Title: Goodnature Traps and The Conservation of New Zealand Native Birds

Background:

Goodnature, a New Zealand-based company, manufactures traps that humanely kill mice and rats. Unlike traditional poisons or methods that cause prolonged suffering, these traps are designed for an instant kill using a pneumatic gun. Due to this Goodnature's traps are suitable to be used in conservation work. Over the years foreign predators were introduced into the country which have wreaked havoc on native species of birds as a lot of these birds do not have the ability to fly, such as kiwis and Kākāpōs. Among the invasive species that were brought in by people, whether intentional or not, are mice and rats. Although these rodents don't usually directly attack the birds, they are food for other predators. They can also attack the bird nests and feed on the eggs, which could be devastating if left unchecked.

Outside the other mechanisms of conservation work, reducing the mice and rat population is a key issue that constantly needs to be addressed. However, we don't want to use toxic chemicals to poison the rodents as that may have unintended consequences on the ecosystems when their dead bodies are eaten by other predators or the soil being contaminated as the carcasses decompose.

Beside its non-toxic feature the traps are also equipped with IOT capabilities that are able to record their activities, and sync their data with a server. The data collected over a period of time could then be used to analyse the effectiveness of the conservation work along with other insights. Also in the trap's favour, the lure that is used is designed to attract in particular mice and rats and reduce the likelihood of accidentally killing other animals, especially native species.

Introduction:

The trap data provided contains 16 columns, as shown in the table below.

	Field	Data Type	Example
1	id	Integer	1, 4, 7
2	when	Timestamp	2018-06-17 20:12:02.455+00
3	activityType	String	CO2_LOW CO2_REPLACED LURE_LOW LURE_REPLACED NO_CO2_LEFT STRIKE SYNCED TEST_STRIKE UNCOLLECTED_DATA
4	strikeTime	Timestamp	2017-04-04 06:10:20+00
5	batchId	Integer	1, 2, 3
6	createdBy	Integer	1, 2, 3
7	trapId	Integer	1, 2, 3
8	groupId	Integer	1, 2, 3
9	organisationId	Integer	1, 2, 3
10	killType	String	
11	latitude	Float	-41.2940663
12	longitude	Float	174.7852885
13	temperature	Integer	37
14	batteryLevel	Integer	100
15	hasImage	Boolean	FALSE
16	trapInstalledAt	Timestamp	2018-06-17 20:12:02.157+00

The trap data provided contains the latitudes and longitudes of the traps or at least the locations of the phones connected to them via bluetooth. [1] They can be used to

see the exact location of the trap on Google map, or any other map, but in order to be able to perform some analysis on the data we need to convert them to territories/districts, towns/cities, suburbs/localities, or even street addresses which are more human-friendly.

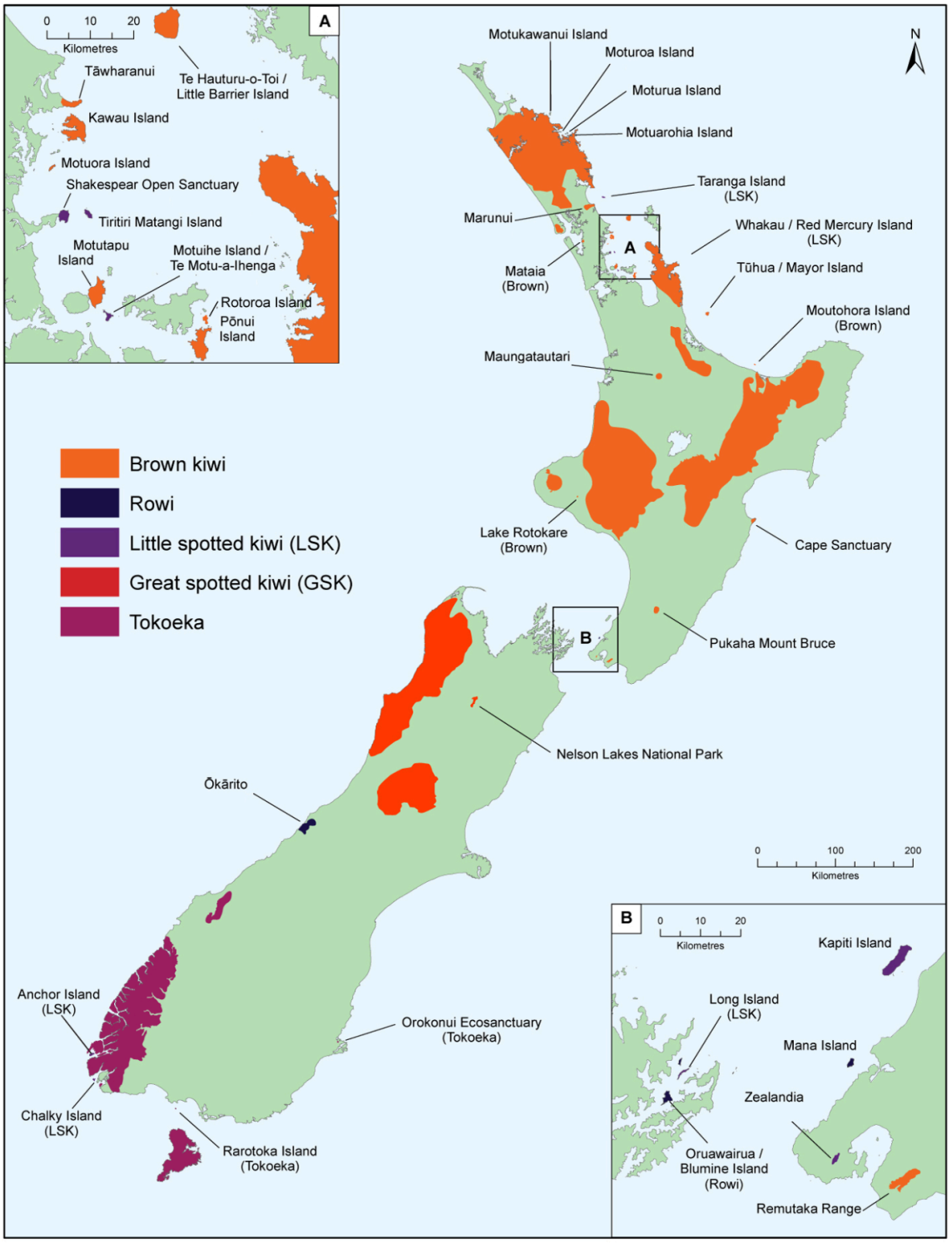
As well as this, I am also pulling the Territory boundaries map data and Suburb and Localities data from the website of Land Information New Zealand which are required to create choropleth maps with Plotly Express.

Since we are interested in learning about the impact of the traps on the conservation effort of New Zealand native birds, I am also going to refer to data from the websites of Save the Kiwi and ArcGis.

From the website of Save the Kiwi we obtain the habitat map of all Kiwi species. The map shows Tokoeka species can be found in Fiordland National Park, Mount Aspiring National Park and Codfish Island/Whenua Hou. Great Spotted kiwi are found in some part of Arthur's Pass National Park and along the coastal area of Kahurangi National Park and Karamea Bight bay. North Island Brown kiwi are the most common kiwi and they are found largely in the North Island, thus the name. Little spotted kiwi are only found on Kapiti Island. Rowi are found only in the Ōkārito forest which is located on the West Coast of the South Island. [3]

From the ArcGis website we can get the Kea bird habitats map. The map shows that Kea are found only on the South Island [4], in areas where southern beech trees are found [5]. Combining this data together we can see if the traps are making any direct and meaningful difference on the conservation work.

I have also checked out the habitats of kākāpō birds and they live in the same area as the Tokoeka kiwi [6], therefore I have decided I am not going to focus on them.



Where to see kiwi [2]

Approach

Among the 16 columns of trap data, some of them are largely empty. For example, in the ‘groupId’ column only 13.25% of them have values. Only 14.23% of the organisationId column has values. Only 12.8% of the temperature column has values. Only 0.67% of the batteryLevel column has values. At this stage I am not looking at these columns due to time constraint and focusing on data that will add value to the conservation of native birds.

Description	NUM_ROWS	PERCENTAGE
killType with non-null values	44054	4.41
temperature with non-null values	128036	12.8
organisationId with non-null values	142379	14.24
batteryLevel with non-null values	6781	0.68
groupId with non-null values	132558	13.26

On the other hand, only 4.4% of the killType has values and the values are ‘Test strike’, ‘Rat’, ‘Stoat’, ‘Mouse’, ‘Hedgehog’, ‘Scavenged’ and ‘Other’. I find these values interesting, as they confirm that besides mice and rats, the goodnature traps do occasionally kill stoats, hedgehogs and other predators that are of similar size and behaviours to mice and rats.

The `when` column in the original file, I have renamed it to `uploadTime`, as the name is a keyword in the SQL language. I have confirmed that the column is always greater than the `trapInstalledAt` column, except 4 rows, that’s 4 out of 999,999, so I am confident that the `when` column is the time the device synced its data with the server. The `strikeTime` , on the other hand, is always before the `uploadTime`. From the data I conclude that the device doesn't get an internet connection at all times to upload the activity data in real time. Instead, occasionally someone will come and upload the data, which in a lot of cases is days or months later.

There are 265 rows of data with strikeTime dated back to 1970, which was way before the company was formed, it is therefore safe to conclude that the devices were not being configured properly. I can potentially keep the time of the timestamp and combine it with the date of the trapInstalledAt timestamp but that's a lot of extra work with not much value, so I will exclude these 265 rows from the analysis.

First the provided latitude and longitude pairs were reverse geocoded to real human-friendly addresses. Although there were many methods to achieve that, the BigQuery Geography functions were preferred to find the nearest addresses within a 20 km range. The 'geopy' Python library could also be used, but it was going to take too much time to run, because behind the scenes it is making HTTP requests to an API server somewhere. To obtain the addresses for over 15 thousand unique locations it could take a good 4 hours.

```
WITH locations AS (
    SELECT
        DISTINCT
        latitude,
        longitude
    FROM {{ ref('stg_trap_data') }}
)
SELECT
    ROW_NUMBER() OVER(ORDER BY longitude) AS location_id,
    latitude,
    longitude
FROM locations
WHERE (longitude >= -180 AND longitude <= 180) AND (latitude >= -90 AND latitude
<= 90)
```

Obtain unique addresses from the trap data

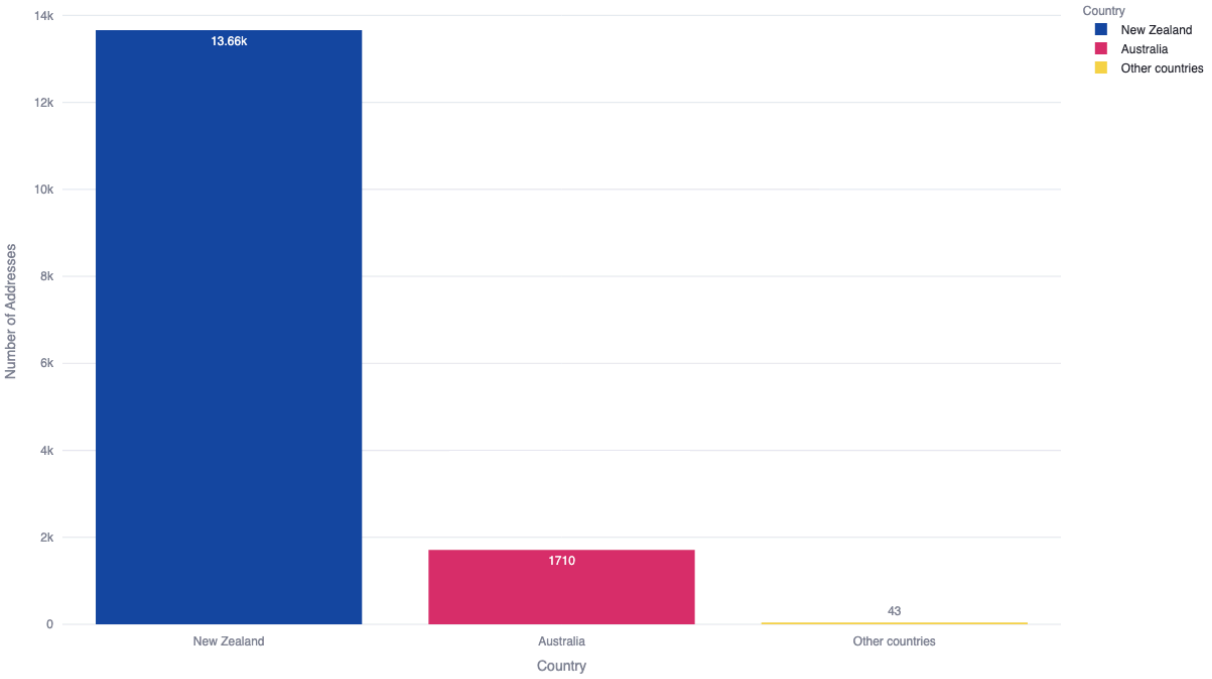
```
WITH locations AS (
    SELECT
        location_id,
        latitude,
        longitude
    FROM {{ ref("int_trap_locations") }}
), addresses AS (
    SELECT
        address_id,
        full_address,
        full_address_number,
```

```
        full_road_name,
        suburb_locality,
        town_city,
        territorial_authority,
        water_name,
        water_body_name,
        longitude,
        latitude
    FROM {{ ref("stg_nz_addresses") }}
)
SELECT
    loc.location_id,
    addr.full_address,
    addr.full_address_number AS address_number,
    addr.full_road_name,
    addr.suburb_locality,
    addr.town_city,
    addr.territorial_authority,
    loc.longitude AS trap_longitude,
    loc.latitude AS trap_latitude,
    addr.longitude AS address_longitude,
    addr.latitude AS address_latitude,
    ST_DISTANCE(
        ST_GEOGPOINT(loc.longitude, loc.latitude),
        ST_GEOGPOINT(addr.longitude, addr.latitude)
    ) AS distance_in_meters
FROM
    locations AS loc
    JOIN
    addresses AS addr
    ON ST_DWITHIN(
        ST_GEOGPOINT(loc.longitude, loc.latitude),
        ST_GEOGPOINT(addr.longitude, addr.latitude),
        20000  -- The radius in meters. Adjust this value based on your data's
density.
)
QUALIFY ROW_NUMBER() OVER (PARTITION BY loc.location_id ORDER BY
distance_in_meters ASC) = 1
```

Find the nearest known address to the trap GPS location

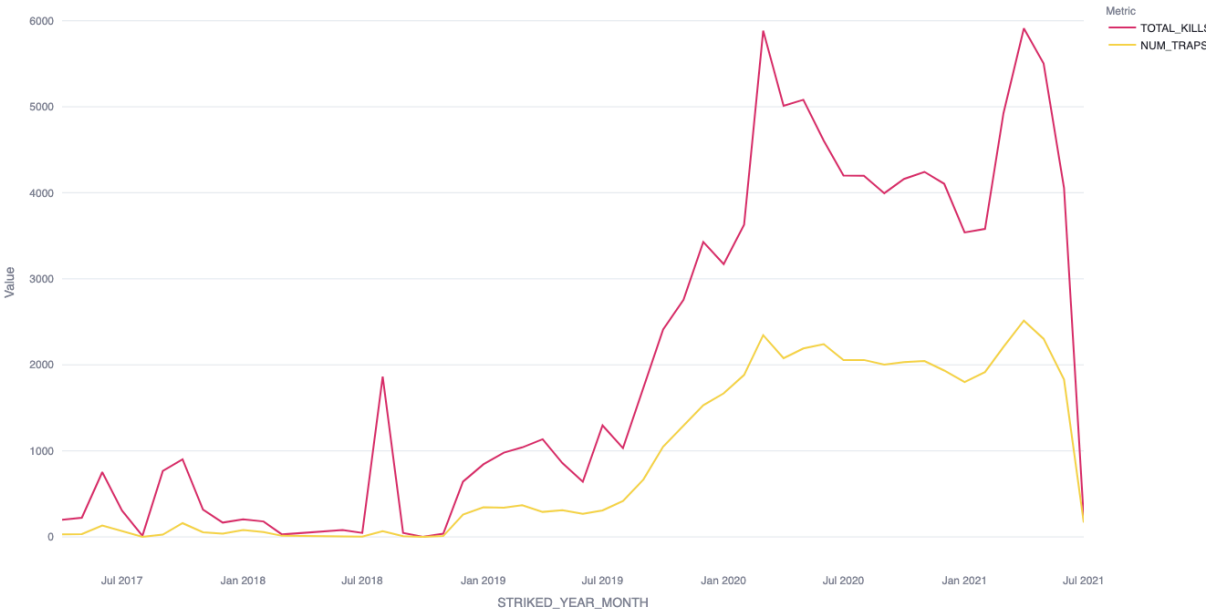
After performing these operations for both New Zealand and Australia, it was found that 1,710 traps were located in Australia and 43 are in other countries, such as Taiwan and the USA. Since these locations were outside of the scope, they are excluded from further analysis.

Goodnature Trap Locations by Country



Number Traps and Number of Kills

Monthly #Kills vs #Traps Over Time



By looking at the graph above, it can be seen that as the number of traps increase the number of kills also increase and vice versa. Does this indicate there is a strong correlation between the number of kills and the number of traps? In order to prove that, we will need to calculate the Square of R Coefficient between the two variables.

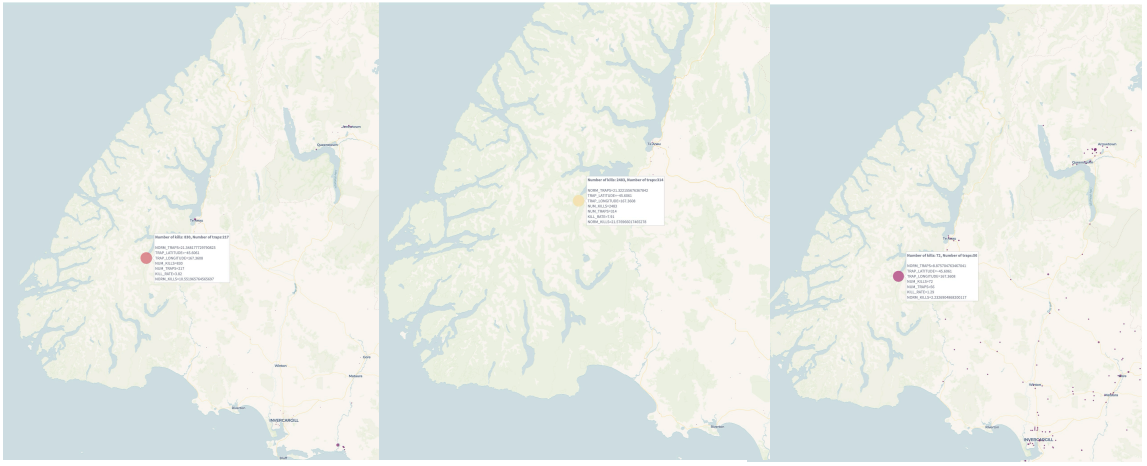
$$r = \frac{\sum \left(x_i - \bar{x}\right)\left(y_i - \bar{y}\right)}{\sqrt{\sum_{(\ )} \left(x_i - \bar{x}\right)^2 \sum \left(y_i - \bar{y}\right)^2}}$$

$$\bar{x} = 910.3;\ \bar{y} = 2099.02;$$

$$r = \frac{\Sigma(x_i - 910.3)(y_i - 2099.02)}{\sqrt{\Sigma(x_i - 910.3)^2 \Sigma(y_i - 2099.02)^2}} = 0.9821;\ r^2 = 0.965$$

The result of the Square of Determination or the Square of R Coefficient calculated above is 0.965, which is very close to 1, thus indicating a strong correlation between the number of traps and the number of rats or mice killed. The practical application is that if we desire to see more rats or mice eliminated, we can increase the number of traps being laid. This will remain true as long as the mice/rats population remains high to a certain extent.

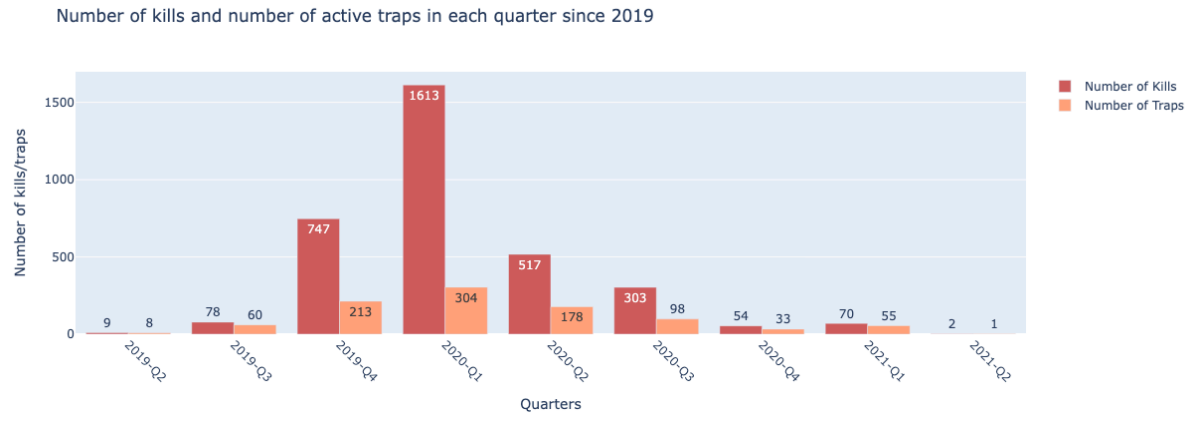
Goodnature Traps in Native Birds Habitats



Goodnature traps in Fiordland National Park from 2019 to 2021

Based on information from Save the Kiwi, the most vulnerable kiwis are the Little Spotted kiwis and the Rowi kiwis, their estimated populations are 1,800 and 500 respectively [7]. According to Save the Kiwi, the Little Spotted kiwis are mainly found on Kapiti island, while Rowi kiwis are found in Okarito kiwi sanctuary and Blumine Island. Sadly, in the five years history there has been no Goodnature traps being deployed in these places.

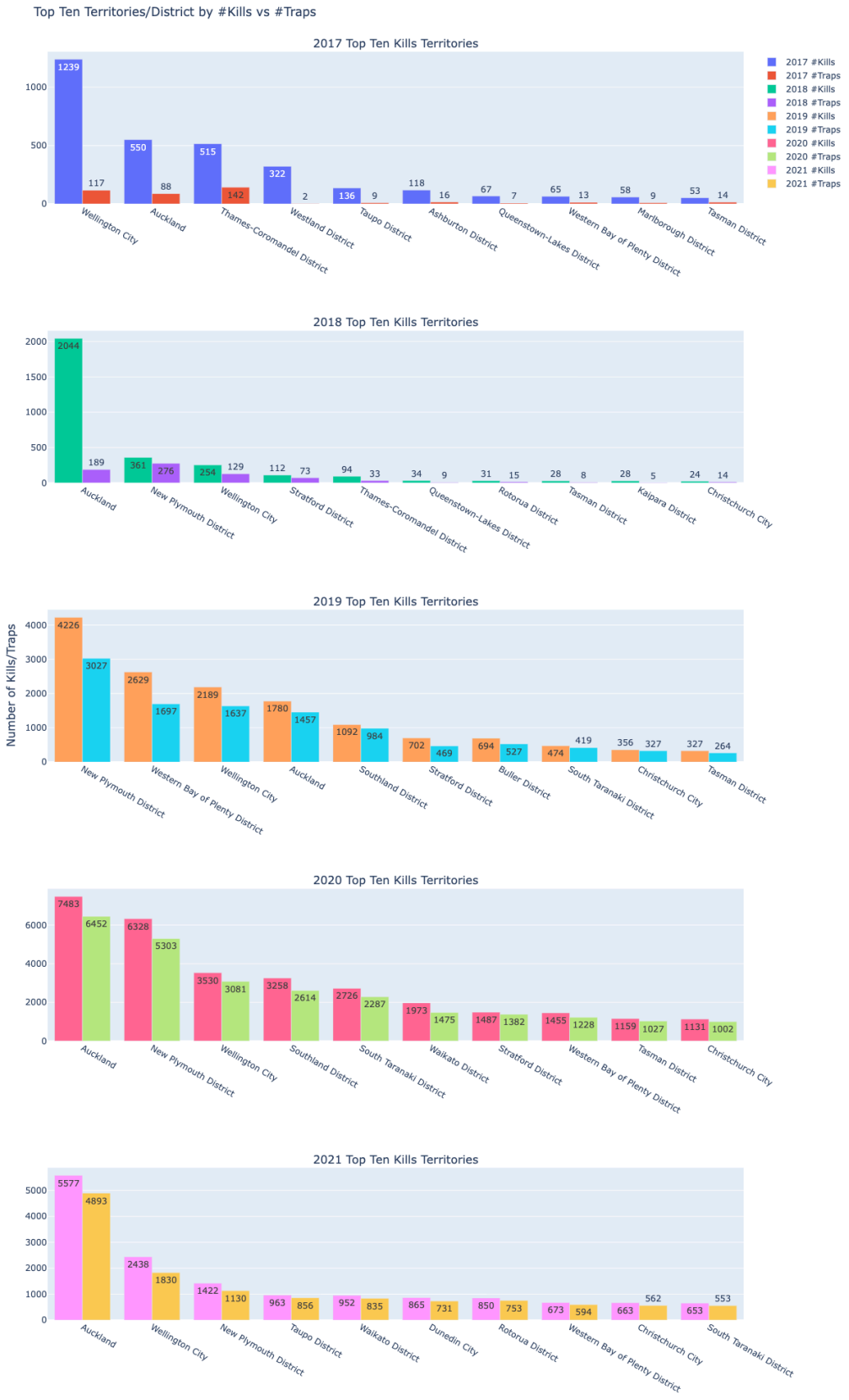
In contrast, the Tokoeka habitats have seen a tremendous increase in the number of traps since 2017, where there were none. In 2019, 217 traps were deployed in total and together they killed 817 rats or mice in that year. Making comparisons across each year is going to be misleading since traps were not being deployed until the second quarter of 2019. In 2021, the last transaction of trap activities was recorded on 28 April. Plotting the number of kills and number of active traps for each quarter, would do the analysis more justice. As can be seen in the graph below, the number of kills were reflected by the amount of efforts and resources invested by conservationists.

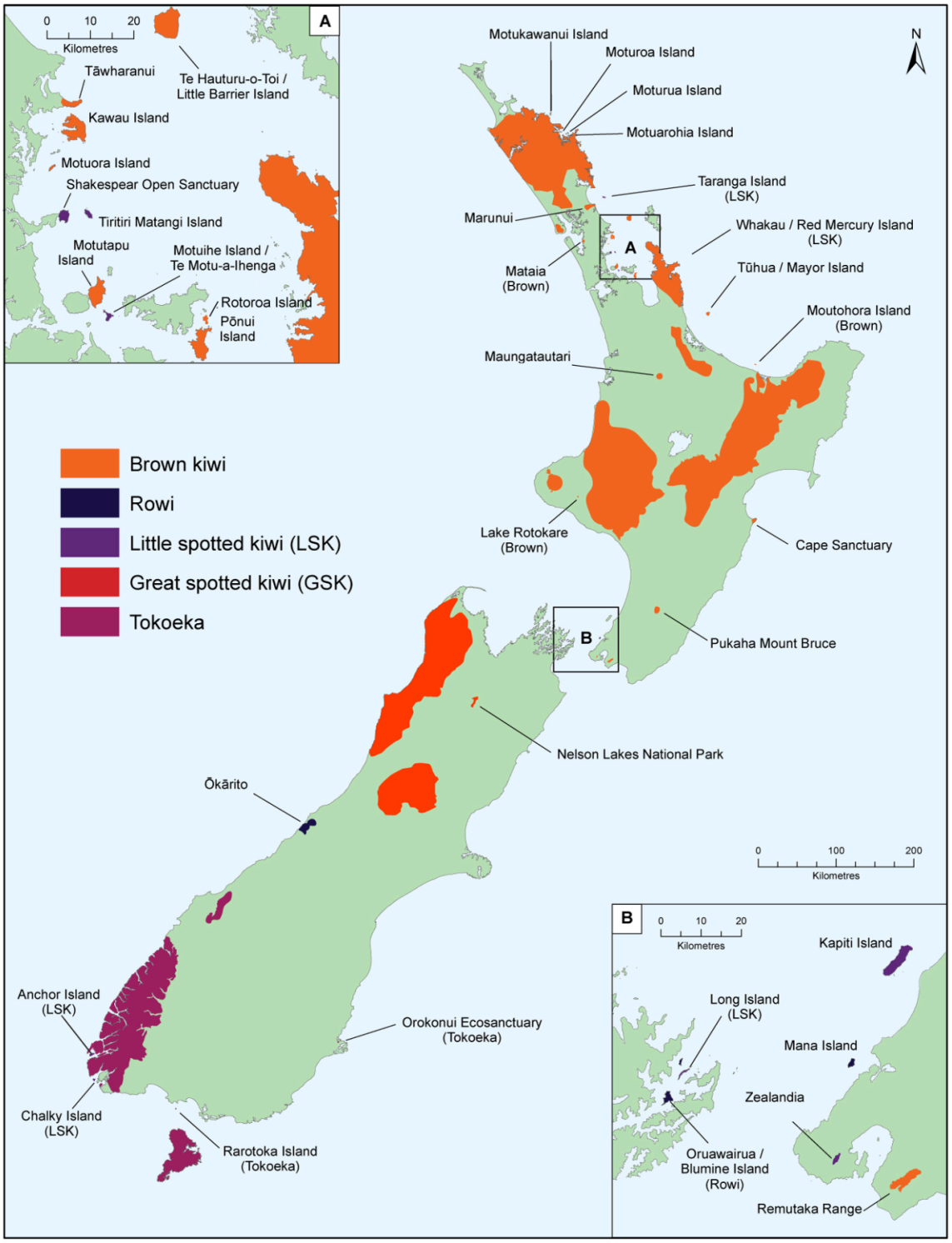


We have already established that there is a great correlation between the number of active traps to the number of kills, if consistent efforts and investments are maintained in existing areas. If Goodnature traps were deployed in new areas, such as on Kapiti island and Okarito lagoon area, it would make a huge difference to the near extinct kiwi species.

Taking a step back to look at the annual overall trap performance in each territory or district, we can see as illustrated in the charts below, Southland District was in the

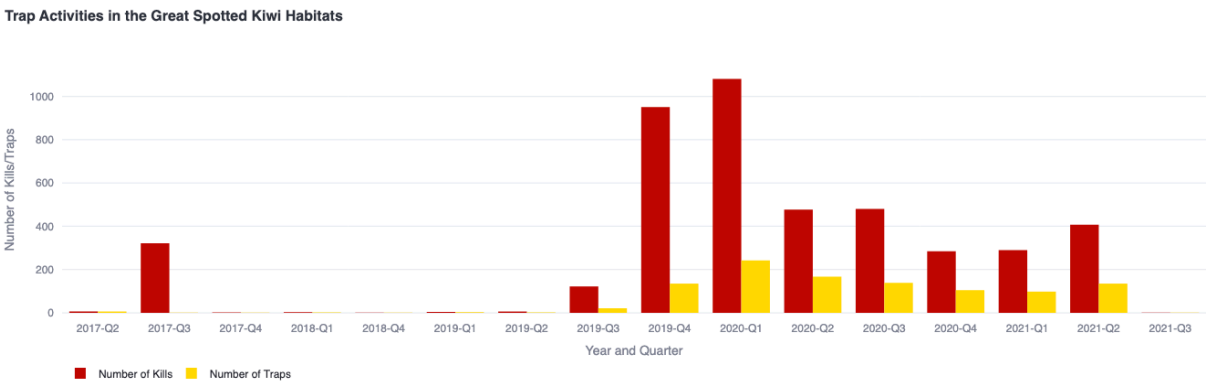
top ten in 2019 and 2020, in spite of the fact that trap activities were not being recorded until the 2nd quarter of 2019. In the first two quarters of 2021, Southland District lost its position in the country's top 10 list.



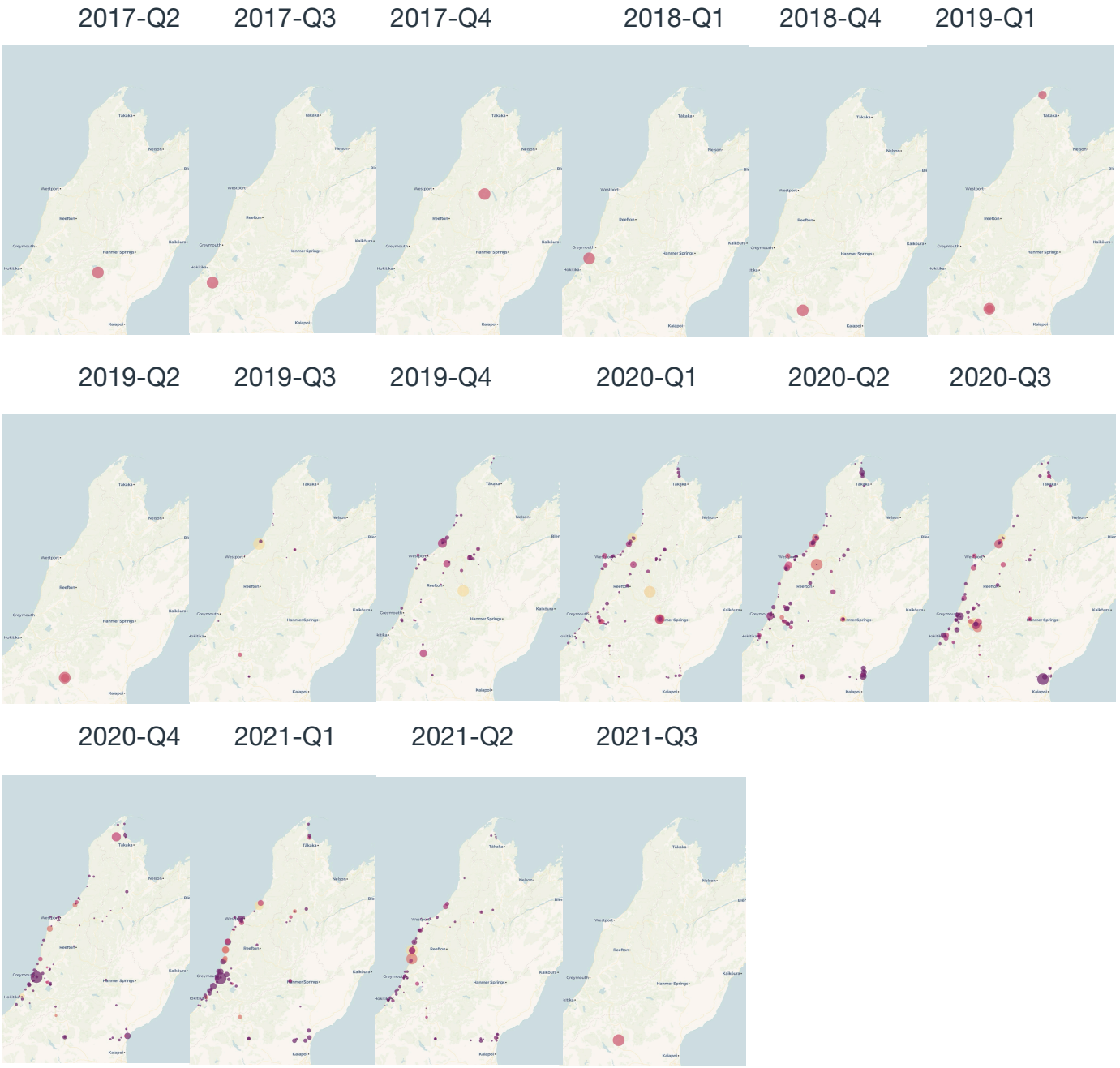


Where to see kiwi, https://savethekiwi.nz/about-kiwi/where-to-see-kiwi/

The Great Spotted Kiwi Habitats



Looking at activities in the habitats of the Great Spotted kiwis, we can also see a similar trend. Six traps were first introduced in a farming area along Mangles Valley Road, Tutaki, Murchison town in Tasman district in the second quarter of 2017. In the following quarter one trap was introduced on Hackells Mill Road, Kokatahi, Westland District, also a farming area. In just 3 months, that trap recorded 322 strikes. There wasn't much trap activity in the region in the fourth quarter of 2017 up until the 3rd quarter of 2019, where 21 active traps were recorded. In the following quarter, 135 traps were recorded, that is an increase of approximately 543%. As a result of increased efforts, 951 strikes were recorded in that quarter, that's an increase of 679%. The peak of Goodnature trap activities was in the first quarter of 2020, where we saw 242 active traps, with a recorded 1081 strikes. Since then there was a gradual decrease in the number of active traps by roughly 20% per quarter, until the second quarter of 2021. We see the number of active traps picking back up to 135 traps in that quarter with a total 407 strikes, that is an average of 3 strikes per trap. The record ended on 28 April 2021, which is not a full quarter, so comparing the statistics of the 3rd quarter of 2021 to the previous quarters won't do it any justice.



Goodnature Traps Scatter Map on the northern part of the South Island between 2017-2021

Recommendation and Conclusion

One thing we have established is that there is a strong correlation between the number of traps deployed to the number of rats and mice killed. Whether we look at the overall data or focus on a certain area, we have confirmed the same trend. We have compared traps activities on the northern part of the South Island, where the Great Spotted kiwis are found, to activities in Southland district, where Tokoeka

kiwis are located. When we see more active traps, we see more kills being recorded and vice versa. What is also true is that we have observed a decrease of the number of active traps on the island since the 2nd quarter of 2020. Whether that is due to the lack of funds or other reasons, is beyond the scope of this project. There is no evidence to suggest that the rats or mice population is in decline, because whenever more active traps are being deployed we see a proportional increase in the number of kills.

In order to give kiwis the best chance of survival, we need to maintain control of the rodent population. A public campaign encouraging citizens living near the habitats of these birds to keep their rat or mice populations in check could help in achieving this. It is important that traps continue to be deployed and maintained in the forest where kiwis reside. Figuring out why there are no current active traps in the Okarito lagoon area and Kapiti island, where kiwi numbers are in such decline, is vital for conservation efforts. Perhaps other types of traps are being used, and this could be an opportunity for Goodnature. If we can get some traps to go live, we need to ensure that there is continuous funding to increase the number and maintain the existing ones, whether from private donors or government grants.

References:

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