
25 MAY	3 NIGHTS	Comedy Cruise J823 Departs: Auckland	Up to AUD$100 OBC	$487	$162
28 MAY	10 NIGHTS	Discover Vanuatu Cruise J824 Departs: Auckland		$899	$90

Downloaded 8 February 2018 from http://www.cleancruising.com.au/ship.asp?ship=PACJEW

Cruise Timetables

Website that offers cruise planning tools. Can select cruise departures points – Auckland is the only New Zealand departure port listed. List is updated so only show current and future dates although search options do include some 2017 months (no data available for Auckland). Image below shows data available.

CRUISE YEAR

Cruises From Auckland 2018

Showing 67 cruise(s)

Day of Departure	Ship	Cruise Name	From/To	Price From
January				
Wed 31	Norwegian Jewel	10-Night Australia & New Zealand from Auckland	Auckland / Sydney	
February				
Thu 1	ms Maasdam	25 Night South Pacific Crossing	Auckland / San Diego	
Fri 2	ms Amsterdam	35 Night Grand World Voyage	Auckland / Hong Kong	
Sun 4	Silver Whisper	16 Night Auckland To Sydney Australia & New Zealand Cruise	Auckland / Sydney	
Mon 5	Regatta	53 Night Turquoise Seas Sojourn Auckland To Honolulu	Auckland / Honolulu (Oahu)	
		24 Night Coral Sea Crossing Auckland To Bali	Auckland / Bali	
Tue 6	Seabourn Encore	34 Night New Zealand & Coral Sea Jewels	Auckland / Bali	
		44 Night Southern Cross & Orchid Isles	Auckland / Singapore	
		16 Night New Zealand & Australia	Auckland / Sydney	
	Seven Seas Navigator	19 Nights Auckland To Perth (Fremantle) - Australian Adventure	Auckland / Fremantle	
Sat 17	Celebrity Solstice	16 Night Australia & New Zealand Cruise	Auckland / Fremantle	Interior $1749
	Columbus	7 Nights Auckland to Sydney	Auckland / Sydney	Voyager Inside Guarantee GBP 919
Sun 18	Diamond Princess	12 Night Australia & New Zealand	Auckland / Sydney	Interior Sold Out
	ms Noordam	11 Night Atlantis Auckland To Sydney Cruise	Auckland / Sydney	NA
Wed 28	Sun Princess	13 Night New Zealand	Auckland / Auckland	Interior Sold Out
March				
Sat 3	Crystal Symphony	16 Night Polynesian Palette - Auckland to Papeete	Auckland / Papeete	From $5,250

Downloaded 9 February 2018 from https://www.cruisetimetables.com/cruises-from-auckland-new-zealand-2018.html

CRUISE DETAILS

Cruises on Celebrity Solstice departing February 2018

Showing 1 to 2 of total 2

From **Sat 3 Feb 2018**
(To Sat 17 Feb 2018)
14 Night New Zealand Cruise
Ship Celebrity Solstice

More details at Celebrity Cruises

Cruise Schedule: Sydney, Australia (03 Feb d1830); Melbourne, Australia (05 Feb 0800-1800); Hobart, Tasmania (07 Feb 0800-1800); Fjordland National Park, New Zealand (10 Feb 0800-0900); Dunedin, New Zealand (11 Feb 0900-1900); Akaroa, New Zealand (12 Feb 0700-1800); Wellington, New Zealand (13 Feb 0800-1800); Napier, New Zealand (14 Feb 0800-1800); Bay of Islands, New Zealand (16 Feb 0800-1900); Auckland, New Zealand (17 Feb a0600)

From **Sat 17 Feb 2018**
(To Mon 5 Mar 2018)
16 Night Australia & New Zealand Cruise
Ship Celebrity Solstice

More details at Celebrity Cruises

Cruise Prices Interior $1749 Outside $3199
Balcony $3299 Concierge NA Aqua NA Deluxe NA

Cruise Schedule: Auckland, New Zealand (17 Feb d2000); Tauranga, New Zealand (18 Feb 1100-2200); Napier, New Zealand (20 Feb 0800-1700); Wellington, New Zealand (21 Feb 0800-1800); Picton, New Zealand (22 Feb 0800-1700); Sydney, Australia (25 Feb 0700-2100); Hobart, Tasmania (27 Feb 0800-1600); Adelaide, Australia (01 Mar 0900-1800); Fremantle, Australia (05 Mar a0630)

Change Month <<prev next>>

Downloaded 9 February 2018 from https://www.cruisetimetables.com/cruisesoncelebritysolstice-feb2018.html

Cruise Schedules

Our cruise schedule shows information for all arriving cruise ships into Ports of Auckland. The schedule is maintained in real-time, displaying any delays as they arise.

See answers to frequently asked questions here or contact cruise@poal.co.nz directly with any queries.

Last updated: 09 Feb 2018 09:43am

Vessel	Wharf	Arrives	Departs	Previous Port	Next Port
RADIANCE OF THE SEAS	Queens	09 Feb 2018 07:35	09 Feb 2018 18:00	Tauranga	Bay Of Islands
PACIFIC PRINCESS	Queens	10 Feb 2018 05:30	10 Feb 2018 23:00	Bay Of Islands	Sydney
CALEDONIAN SKY	Queens	11 Feb 2018 05:30	11 Feb 2018 18:30		Bay Of Islands
OCEAN DREAM	Queens	15 Feb 2018 04:30	15 Feb 2018 21:00	Lyttelton	Noumea
CELEBRITY SOLSTICE	Princes	17 Feb 2018 04:30	17 Feb 2018 20:00	Tauranga	Tauranga
COLUMBUS	Queens	17 Feb 2018 05:30	17 Feb 2018 19:00	Bora Bora	Tauranga
DIAMOND PRINCESS	Queens	18 Feb 2018 04:30	18 Feb 2018 18:00	Tauranga	Tauranga

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