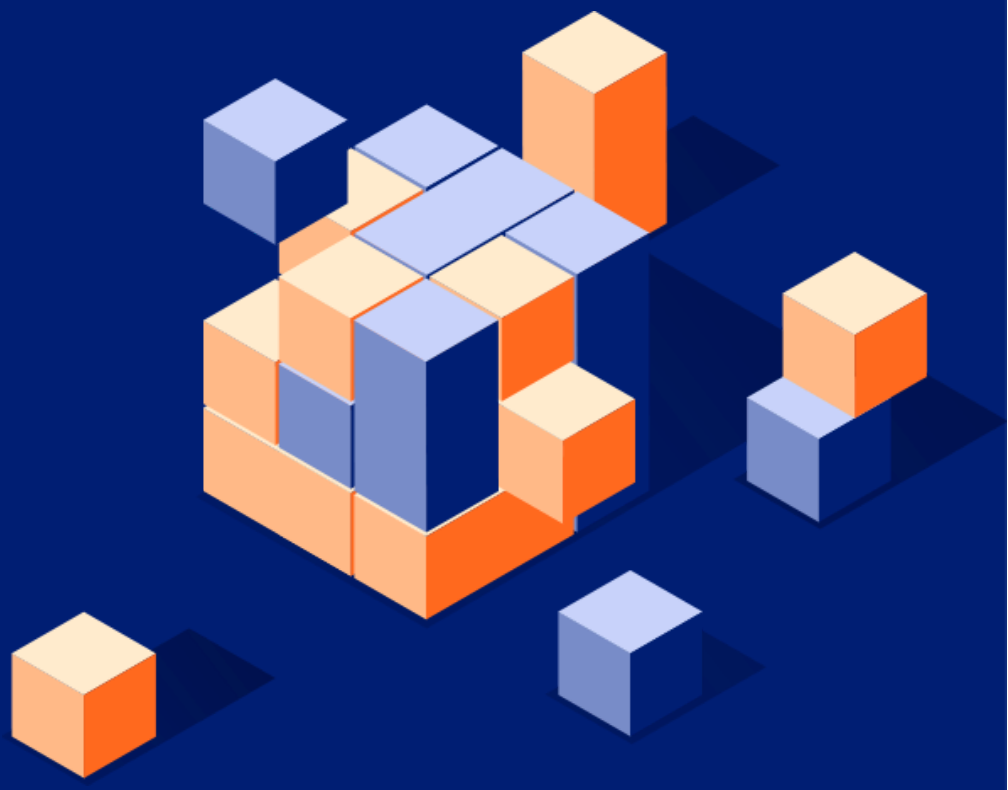
New Zealand Search and Rescue

Exploring Value from Mobile Data

July 2024



NEW ZEALAND SEARCH AND RESCUE
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1. Executive Summary

1.1. Background

New Zealand Search and Rescue (NZSAR) wishes to build a comprehensive view of Search And Rescue (SAR) incidents as well as water and land safety across New Zealand, including a broader spectrum of data from other providers. To this end, DOT has developed a data analysis service (DAS), a Snowflake data mart, that combines NZSAR's SARdonyx data with datasets from partner SAR organisations as an end-to-end data system.

Currently, NZSAR's SARdonyx database features standard reporting outputs, but is not designed for deep analysis, modelling, or projections. One of the main challenges is that the current NZSAR reports do not facilitate geospatial analyses of key areas of interest, such as holiday spots and walking tracks. One of the functionalities of DAS provides the ability to map incident coordinates with geographical areas and boundaries of interest. DAS also ensures data standards across different sources as well as identifies and merges incidents that exist in more than one source. This allows NZSAR, for example, to investigate how many incidents occurred in a specific location (such as the Great Walks), when and why the incidents occurred, and who were involved to resolve the situations.

In the current project, NZSAR has asked DOT to identify opportunities to extract greater value from the DAS based on their knowledge of other datasets available in New Zealand. With this objective, DOT has identified a potential dataset—Anonymised Location Activity data from Qrious (henceforth: Mobile data)—that could enrich the current DAS and allow deeper analysis of SAR incidents on top of the DAS system in terms of the magnitude of recreational activities and their risks associated with SAR demand.

NZSAR purchased the Qrious Mobile data, which contains hourly cell phone event estimates on the basis of unique device counts and is upweighted from Spark's market share. The data covers the preceding five year period between 1 January 2019 and 1 January 2024, aggregated to a Stats NZ Statistical Area 2 (SA2) level.

1.2. Objectives

The goal of this work is to explore how Qrious Mobile data can be used to provide insights into the drivers behind SAR demand associated with recreational activities. The report demonstrates the types of analysis possible when combining the Mobile data with the historical SAR incident information, as well as exploring the limitations associated with using this data source to predict future SAR demand.

2. SAR Demand

According to NZSAR, approximately 62% of SAR incidents are related to recreational activities. During the period between 2020 - 2022, a total of 7656 incidents were recorded in SARdonyx with approximately 69% of those being Category 1 SAR and 28% Category 2 SAR. Figure 1 below shows that

there is an observable trend of more incidents occurring in summer months from December to February across the three year period. Unsurprisingly, there was a significant dip in April 2020, which coincides with the lockdown restrictions to manage the COVID-19 outbreak within New Zealand. Figure 2 further confirms that there were more incidents during summer than winter (during July, August, and September), and more incidents also occurred on weekends compared with weekdays during both seasons.

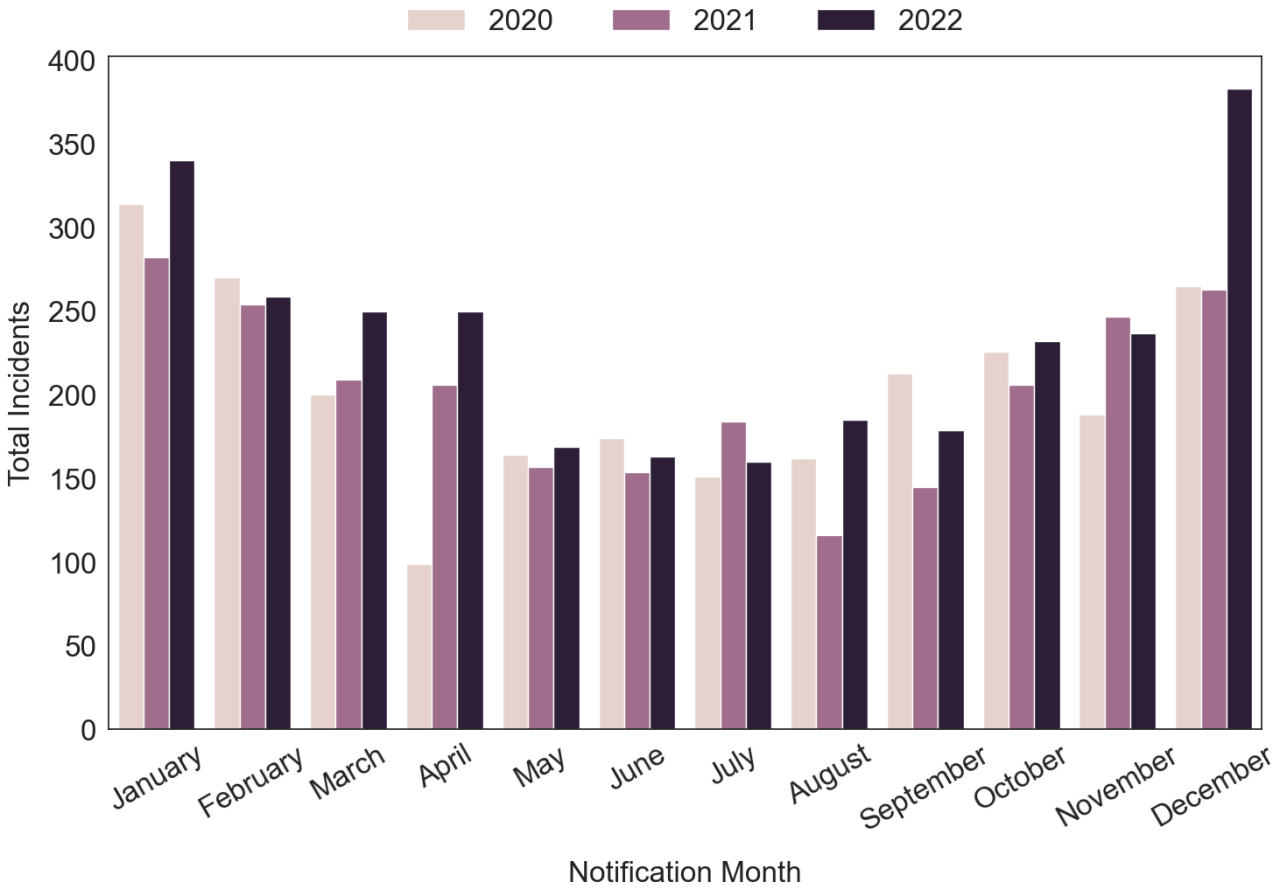

Figure 1. Total number of SARdonyx incidents by month and year, 2020 - 2022.

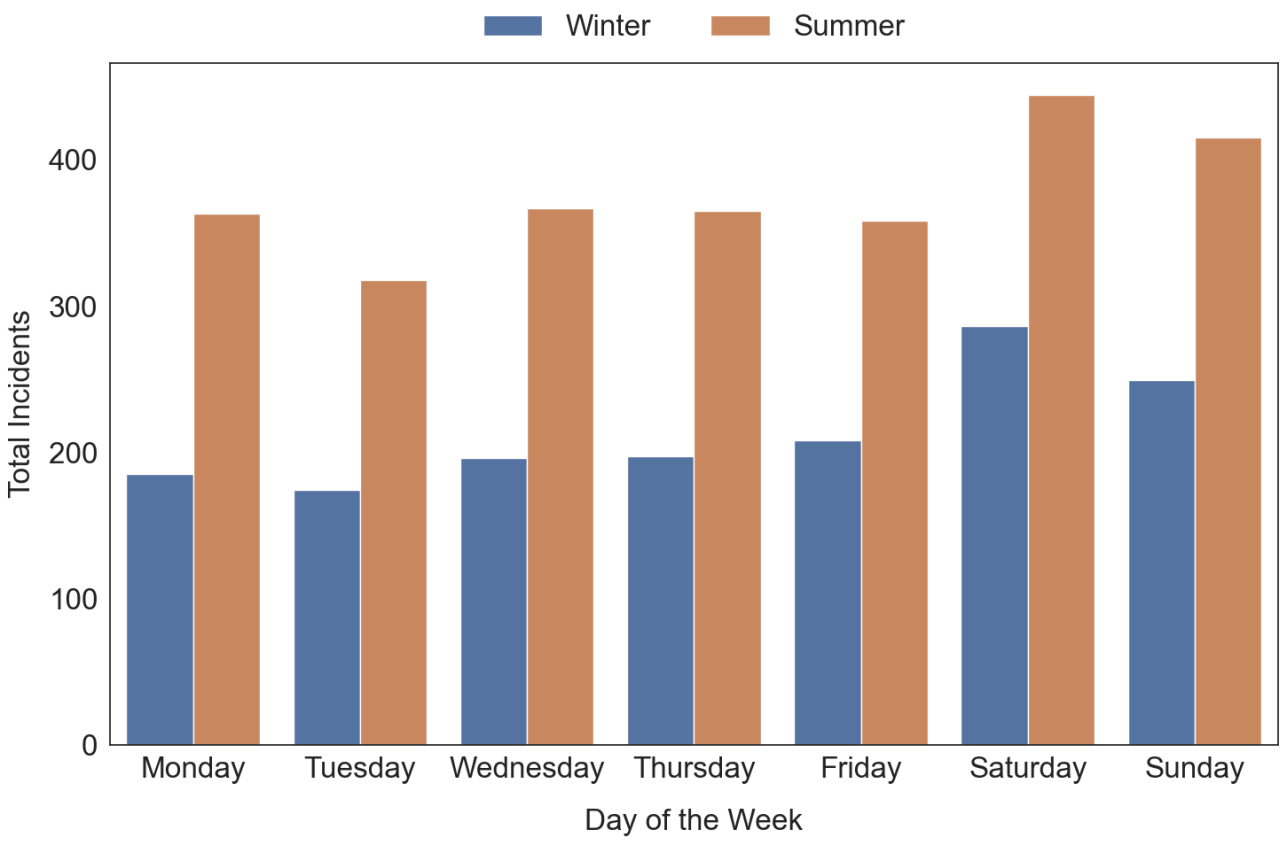

Figure 2. Total number of SARdonyx incidents by day of the week and season, 2020 - 2022.

When examining the environment where incidents occurred, the majority of incidents occurred on land and water; while significantly fewer air incidents were recorded (Figure 3). Furthermore, there was a higher number of incidents occurring during the daytime, commencing 10AM across weekdays, but the overall incident peaks are observed during the weekends (Figure 4).

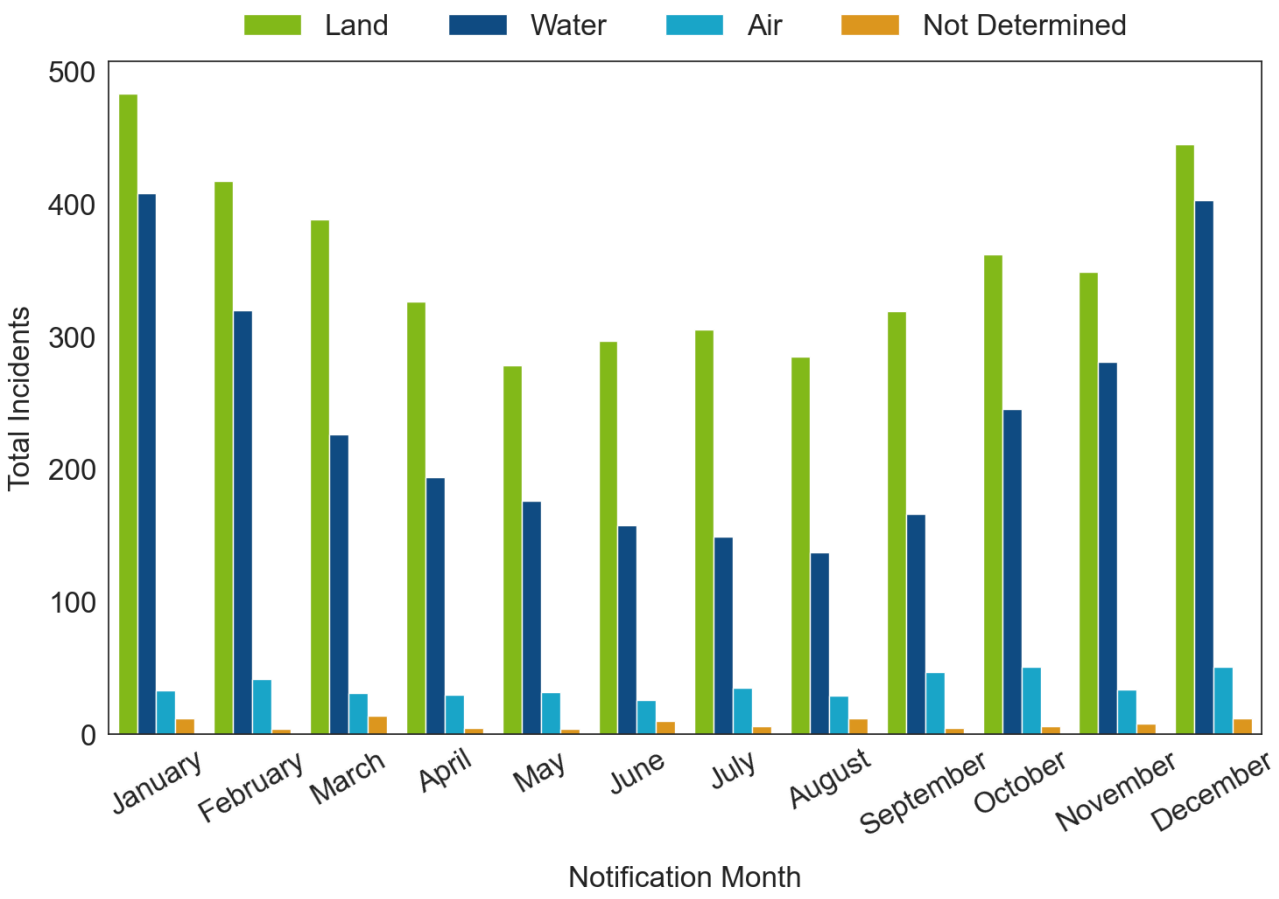

Figure 3. Total number of SARdonyx incidents by month and incident environment, 2020 - 2022.

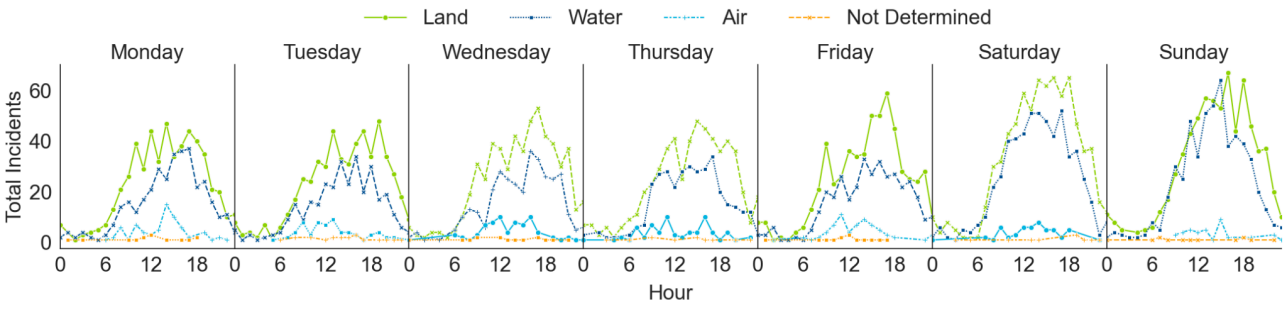

Figure 4. Total number of SARdonyx incidents by hour of the week and incident environment, 2020 - 2022.

When delving deeper into the type of activities related to different environments, the data shows that the main land activities contributing to SAR demand are day-walking and tramping (Figure 5), while recreational boating is the major water activity causing SAR demand (Figure 6). These insights also guide the analyses of recreational activities and incident rates below, concentrating on areas popular for day-walking, tramping, and recreational boating, namely Tongariro National Park, Whangaruru, and Lake Taupō.

Figure 5. Total number of SARdonyx incidents by day of the week and land activities, 2020 - 2022.

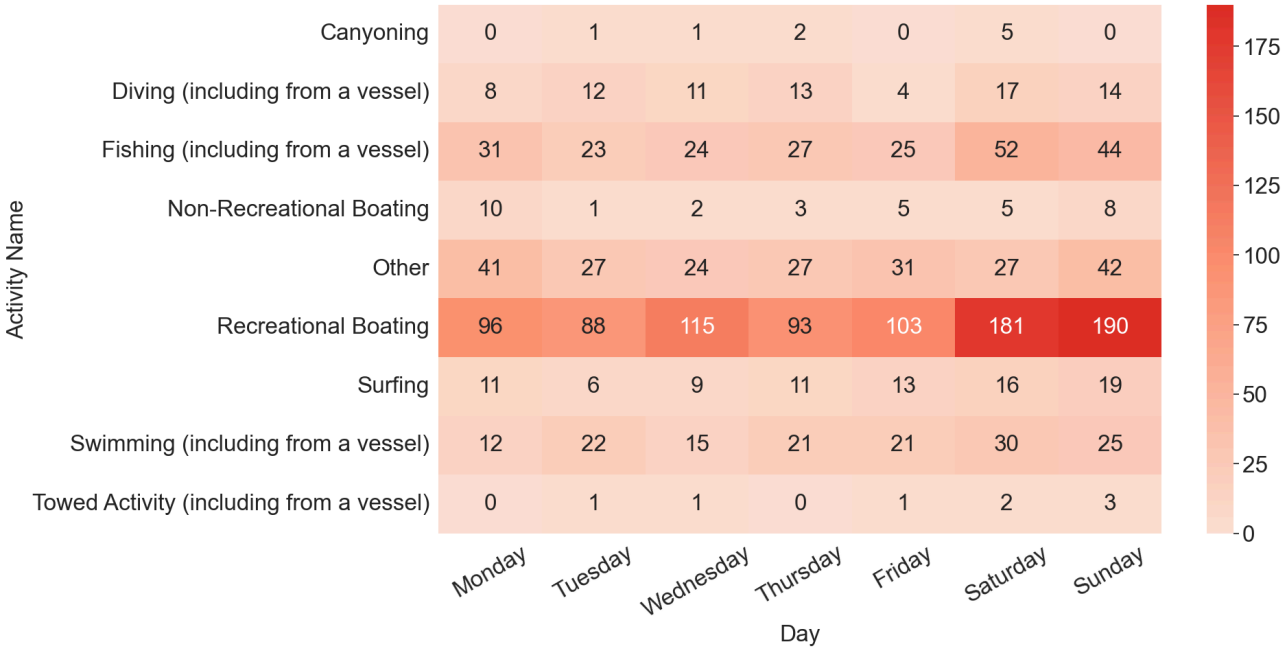

Figure 6. Total number of SARdonyx incidents by day of the week and water activities, 2020 - 2022.

Other than annual reports of summary statistics on SAR incidents and subject demographics, research on the direct relationship between recreational activity and SAR demand has been limited. In March 2023, the NZSAR Secretariat launched a quarterly survey intended to track trends in land-based recreational activity participation and preparedness over time. Although the quarterly survey sheds light on people's attitudes and behaviours when doing recreational activities, it is limited in terms of

inferences on the magnitude of recreational activity participation, the granularity of locations and the times popular for the activities, and importantly the relationship between recreational participation and the risk of it resulting in a SAR incident. There is, therefore, a gap in understanding of the relation between recreational activity and SAR demand, necessitating a need to conduct a deeper and more detailed analysis on the impact of recreational activities on SAR demand.

3. Mobile Data

To assess and monitor the level of recreational activity participation, one approach is to estimate the number of people "active" or "present" together with prior knowledge of the relevant recreational activities of a specific location and time. For example, visitors to Tongariro National Park are likely to engage in day walking or tramping in summer, but mostly skiing in winter. On top of this, New Zealand's recreational experiences have attracted not only domestic participants but also overseas tourists. This distinction, from a perspective of SAR demand, is important because overseas visitors are related to a broader trend in international travel preference, but not directly to New Zealand socio-demographic outlooks.

The Mobile data from Qrious provides an hourly estimate of the number of people present in a particular area. The estimates are calculated from the unique device registration counts and then upweighted from Spark's market share. In this report, the Mobile data is used as a proxy for the number of people present in specific areas at specific times (also see the Limitations section). The data also distinguishes people into: local, international, domestic, and unknown. These were categorised based on International Mobile Subscriber Identity (IMSI) and Regional tourism organisation (RTO) (see Appendix for more information). In the current analysis, visitors are defined as either international and domestic, and are used to distinguish and infer people engaged in recreational activities from the residential population. Weekends also include New Zealand public holidays, such as the Christmas period.

As the Mobile data does not directly distinguish the type of activities people are undertaking, the number of people engaged in recreational activities should be estimated under a set of assumptions about a specific location and time. For example, it is assumed that people are more likely to engage in recreational activities during weekends and holidays rather than weekdays in popular outdoor locations, such as Tongariro National Park and Lake Taupō, and thus an increase in the number of people (both New Zealanders and overseas visitors) during the weekends in these areas is likely indicative of the level of recreation participations in such areas. This assumption, however, is not applicable to all areas in New Zealand, and should be combined with the prior knowledge on prevalent recreational activities popular in varying areas.

See the Appendix: Methodology for more detailed information on how the Mobile data is processed to estimate the number of people at different locations and times.

4. What Mobile data can tell us about SAR demand

Mobile data can be used to estimate the number of people present, and further to infer the magnitude and patterns of recreational activities for potential SAR incidents. One assumption here is that people are more likely to engage in recreational activities during the weekends and holidays* compared to the weekdays in certain outdoor areas. This is to distinguish from the travel-to-work movement patterns in areas where the increase is likely due to people spending their weekend at home but travelling to work on weekdays. Another assumption is that recreational activities are more likely to happen during the daytime and that certain areas attract different recreational activities in summer and winter seasons. For example, Ruapehu National Park attracts more day walkers and trampers during summer, while skiing is more prominent in winter. In the following analyses, winter includes July, August, and September; while summer includes December, January, and February.

*Weekends include New Zealand public holidays, such as the Christmas period.

4.1. Analysis of the Mobile data

Mobile data on its own can be used to analyse the patterns of where people spend their time while not at home or work as well as to compare different areas to each other and rank based on the increase in the number of people in the area this creates. Analysis below shows examples of the insights the Mobile data can provide.

4.1.1. Where do people go during the weekends?

The map below shows the SA2 areas by percentage of daily average visitors (between 7AM and 6PM) during weekends between 2020 and 2022, highlighting popular locations for recreational activities (Figure 7).

The notable areas with the highest percentage and high number of visitors, with the exception of inlets with no local residents (such as, the Wellington Harbour Inlet), include:

- Fiordland - 90% (798 visitors)
- Whakarara (Far North) - 63% (500 visitors)
- Marlborough Sounds West - 62% (2556 visitors)
- Stewart Island - 62% (847 visitors)
- Kaimanawa (Taupō) - 62% (502 visitors)
- Marlborough Sounds East - 62% (5196 visitors)
- Aviemore (Canterbury) - 61% (1624 visitors)
- Whakapaku (Far North) - 61% (627 visitors)
- Russell Forest-Rawhiti (Far North) - 60% (718 visitors)
- Mackenzie Lakes - 59% (2161 visitors)

These areas are known as popular tourism and recreation destinations.

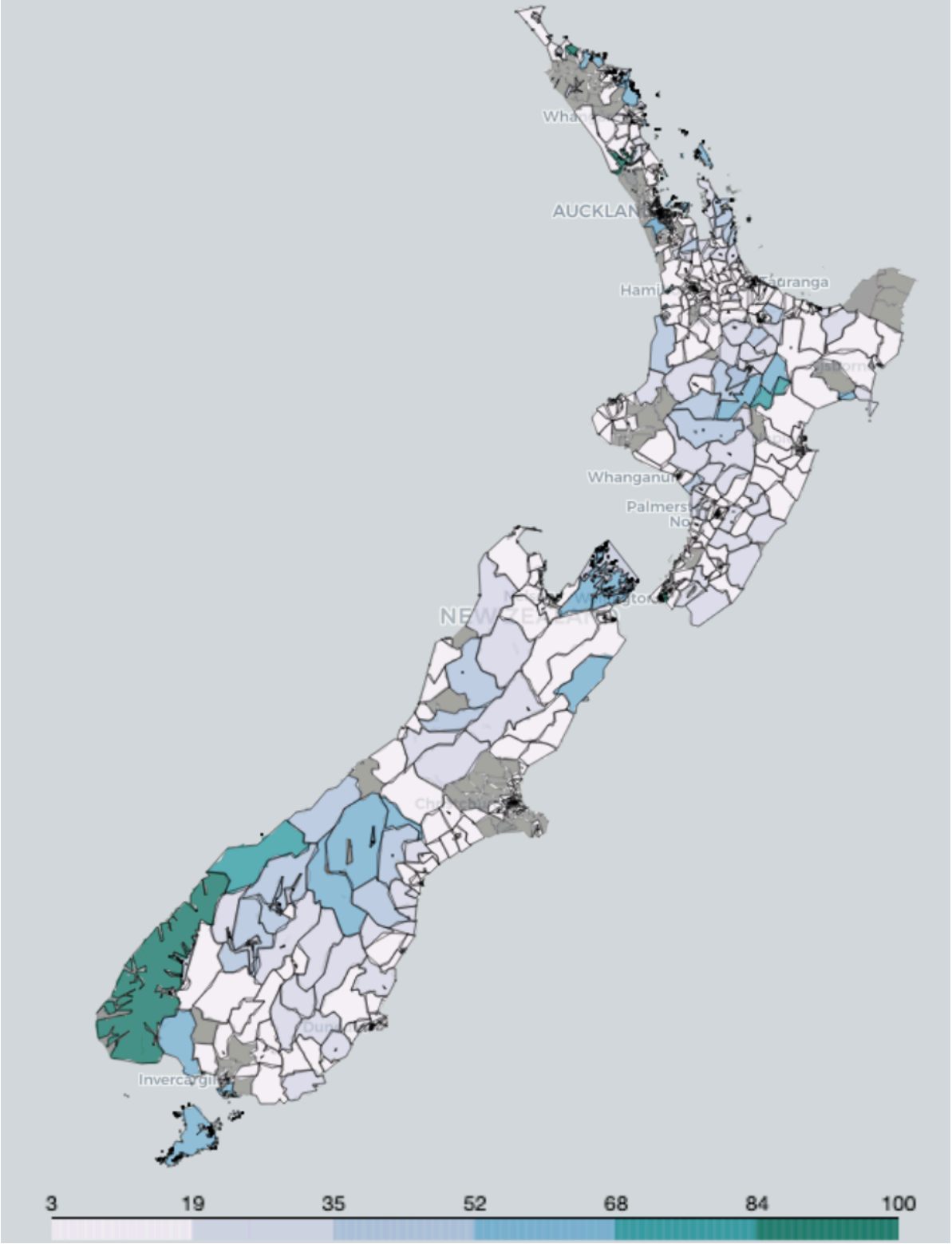

Figure 7. Percentage of daily average visitors during weekends, 2020 - 2022; areas with less than 100 visitors are shown in grey.

Figure 8 shows popular areas for visitors during the weekends in the Far North. Doubtless Bay has almost 1,000 visitors on average during the weekends. Whakarara, Whakapaku, Russell Forest-Rawhiti, and Whangaruru also see a significant number of visitors, approximately 60% of the people present in the areas.

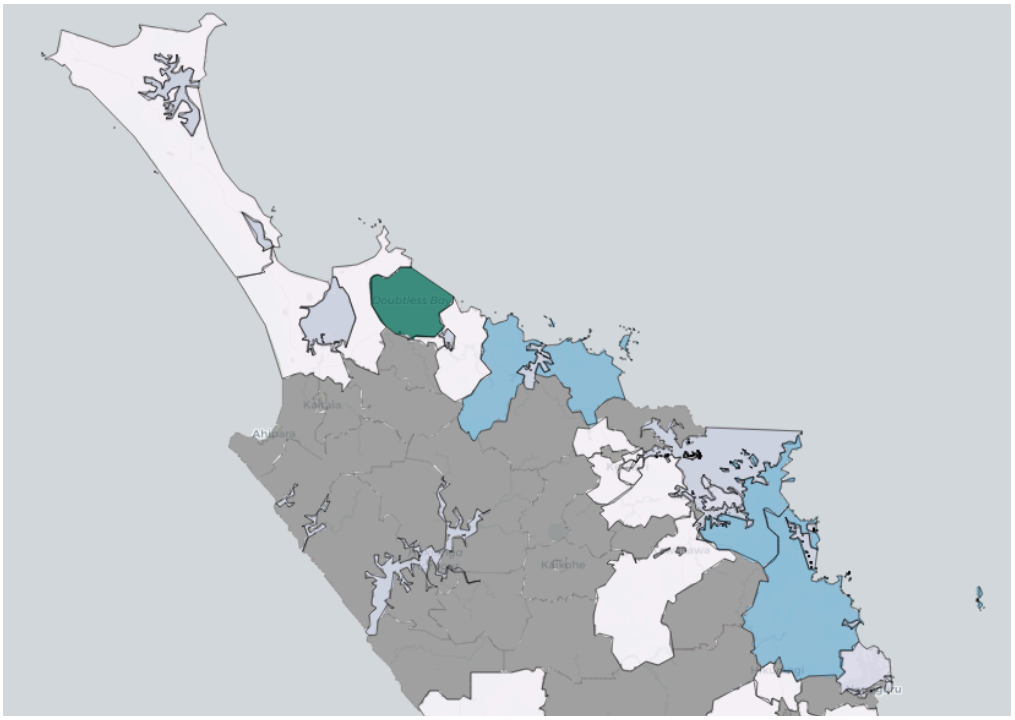

Figure 8. Percentage of daily average visitors during weekends around Far North, 2020 - 2022; areas with less than 100 visitors are shown in grey.

Figure 9 shows popular areas for visitors during the weekends surrounding Auckland. These are the typical destination locations for Aucklanders during the weekends (areas around Auckland CBD are grey, showing that there are less people there on the weekends). Islands and harbour inlets (such as, Barrier Islands, Gulf Islands, Kaipara Harbour inlet, and Manukau harbour inlet) as well as Coromandel are notable destinations.

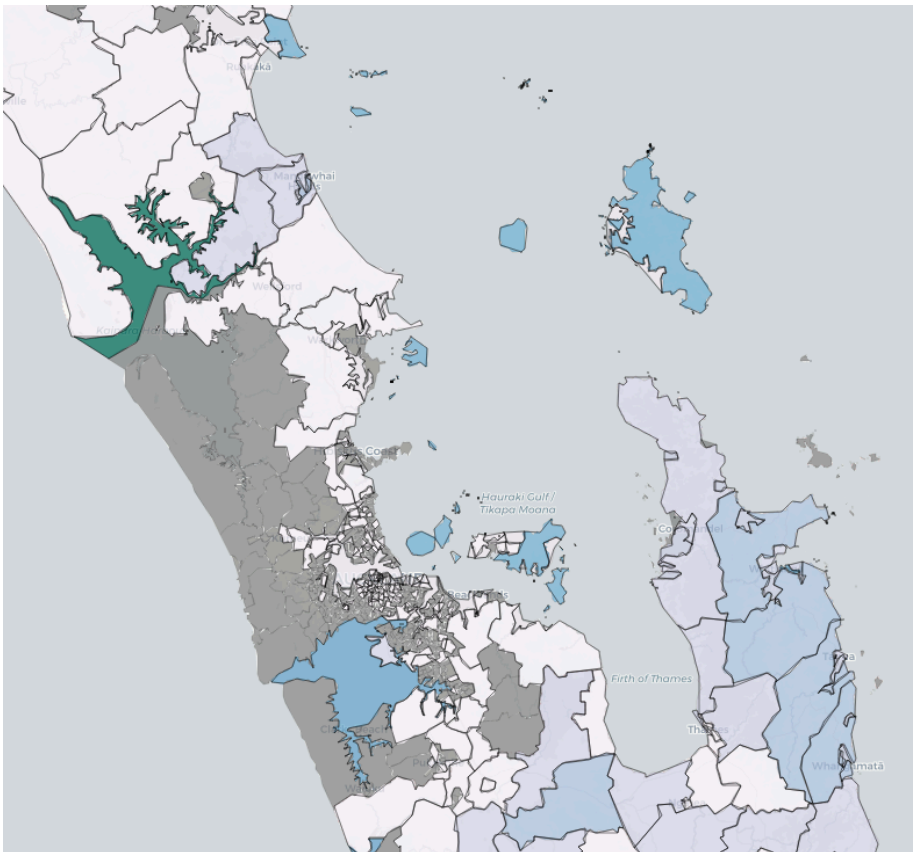

Figure 9. Percentage of daily average visitors during weekends around Auckland and Thames-Coromandel, 2020 - 2022; areas with less than 100 visitors are shown in grey.

Figure 10 shows popular areas for visitors during the weekends around Central North Island, surrounding Lake Taupō. Visitors seem to spread around Forest and National Parks, including Whanganui National Park, Tongariro National Park, and Kaimanawa Forest Park.

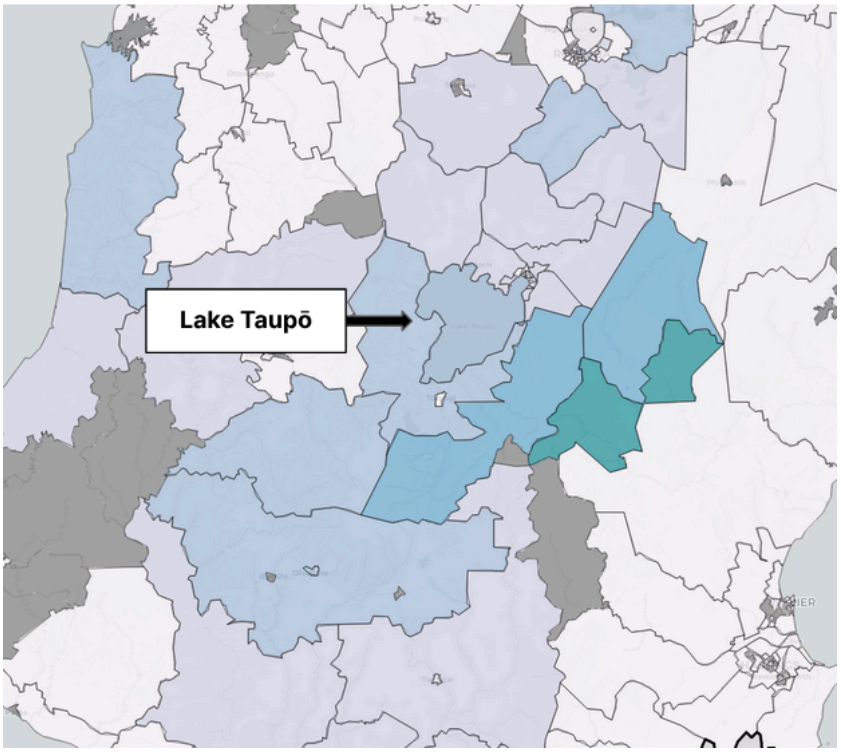

Figure 10. Percentage of daily average visitors during weekends surrounding Lake Taupō, 2020 - 2022; areas with less than 100 visitors are shown in grey.

Marlborough Sounds, not so surprisingly, is one of the top destinations for visitors, with many of both land and water recreational activities to be enjoyed (Figure 11).

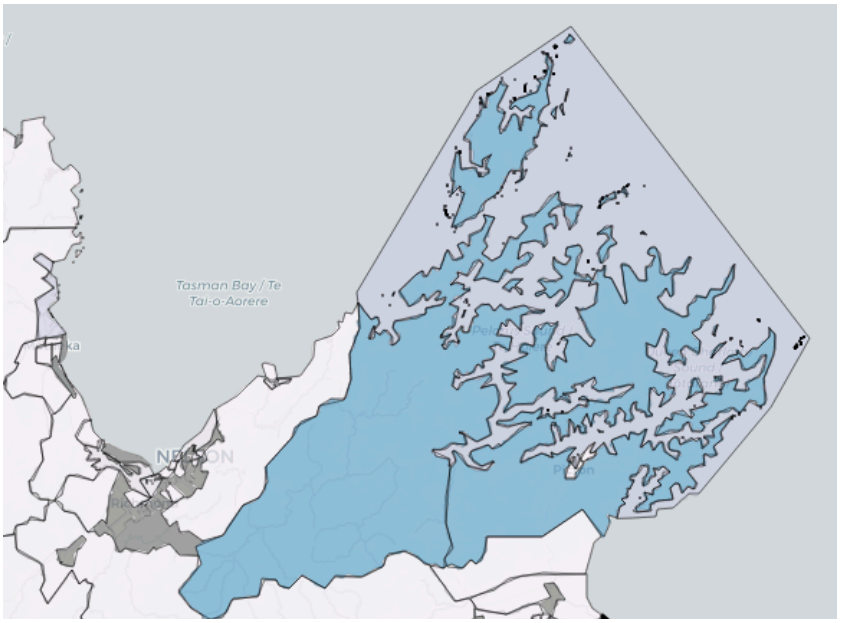

Figure 11. Percentage of daily average visitors during weekends around Marlborough Sounds, 2020 - 2022; areas with less than 100 visitors are shown in grey.

Figure 12 shows popular areas for visitors during the weekends in the southern part of South Island. Notably, Fiordland with the population of around 100 sees approximately 8 times the number of visitors, compared to its locals. Mackenzie district, Wanaka, Queenstown, and Stewart Island are, as expected, popular weekend destinations.

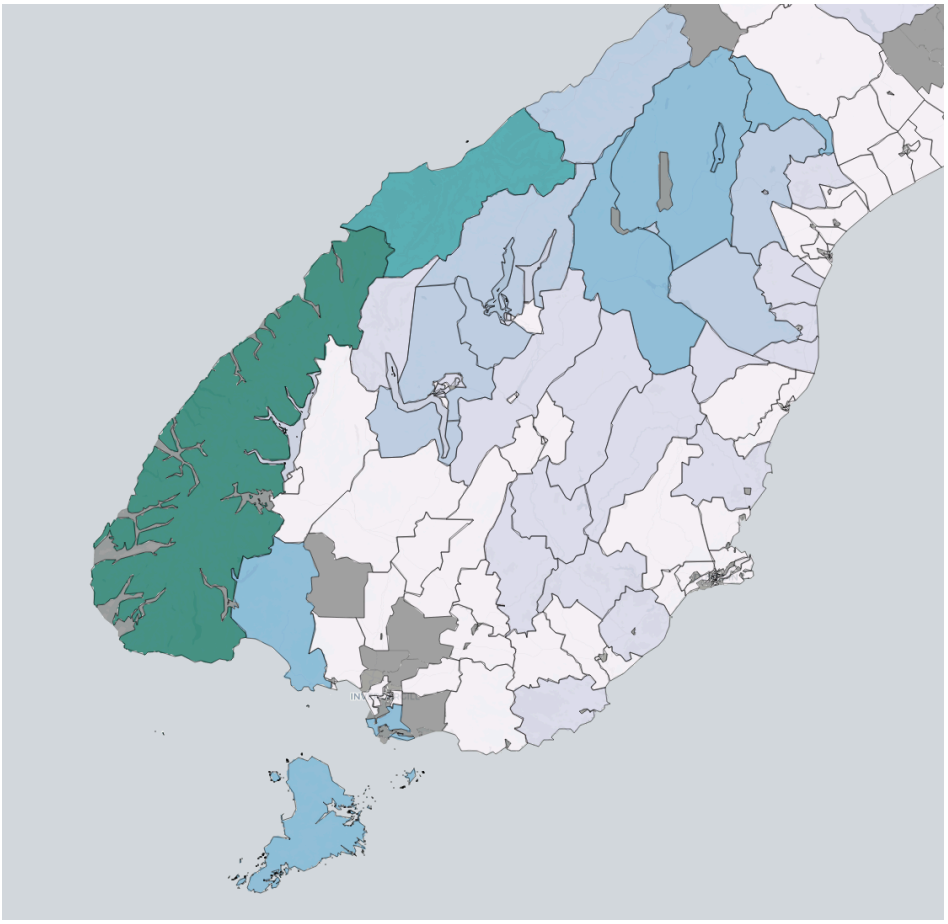

Figure 12. Percentage of daily average visitors during weekends in the southern part of South Island, 2020 - 2022; areas with less than 100 visitors are shown in grey.

4.1.2. Where are people during the weekends in summer?

Delving deeper, the map below highlights the SA2 areas where there were significantly more people in total, including both visitors and locals, during daytime hours (7AM to 6PM) on an average weekend in summer, compared to the usual number of people on weekdays during the period between 2020 and 2022 (Figure 13).

The areas with the largest differences include:

- Whangamatā (Coromandel District) - additional 1444 people (23% compared to a typical weekday)
- Inlet Manukau Harbour - additional 1305 people (7%)
- Aviemore (Waitaki District) - additional 1188 people (42%)

- Whangaruru (Whangarei District) - additional 1056 people (21%)
- Inland water Lake Taupō - additional 1023 people (21%)

In line with anecdotal expectations, these areas are popular for summer recreational activities, such as daywalking, swimming, boating, and fishing among others.

Such a measure provides a way to compare the areas in terms of visitor fluctuations (in this example, during summer weekends) and highlight the areas with the maximum absolute and relative change in the number of people present over the weekends. This can be used as a basis for further investigation of SAR incidents risk. Note, however, that the difference may not come from people attracted by recreational activities only; it is also possible, for example, that people residing in these areas stay at home on the weekends and travel to other areas for work during weekdays.

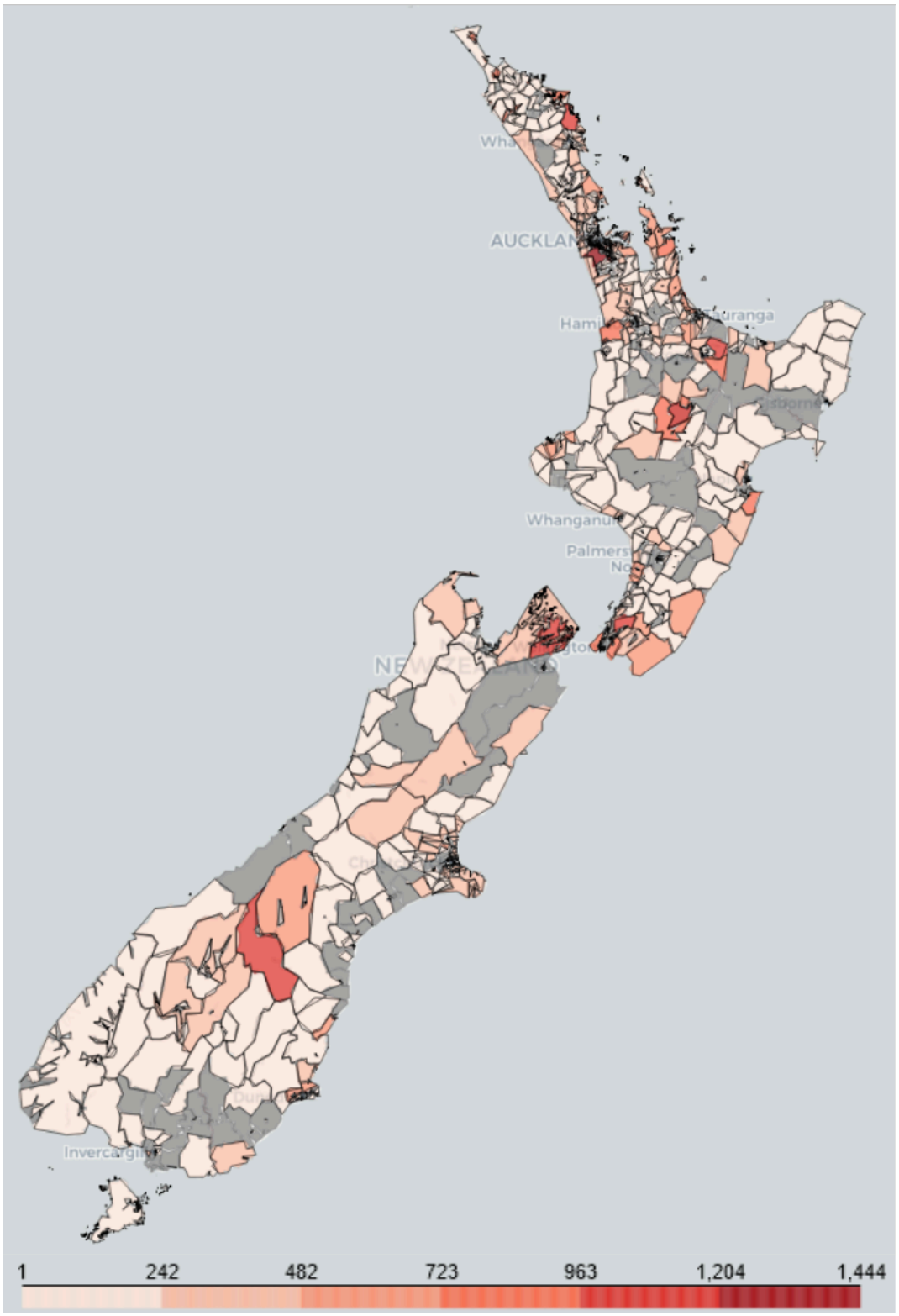

Figure 13. Difference in the average number of total people during daytime between summer weekends and weekdays, 2020 - 2022; grey areas are where the number of people is higher during summer weekdays than over summer weekends.

Figure 14 shows the likely destinations that Aucklanders leave the city (grey areas around the Auckland CBD) to go to during the summer weekends.

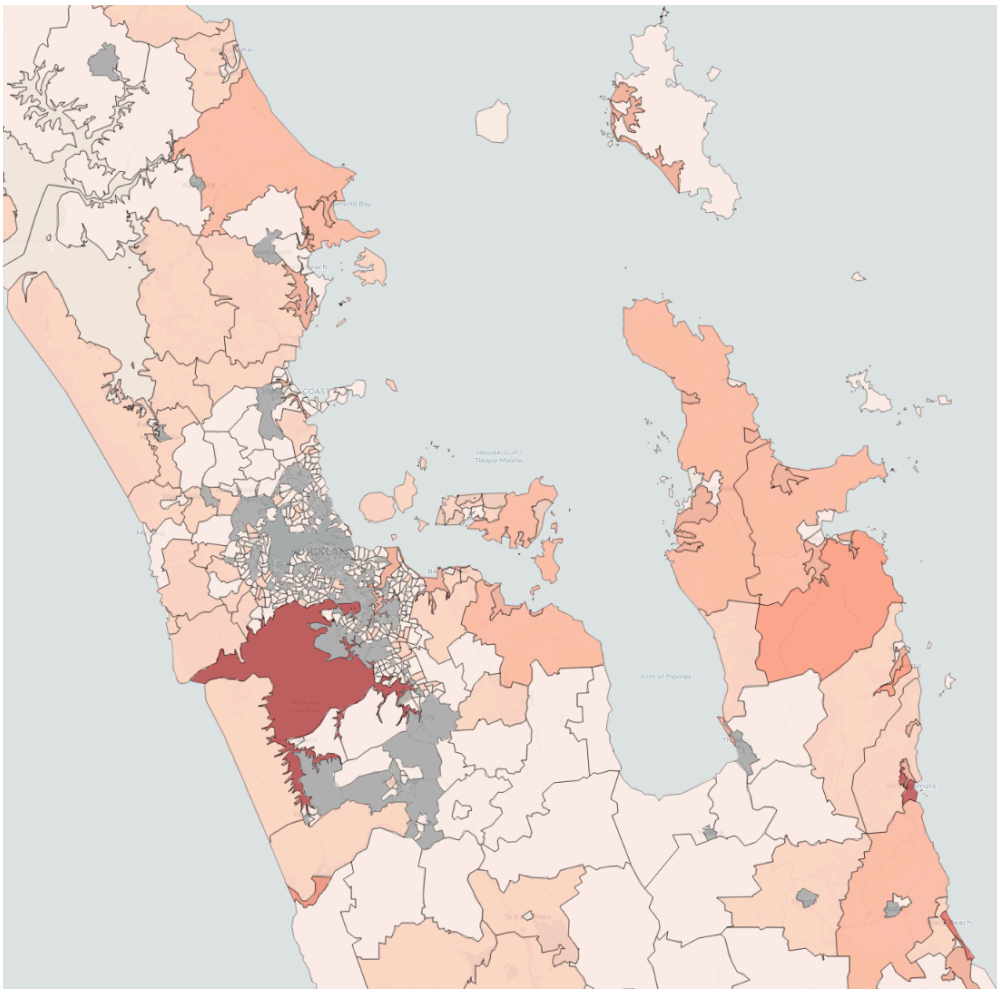

Figure 14. Difference in the average number of total people during daytime between summer weekends and weekdays around Auckland and Thames-Coromandel, 2020 - 2022.

4.1.3. Where are people during the weekends in winter?

Similarly, the map below highlights the SA2 areas where there were significantly more people in total during daytime hours (7AM to 6PM) on an average weekend in winter, compared to the usual number of people on weekdays during the period between 2020 and 2022 (Figure 15).

The areas with the largest differences include:

- Inlet Manukau Harbour - additional 1748 people (9% increase on a typical weekend compared to a typical weekday)
- Makara-Ohariu - additional 1264 people (26%)
- Pencarrow (Lower Hutt) - additional 1088 people (29%)
- National Park - additional 983 people (37%)

- Hanmer Springs- additional 981 people (71%)

Other notable areas include Tangiwai and Mackenzie Lakes, popular destinations for skiing.

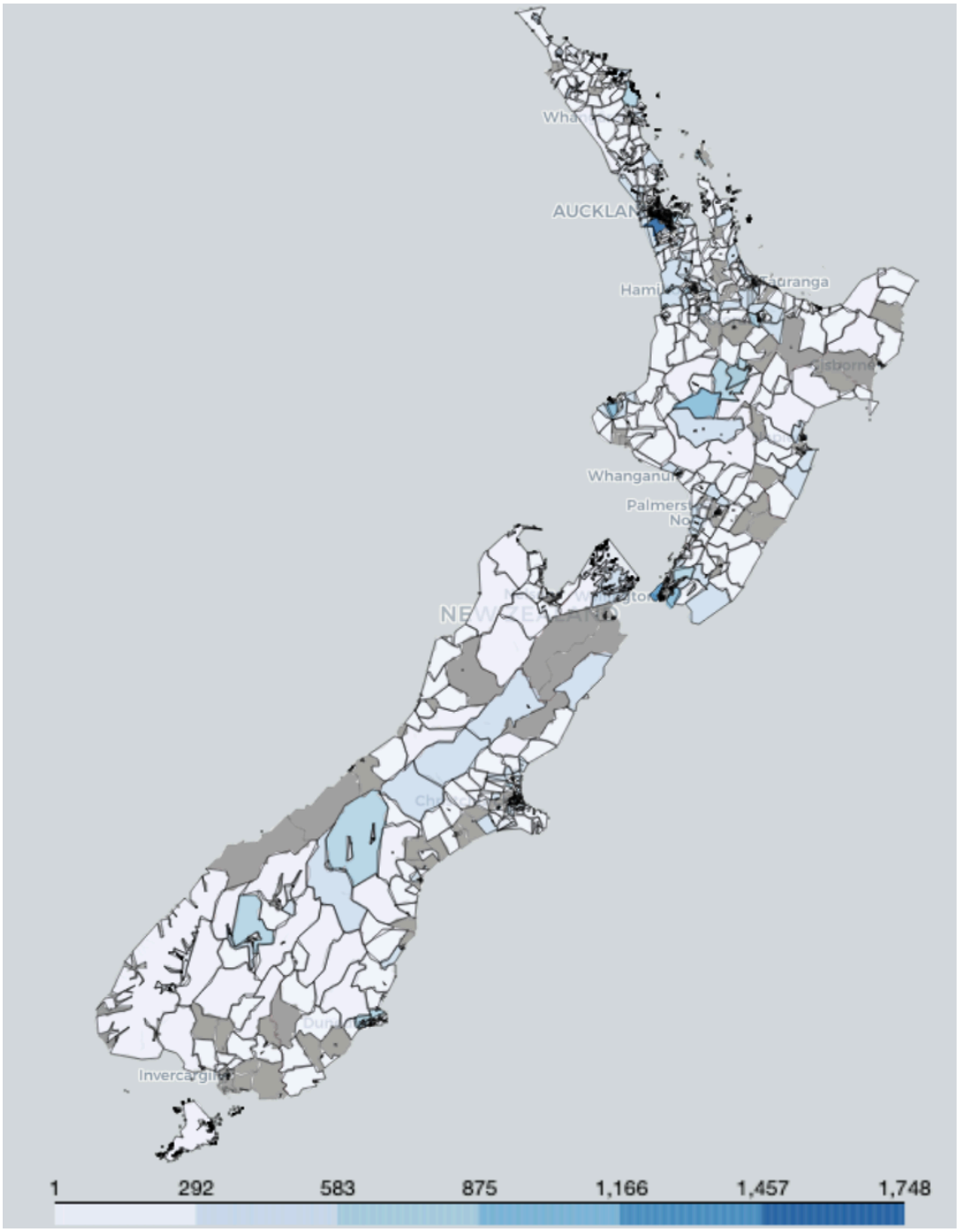

Figure 15. Difference in the average number of total people during daytime between winter weekends and weekdays, 2020 - 2022; grey areas are where the number of people are higher during daytime winter weekdays.

Delving into the notable areas mentioned above, Figure 16 shows Hanmer Springs, famous for its mineral thermal pools and spa, as one of the top winter destinations, especially for people living in and around Christchurch.

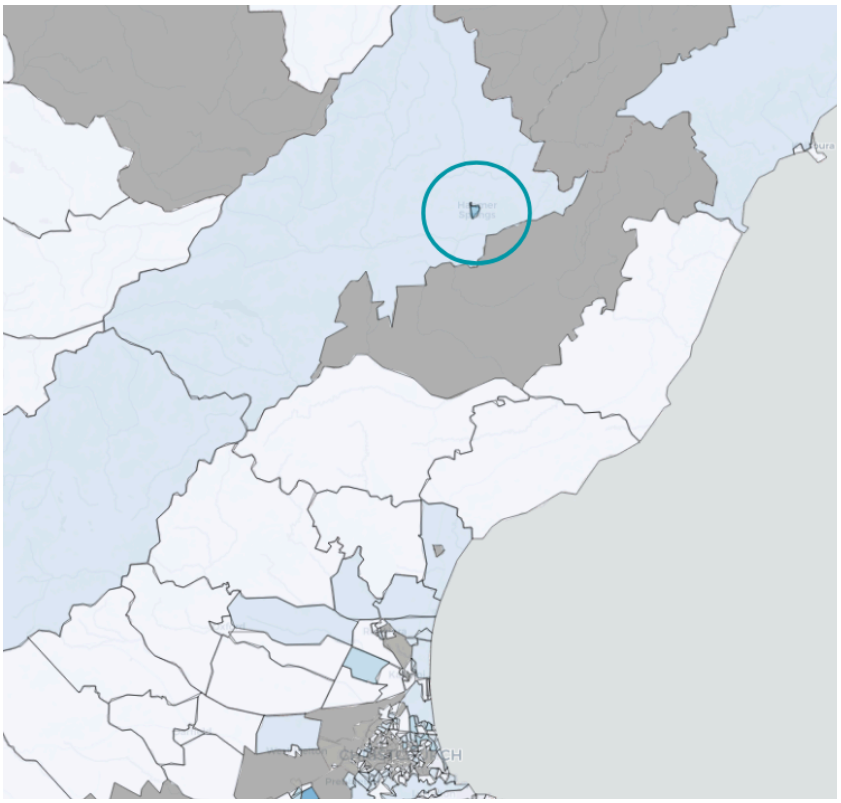

Figure 16. Difference in the average number of total people during daytime between winter weekends and weekdays around Christchurch, 2020 - 2022; grey areas are where the number of people is higher during winter weekdays than over winter weekends.

Around the Wellington region, Makara and Pencarrow (East Harbour Regional Park) show some of the largest differences in the number of people between winter weekends and weekdays (Figure 17). These areas are popular for a variety of outdoor activities, including hiking, cycling, and fishing.

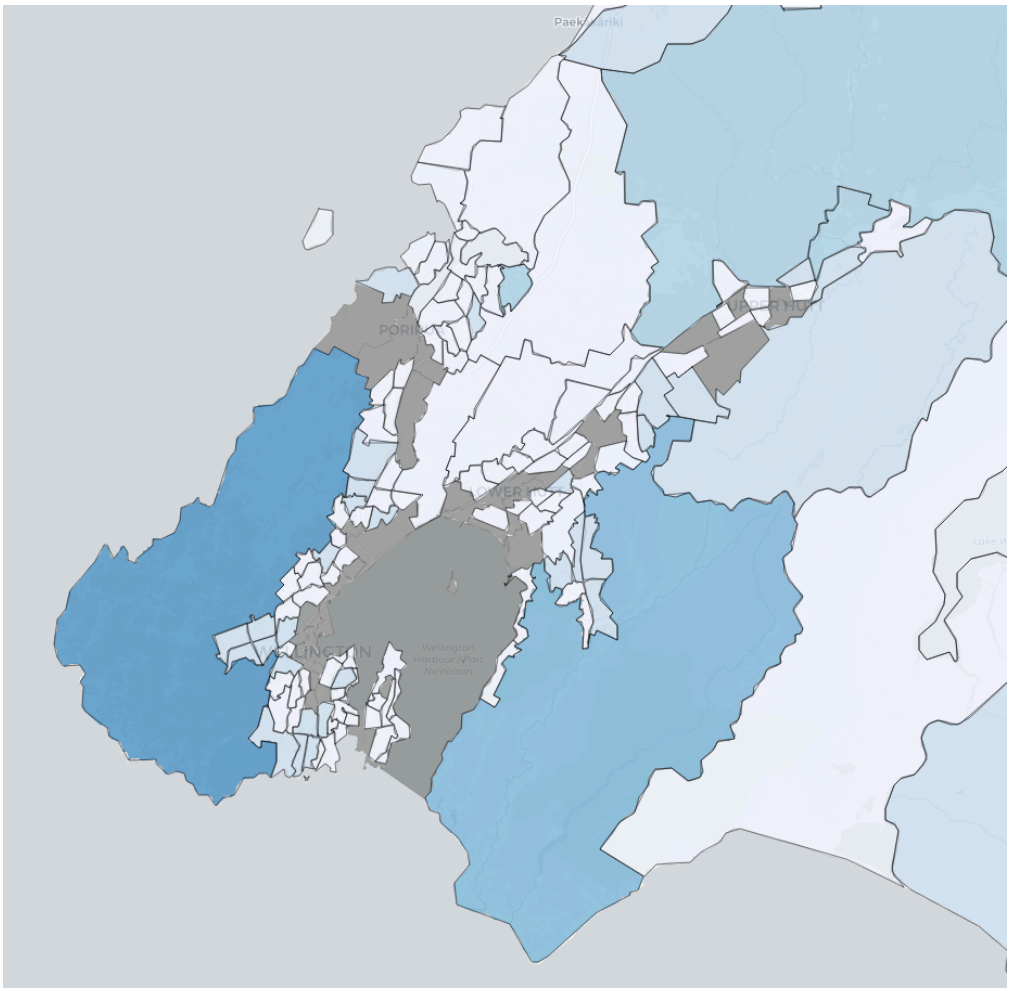

Figure 17. Difference in the average number of total people during daytime between winter weekends and weekdays around Wellington, 2020 - 2022; grey areas are where the number of people is higher during winter weekdays than over winter weekends.

4.1.4. How many people are in Whangaruru and Tongariro National Park in summer and in winter?

Mobile data can be also used to examine the average number of locals and visitors by hour of the week, comparing summer and winter, for specific areas. For this comparative analysis, the Tongariro National Park area—National Park, Kaimanawa Forest Park, and the part of the Desert Road—and the Whangaruru area on the east coast of Northland have been chosen based on different recreational activities distinctly popular in summer and winter in each area. As also seen above, during summer weekends Whangaruru sees one of the highest peaks in the number of people present compared to weekdays, while in winter the Tongariro National Park area receives a significant influx of people (presumably due to skiing). The graphs below show analysis on the composition of people—locals and visitors—in these areas.

The Tongariro National Park area sees a higher average number of locals in winter than in summer. In winter, the number of locals consistently drops during daytime on weekdays compared to the

weekends (Figure 18a), suggesting a travel-to-work movement away from the areas. In comparison, there is a significant peak in the number of visitors in winter during daytime of the weekends compared to the weekdays (Figure 18b), as expected of the recreational skiing season popular in the Ruapehu region. More specifically, in winter the areas received, on average, 858 more people daily during the weekends compared to weekdays (Figure 18b; blue line), in comparison with a 259 increase in the number of people in summer (Figure 18b; orange line).

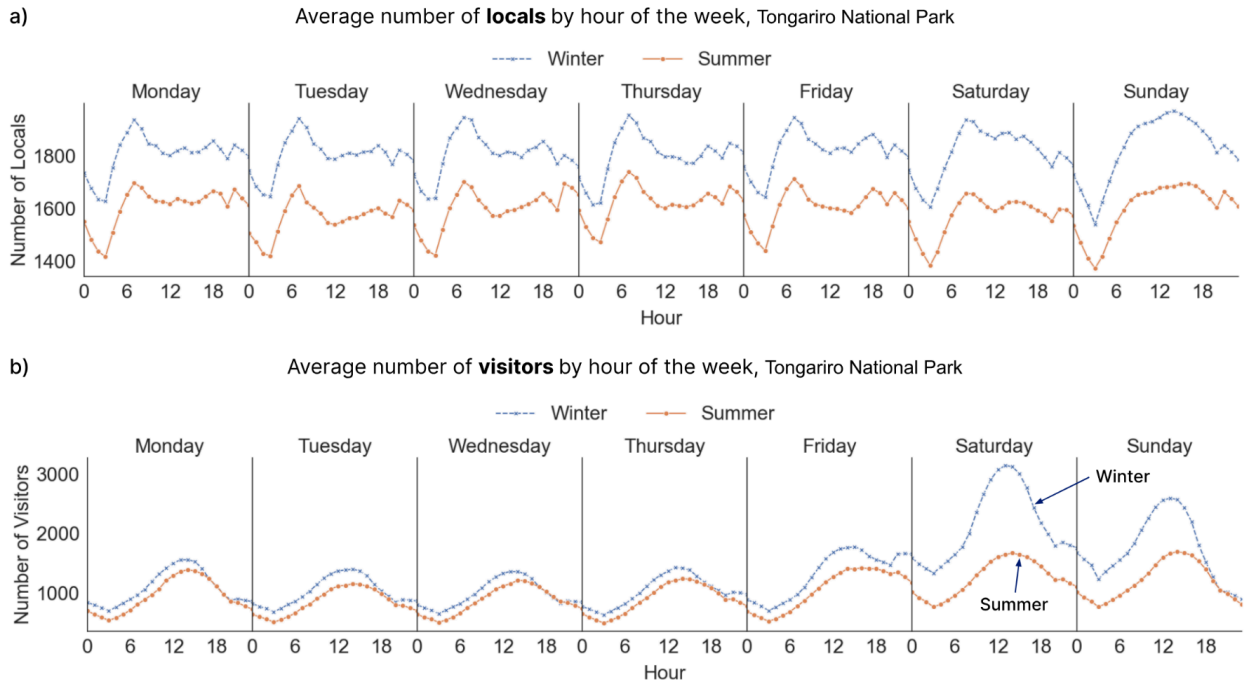

Figure 18. Average number of locals (a) and visitors (b) by hour of the week in summer (orange) and winter (blue) in Tongariro National Park, 2020 - 2022.

In contrast, as Whangaruru is known more for summer recreational activities, such as day walking, boating, and swimming, the opposite seasonal pattern is observed: there was a higher average number of locals in summer compared with winter, with a similar travel-to-work pattern during day time of the weekdays (Figure 19a). The increase in visitors during the weekends (Figure 19b), however, is not as sharp as in Tongariro National Park.

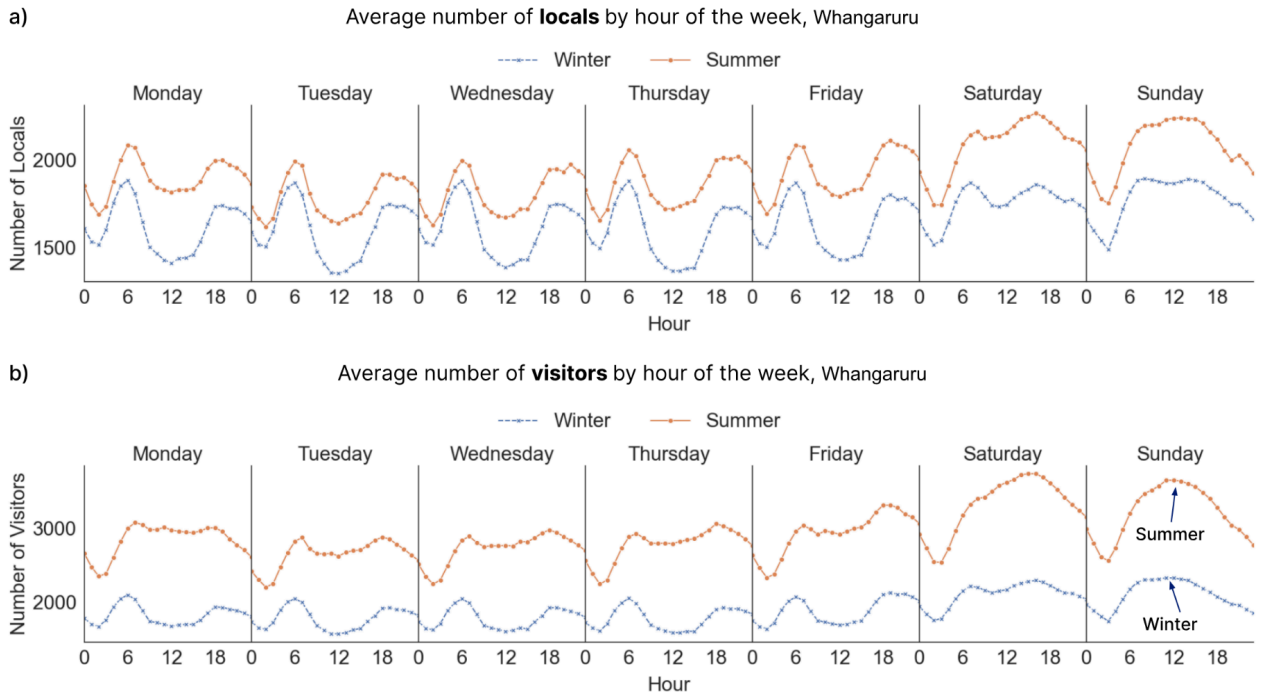

Figure 19. Average number of locals (a) and visitors (b) by hour of the week in summer (orange) and winter (blue) in Whangaruru, 2020 - 2022.

These peaks in the number of people during the weekend provide inference on the number of people engaged in recreational activities based in the areas. The magnitude of peaks also suggests how SAR resources in those particular areas may be anticipated and planned for: with the stark increase in winter, Tongariro National Park could face a higher pressure for SAR demand due to recreational activities, compared to Whangaruru in summer.

The examples above illustrate how the Mobile data can provide inferences on the magnitude and patterns of people engaging in recreational activities in different locations. While the level of recreational participation could be a noteworthy risk factor pertinent to SAR demand, risks are multifaceted: different types of recreational activities as well as specific locations pose varying degrees of consequential risk of needing a SAR operation. For example, according to SAR records from June 2009 to October 2023 in DAS, the number of incidents related to recreational boating alone is almost as many as a combination of those related to tramping and day walking together. Therefore, it is useful to examine the different sides of risk that may result in SAR demand, by combining the Mobile data with the SAR incident data to understand incident rates.

4.2. Analysis of incident rates

Mobile data can be combined with the historical SAR incident data (in SARdonyx) to provide insights into the historical incident rates*. For example, do more people present in an area always lead to more

incidents? The analysis below shows examples of insights on the incident rate and different factors that may influence it.

*Incident rate is calculated as a number of incidents per 1,000 people estimated to be present in the area.

4.2.1. What are the typical incident rates in Tongariro National Park in summer and in winter?

In Tongariro National Park overall there are significantly more people on the weekends than the weekdays in winter than in summer (Figure 20a). However, according to the historical SARdonyx data, more SAR incidents occurred during summer rather than in winter (Figure 20b). This suggests that the number of people undertaking recreational activities does not always correlate with the occurrence of incidents, and there are likely other factors that contribute to SAR demand in the area, such as the types of activity and the availability and readiness of other SAR-related services (for example, the Ski fields' own patrol teams).

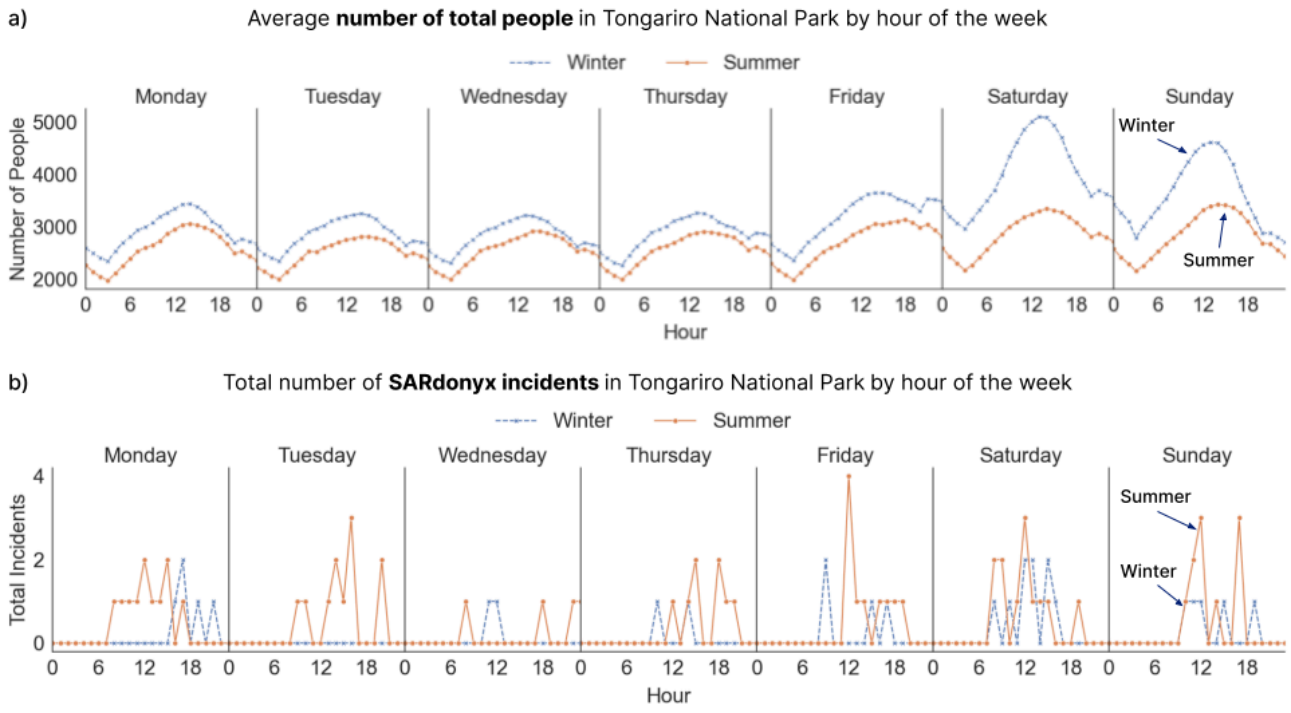

Figure 20. Average number of people (a) and total SAR incidents (b) in Tongariro National Park by hour of the week in summer (orange) and winter (blue), 2020 - 2022.

In addition, a deeper examination of incident locations provides further inferences on the type of SAR-related recreational activities. The white oval in Figure 21 highlights a concentration of incidents along the Tongariro Crossing track, a popular summer activity in Tongariro National Park. Other orange dots in the highlighted area are likely associated with hunting and tramping activities in the neighbouring hills.

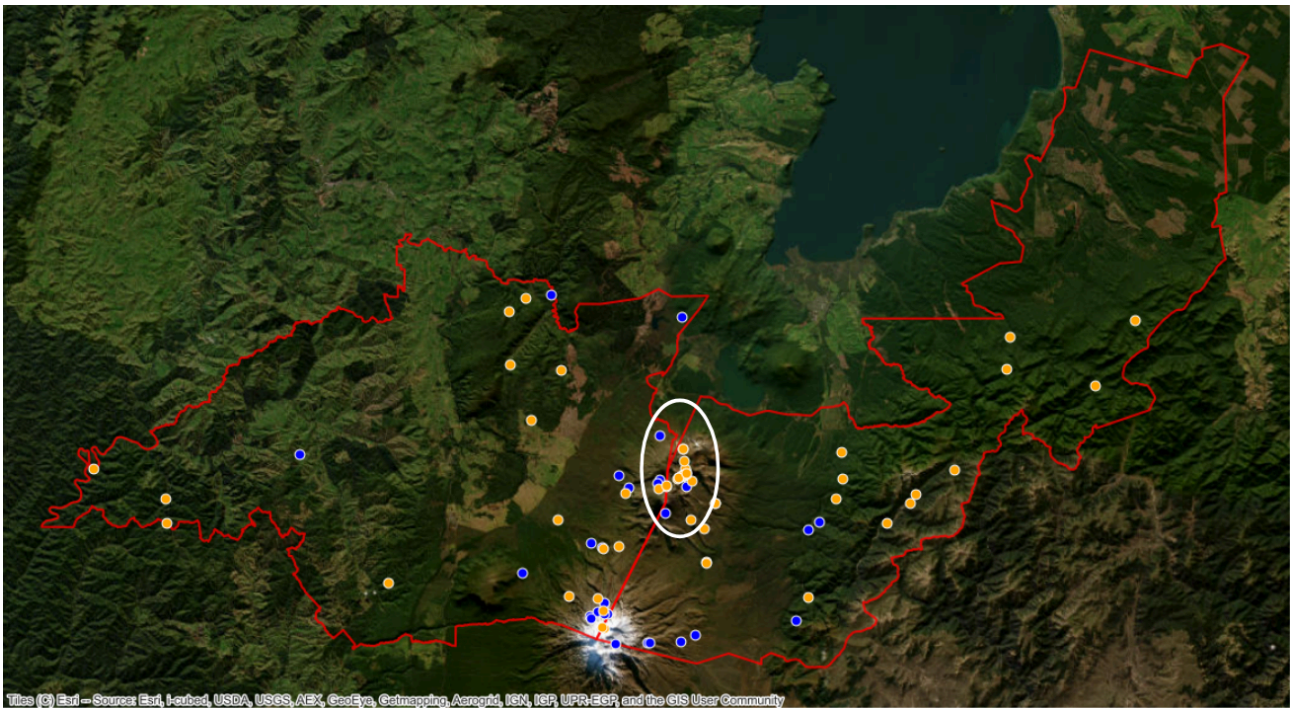

Figure 21. SARdonyx incident locations around Tongariro National Park, 2020-2022, in summer (orange) and winter (blue).

This suggests that the risk of SAR incidents in Tongariro National Park does not depend on the number of people alone, but also the types of activities that people engage in. While there are significantly more people during winter weekends, this is not directly reflected in SAR demand, presumably because most people ski in commercial ski fields with their own health and safety operations and services. In comparison, the number of incidents along the Tongariro Crossing track can be observed with the slight increase in people during summer weekends, suggesting that in Tongariro National Park the risks associated with recreational activities are relatively higher in summer (presumably hiking, tramping, and hunting) compared to winter (skiing).

4.2.2. What are the typical incident rates in Tongariro National Park and Lake Taupō? Comparing different recreational activities popular in each area.

In contrast to the Tongariro National Park area, the number of total people within the water area of Lake Taupō in summer is typically higher than in winter (Figure 22).

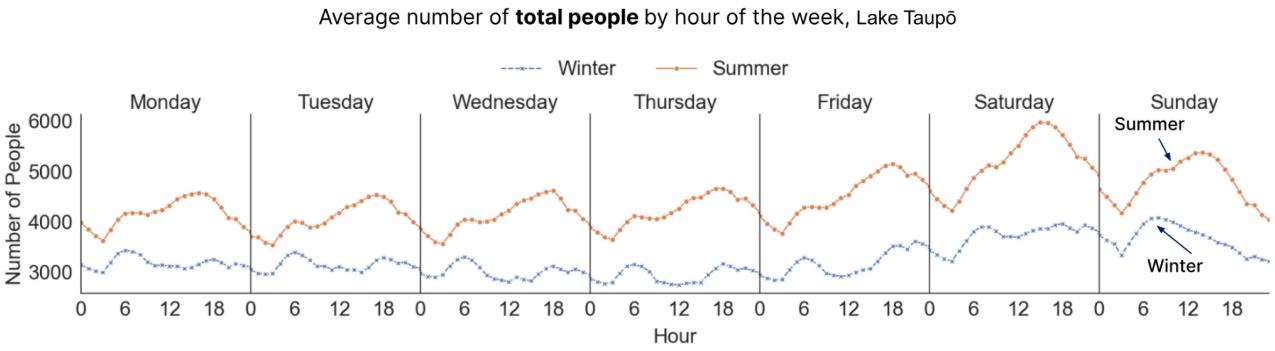

Figure 22. Average number of people in Lake Taupō water area by hour of the week in summer (orange) and winter (blue), 2020 - 2022.

The incident rates during summer months in the Tongariro National Park area (Figure 23a), where presumably only some of the visitors are involved in day hiking and tramping activities, are consistently higher than the summer incident rates in the Lake Taupō water area (Figure 23b), where popular recreational activities involve boating and fishing. This demonstrates that not all recreational activities pose the same levels of risk of SAR incidents. Figure 24 below shows the locations of the incidents that occurred at Lake Taupō in 2020-2022 with orange dots indicating summer incidents and blue - winter.

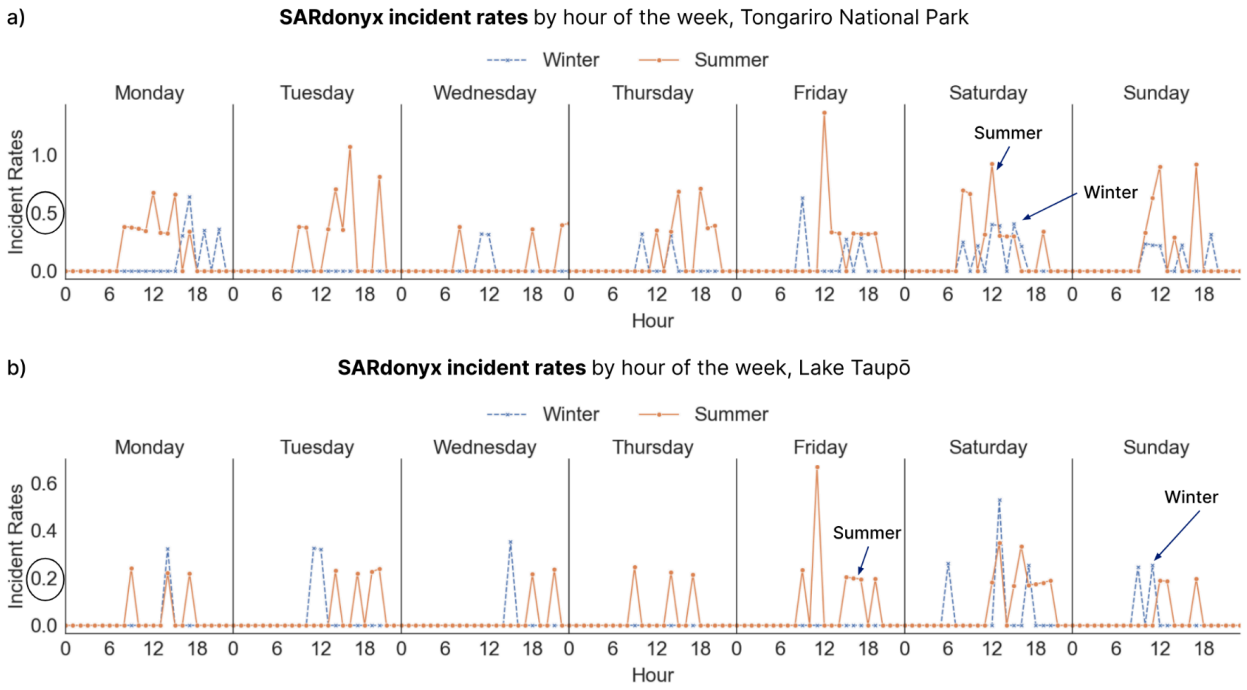

Figure 23. Incident rates at Tongariro National Park (a) and at Lake Taupō (b) by hour of the week in summer (orange) and winter (blue), 2020 - 2022.

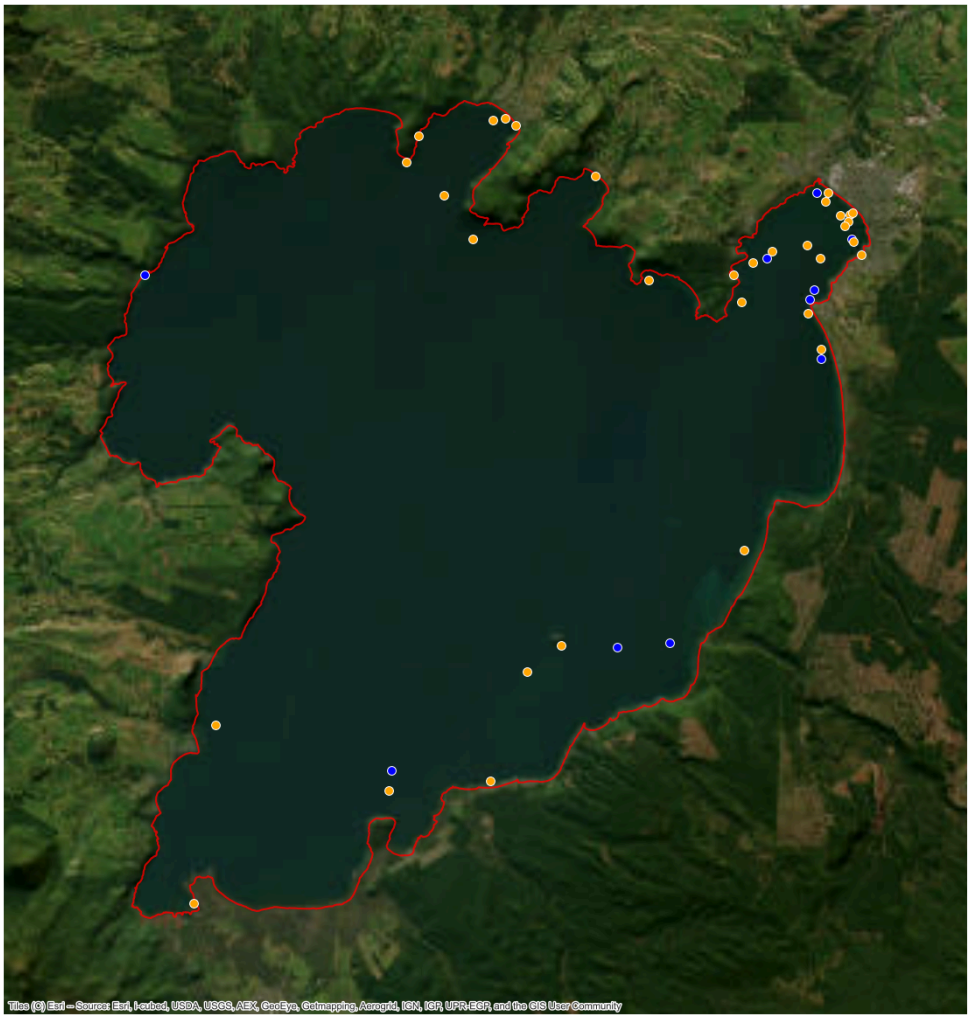

Figure 24. SARdonyx incident locations at Lake Taupō, 2020-2022, in summer (orange) and winter (blue).

5. Limitations of Mobile data for SAR demand analysis

5.1. Mobile data is limited by network coverage

The Mobile data estimates the number of people using mobile device counts on the basis of Spark mobile connections (extrapolated based on annual market share). This means the estimates are also dependent on the network coverage (Figure 25): there is a possibility of undercounting in the areas where signal strength is weak.

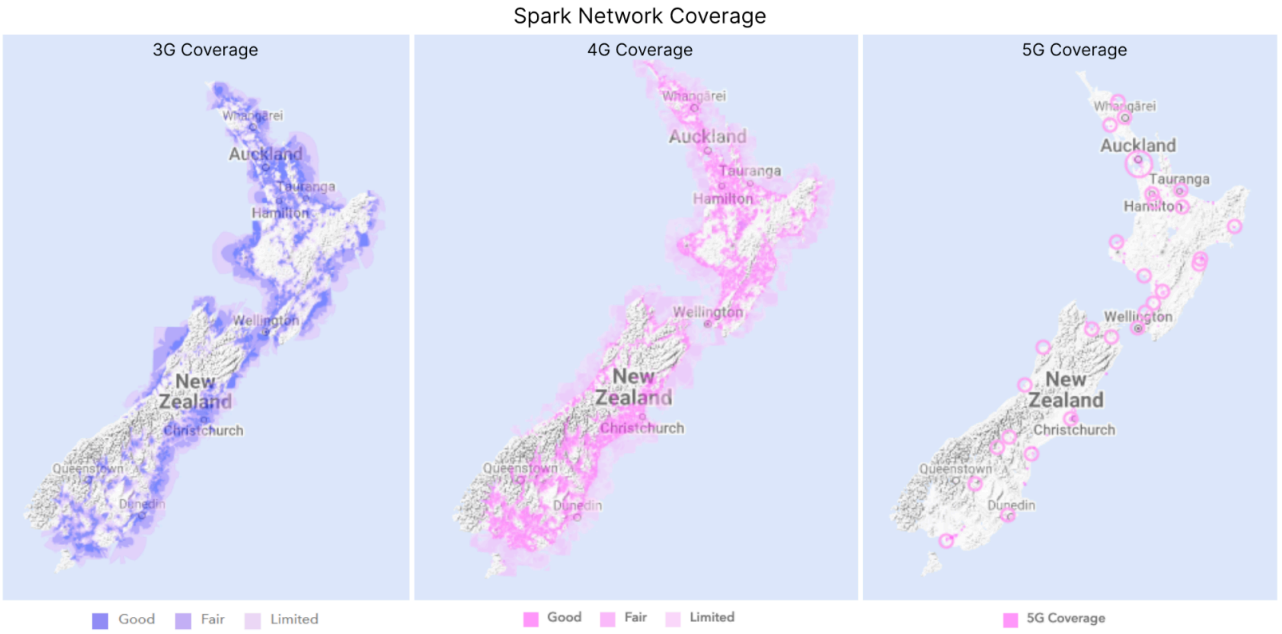

Figure 25. Maps of Spark network coverage and signal strength for their 3G, 4G, and 5G networks (July 2024) (retrieved from https://www.spark.co.nz/shop/mobile/network/).

The map below shows the difference between the daily average number of locals compared to the more permanent estimated resident population (ERP) (Figure 26). Blue represents areas where the number of locals estimated from the Mobile data is higher than the ERP; red represents areas where the estimated number of locals is lower than the ERP, which potentially suggests undercounting of the number of local people present in the areas in the Mobile data. When comparing with the maps of network coverage, the difference (red areas) corresponds with the regions with limited network coverage, such as Far North, West Coast and Gisborne.

However, the comparison between permanent population and the Mobile data estimates of local people is not exactly analogous, and the magnitude of difference should be interpreted with caution. Population estimates are the counts adjusted from the count at a single point in time during Census, while Mobile data has an expected degree of variability as it depends on several factors such as network coverage (as discussed above), people travelling out of the country, significant events that impact tower outages, among other factors. This caveat does not limit the usage of the Mobile data to compare the magnitude of people present in an area at different times and draw inferences as long as certain assumptions are explicitly stated and understood.

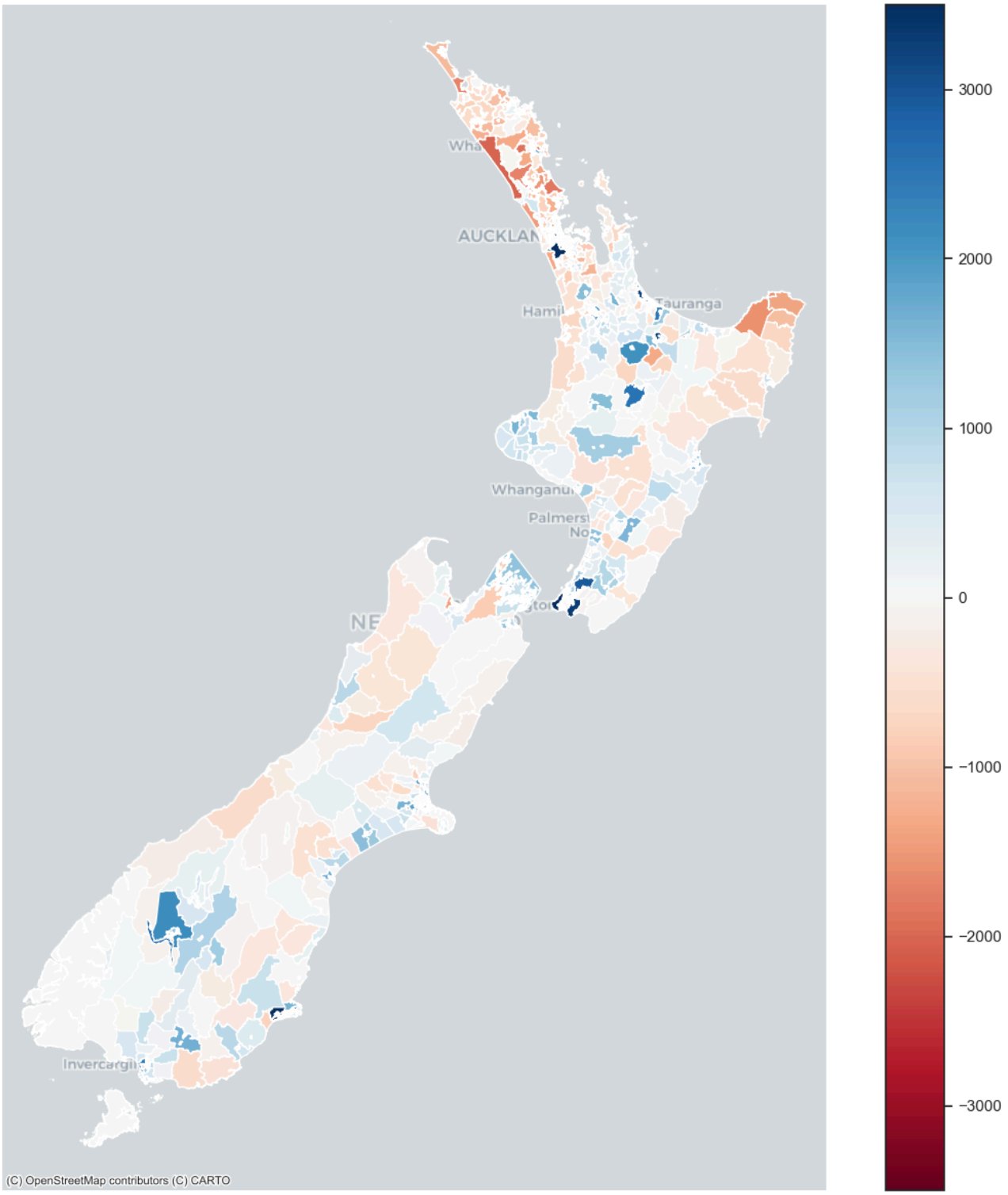

Figure 26. Difference between the daily average number of locals and population estimates (extrapolated from Stats NZ Census 2018 population counts). The differences are capped within -3500 and 3500.

5.2. Large remote SA2 areas are not suitable for SAR demand analysis

Tramping is one of the most popular outdoor recreation activities in New Zealand; the most popular tracks are the New Zealand Great Walks. Most of these tramping tracks are situated in the remote areas of New Zealand. For example, the figure below shows the SA2 boundary around Fiordland National Park (red) and the three Great Walks (green)—The Routeburn Track, The Kepler Track, and The Milford Track (Figure 27a).

As evident in the figure, the three tracks are significantly proportionally smaller in comparison to the SA2 coverage of Fiordland. This means that, in these cases, the Mobile data at the SA2 level will not provide the level of estimates distinct enough to identify the number of people walking/tramping on specific tracks (or other specific activities happening in the area such as The Milford Sound cruise). Mobile data at the SA2 level is, therefore, not suitable for analyses where the relevant SA2 covers a large area in comparison with the smaller areas of interest for SAR incidents. This limitation persists even at the meshblock level, which is the smallest geographic unit for which statistical data is collected and processed by Stats NZ (Figure 27b); as can be seen, the Milford Track, for example, lies in between the two large meshblock areas.

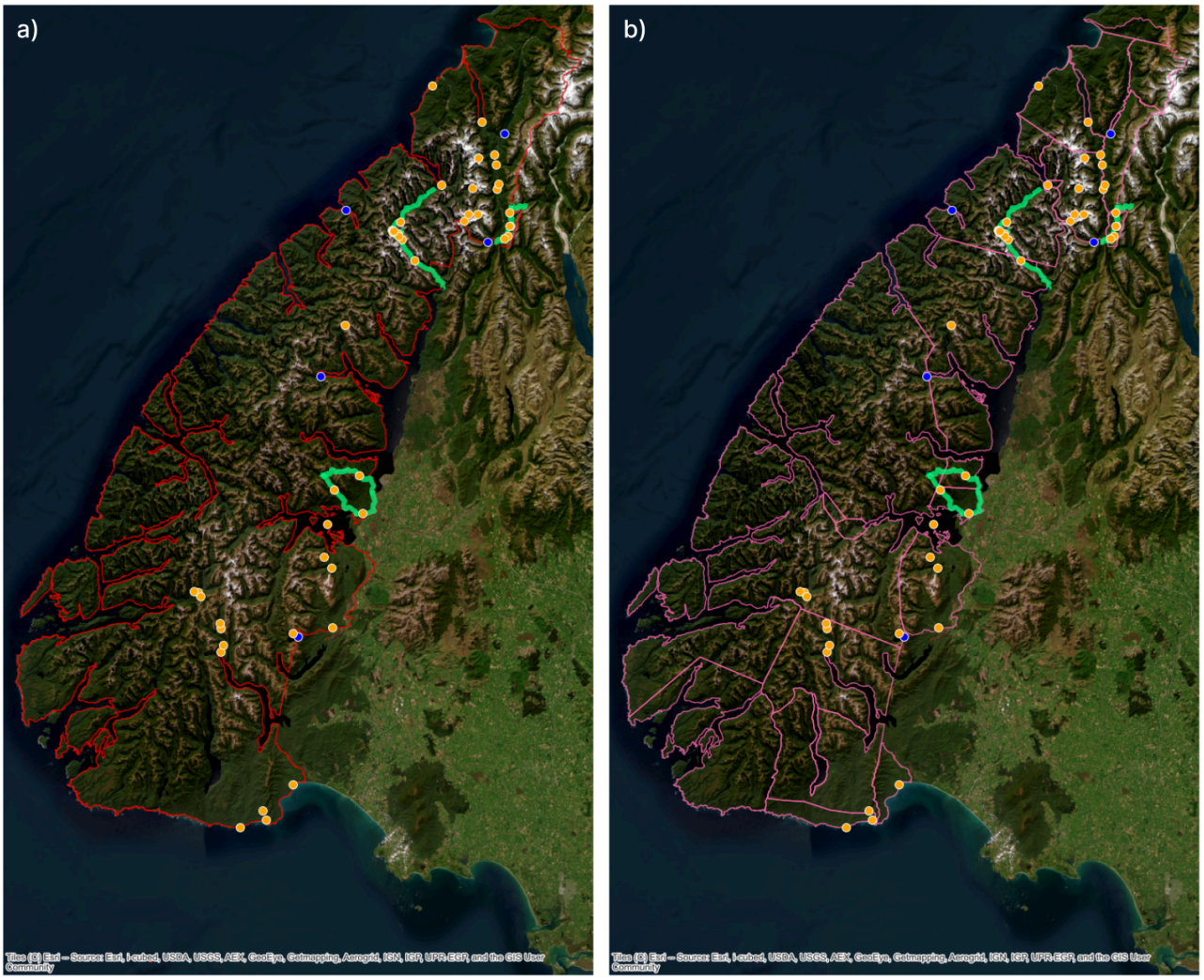

Figure 27. SARdonyx incident locations around Fiordland National Park, 2020-2022, in summer (orange) and winter (blue). The three Great Walks—The Routeburn Track, The Kepler Track, and The Milford Track—are highlighted in green. Statistical Area 2 (a) and meshblock (b) boundary covering the areas around Fiordland National Park are shown in red and pink, accordingly.

5.3. Using Mobile data relies on assumptions

While the Mobile data provides insights on the number of people present in an area at different times, the data is not a direct reflection of the magnitude of recreational activities. To understand the risk of SAR demand resulting from recreational activities, assumptions need to be made based on prior knowledge about the area to infer what recreational activities people are engaged in. This introduces uncertainty when estimating the number of people engaged in different recreational activities from the number of people present in an area alone: it is not possible to know the exact, or even relative, number of people doing different activities. Furthermore, as the precise magnitude of an activity is not known, the second uncertainty is inherent when estimating the risk of a SAR incident based on the number of people engaged in a particular recreational activity. For example, Lake Taupō is popular for many recreational activities, such as swimming, fishing, and recreational boating. The Mobile data, in

this case, cannot tell us how many people participate in each activity, and thus it is difficult to estimate the extent to which each activity contributes to SAR demand in the area.

6. Conclusions

Mobile data provides valuable insights into the movement patterns of both New Zealanders and international visitors. It provides an estimate of how many and at what times people are present in specific regions, allowing comparative analyses to examine pertinent locations where people recreate across New Zealand at different times—such as, daytime and nighttime, weekends vs. weekdays, and winter vs. summer. Overall, the data shows that areas famous for skiing and thermal hot pools (like Hanmer Springs) show a high number of visitors in winter; in summer there are more people present during the weekends in areas like parks and harbours, which are suitable for land and water summer recreations, respectively, such as daywalking, swimming, boating, and fishing among others. However, the data is only available at Stats NZ SA2 level, which means the regions are quite small in highly populated areas, but can be as big as hundreds of square kilometres in the less populated parts of the country (such as Fiordland). This limitation for large rural areas would also apply even if the data was provided at the meshblock granularity for Fiordland. Furthermore, the Mobile data has limitations related to cell tower coverage - only 50% of New Zealand landmass is covered by cell towers in 2023, the coverage of coastal water areas decreases the farther one gets from the populated areas.

Despite these limitations, the Mobile data can provide some inference about different recreational activities likely to attract people to different areas as well as the composition of people (locals and visitors) present. The analysis shows different patterns of people movement at the Tongariro National Park area between winter and summer: the number of locals are higher in winter than in summer; the number of locals consistently drops during daytime on weekdays, inferring that local people tend to move away from the areas for work. Furthermore, in line with the skiing season in the Ruapehu region the Tongariro National Park area sees a significant increase in the number of visitors in winter during the weekends; summer weekends in Tongariro also see an increase in visitors but to a lesser extent. (Note that further analysis comparing domestic and international visitors is also possible, though out of scope here.)

Since about 62% of the recent SAR demand is associated with recreational activities, it is important to understand the patterns around these activities in order to assess the risk of SAR incidents in the future and plan the resources accordingly. When using Mobile data to assess the risk of SAR incidents related to recreational activities in New Zealand, there are two major sources of uncertainty to consider: 1) estimating number of people engaged in recreational activities from the number of people present in an area (level of uncertainty depending on various activities engaged in the area); and 2) estimating the risk of a SAR incident based on the number of people engaged in a recreational activity (level of uncertainty based on a particular activity and the area). These two factors introduce uncertainty that significantly reduces the value of Mobile data in assessing the risk of SAR incidents. In addition, the Mobile data for the remote areas of New Zealand that are the major areas of interest for

NZSAR, has a lower level of accuracy and a higher level of geographical aggregation, which further reduces the accuracy of the analysis.

When looking at the historical incident rates, where the number of SAR incidents per area and time period are compared to the number of people present in the areas as shown by the Mobile data, the analysis shows that the incident rate in an area varies depending on the type of activities people engage in, and the number of incidents is not necessarily correlated with the number of people out doing recreational activities. For example, with the assumptions that the peak of people present in Tongariro National Park is due mainly to skiing during winter and daywalking the Tongariro Crossing track during summer among other activities, there is comparatively higher SAR demand rate in Tongariro National Park in summer than winter. This is presumably because the ski fields have their own health and safety operations and services, thus there is less need for SAR response even though there are significantly more people present in the area than in summer. Therefore, it is not a straightforward exercise to infer the risk of SAR incidents from the Mobile data; it requires prior assumptions about the area and the expert knowledge on recreational activities to understand the SAR demand.

At the same time, Mobile data provides a useful relative measure of people activity between regions. Typical areas of recreational activities around New Zealand may be well known, but the Mobile data provides a way to quantify and compare the typical (and, to some extent, peak) influx of visitors to specific areas, which can be useful when planning SAR resourcing. In order to provide further insights into the drivers behind SAR demand associated with recreational activities, the following future analysis is recommended:

- Understand significant predictors of SAR demand, such as, for example, day and night type factors, weather conditions, public events, local area features (such as preferable fishing locations). In combination with the Mobile data and area-specific estimates of recreational activities rates, all these factors can be combined into an Incident Risk model, providing a relative measure that can be used for SAR resource coverage analysis and planning.
- Report on Incident Rates. In addition to the current insights presented in the NZSAR internal dashboard, local activities and related insights can be added to allow NZSAR to delve further into the details and to share meaningful insights about SAR incident rates with partner organisations.

7. Reference

- Predicting SAR response and operational requirements based on NZ population projections through to 2030.
- New Zealand Search and Rescue Council annual report 2022-2023.
- Land Recreation Quarterly Survey 2023/24 summer report.
- Reducing SAR responses: A framework to achieve safer recreation in New Zealand, June 2016.
- Stats NZ (2018). ANZLIC metadata for statistical area 2, 2018.

8. Appendix

8.1. Terminology

8.1.1. Statistical Area 2 (SA2)

Statistical Area 2 (SA2) is defined by Stats NZ to "reflect communities that interact together socially and economically." Generally, SA2s often approximate a single suburb in urban areas—having a population of around 1,000–3,000 residents in district council areas and 2,000–4,000 residents in city council areas. In rural areas, like Fiordland, SA2s can have fewer than 1,000 residents.

8.1.2. Mobile data

The Mobile data from Qrious provides an hourly estimate of the number of people present in a particular area. The estimates are calculated from the unique device registration counts and then extrapolated using Spark's market share. The count is calculated from any interaction between the Spark network and the mobile device that leads to the measurement and collection of its location, including text messages, calling, mobile data use, and connectivity checks. Only devices present for at least one hour in the area are included in the counts. The estimates are further categorised into:

- "International": Aggregated from events of all International Mobile Subscriber Identity (IMSI), whose mobile country code is different from 530 (New Zealand), regardless of their estimated home locations, if any.
- "Local": Aggregated from IMISI events in which the Regional tourism organisation (RTO) matches the RTO of individuals' home locations
- "Domestic": Aggregated from IMISI events in which the events' RTOs do not match the RTO of individuals' home locations, which implies that a person is travelling domestically. Home location is determined by the area the device spent the most time between the hours of 12 am (midnight) and 6 am in the preceding 25 days.
- "Unknown": Aggregated from all other events from IMSIs for which home location could not be conclusively determined in the preceding reference period.

8.2. Methodology

The daily estimated number of people in an area is calculated by summing the relevant hourly numbers of people each day. Daytime is defined as the hours between 7AM and 6PM. To estimate the number of people at higher frequencies (such as, months, seasons, and years), the daily estimates are aggregated as an average group by pertinent variables (such as, weekdays vs. weekends and winter vs. summer). Based on typical New Zealand seasons, winter months include July, August, and September; summer months include December, January, and February. Weekends include Saturday and Sunday as well as New Zealand public holidays, such as the Christmas period.

For the hour of the week analyses, the estimated number of people are an average of relevant variables (such as winter vs. summer) aggregated per hour (beginning Monday midnight to Sunday 11PM).