Recreational use of Oreti Beach, Southland, New Zealand, 2010 – 2012

A report to Te Ao Mārama, Environment Southland, Invercargill City Council and Department of Conservation

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Executive Summary

The main objectives of this study were to determine year-round volumes of traffic on Oreti Beach (number and type of vehicle, how far they travel on the beach on each visit) and to understand why people choose to visit different sections of the beach. Information gathered in this study will provide a thorough understanding of the recreational use of Oreti Beach and will provide a baseline for future monitoring. The results will also be used to assess the threat to the Oreti Beach toheroa population.

Traffic volumes entering the beach via Main Entrance (Dunns Road) were recorded between 7 April 2010 and 11 April 2012 using an automatic traffic counter.

Between 18 January 2011 and 14 January 2012, the location and activity of all vehicles and people encountered along the length of the study area were recorded during 34 km ‘circuits’ driven using a motorbike. Altogether 196 circuits were distributed over 73 sampling days, with seasonal sampling effort closely matching visitor numbers as recorded by the traffic counter. Circuits were performed on a Saturday, Sunday and a randomly selected weekday in each ‘sampling week’.

During each circuit, the GPS position and type of all vehicles were recorded, as was the location of any people, along with a note of the activity they were undertaking. Additionally, a number of users were interviewed about their trip to the beach. People fishing for flounder or harvesting toheroa were approached and where possible questioned about their trip. The position and direction of any turning circles (tyre marks in sand) were recorded, as were any “doughnut” marks.

Weather and tide data were also collected throughout the study.

We estimate that the minimum total number of vehicles visiting Oreti Beach via the Main Entrance between 10 April 2010 and 9 April 2011 was 96,088; and that at least 90,859 vehicles visited between 10 April 2011 and 9 April 2012. This gives an average of 256 vehicles per day visiting Oreti Beach via Main Entrance over the two years of the study. The number of vehicles per day varied between 42 and 1587. Previous estimates suggest that an average of ca. 2.5 people travel in each vehicle, so all up, around a quarter of a million people visit Oreti Beach each year.

The number of visitors to Oreti Beach fluctuated predictably according to season (more in summer than winter), the day of the week (more in the weekend than weekdays) and the time of day (most in the afternoon, few at night). Climatic factors also influenced the number of beach users, with warmer temperatures in particular leading to greater visitor numbers and cold southerly winds deterring visits to the beach.

Cars (51%) and utilities and four-wheel-drive vehicles (36%) were the most common types of vehicles using Oreti Beach. Motorcycles constituted only 3% of the vehicles, but they were highly visible and many moved almost continuously and at high speed up and down the beach. Approximately 96% of cars and 80% of utilities/4WDs accessed Oreti Beach via Main Entrance and most vehicles were encountered close to this entrance. The distribution of cars was most restricted to the beach close to Main Entrance. Utilities/4WDs, although still concentrated around Main Entrance, occur more frequently along the beach, particularly to the north. Motorbikes were encountered widely throughout the northern half of the study area.

The interviews of beach users revealed that most visitors to Oreti Beach were male and the majority came from Invercargill. The average age was 37 years and most visitors were of European/Pākehā ethnicity.

Visitors to Oreti Beach were observed participating in 31 different activities, with simply ‘sitting in car’ being the most common activity. Most activities were concentrated close to Main Entrance, with the main exceptions being flounder fishing (mostly 1-2 km south of Main Entrance), toheroa gathering (scattered along the length of the beach), whitebaiting (exclusively at the Waimatuku Stream), motorbiking (throughout the northern half of the beach) and dog running from car (north of Main Entrance). Some of the recreational activities are greatly facilitated by being able to drive vehicles onto and along the beach, and the most frequent uses of the beach are enhanced by the shelter from the wind provided by their cars. It is also likely that each visitor can stay and enjoy the beach for longer because they are alongside or inside their vehicle.

Flounder fishing and toheroa gathering are important recreational activities at Oreti Beach. Whitebaiting at the northern end is a smaller but is also an important fishery. Toheroa harvesting is successful along much of the 18 km length of the colony and compliance levels are excellent and damage to toheroa low. A small group of flounder fishers and toheroa harvesters are high intensity repeat users, whereas many others are only occasional fishers. Harvest success is patchy and monitoring of catch per unit effort is the most cost effective method of monitoring the long-term health of the stocks in a complementary way to the very valuable standardised population monitoring of toheroa commissioned every 3-4 years by the Ministry of Primary Industries.

This study has shown that Oreti Beach receives a high volume of visitors each year and has revealed the distribution and diverse scope of activities that beach users participate in. These measures have provided an invaluable base line and will be integral in assessing the impact of visitors on toheroa along the length of the beach. We recommend that repeated recreational surveys like this one are conducted at least every 8-10 years to monitor long term trends. The past 60 year rise in the overall number of vehicles registered in New Zealand is expected to continue, so it is important to prepare and manage expected increasing conflicts from different uses of Oreti Beach. It is therefore paramount that the regular MPI surveys of toheroa are maintained at their present frequency as part of a professional risk management strategy that will simultaneously protect a threatened species, maintain an iconic customary harvest for Māori and minimise disruption to valuable recreational opportunities at Oreti Beach. All these goals are important ingredients for safeguarding Southland's lifestyle, identity and ecology.

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Acknowledgements

This research was jointly funded by Environment Southland (through a grant to Te Ao Mārama), the Department of Conservation and Invercargill City Council. Invercargill City Council provided an automatic traffic counter by the main entrance to Oreti Beach, and the services of Gama Rajapaksa to gather those data. Dr Mike Beentjes and the Ministry of Primary Industries (formerly Ministry of Fisheries) has made the NIWA historical toheroa survey data available for re-use for this study – the original study was funded by the Ministry of Fisheries. Ms Julie Futter, then an MSc student at the University of Otago, helped with field work work for the first phase of studies on vehicle impacts on toheroa. Additional field work was performed by Greg Larkin, James Harvey and Helen White. Greg Larkin (from Environment Southland) provided logistical support and analysis for Phase II of the project, and together with Dallas Bradley has peer reviewed and guided the methods throughout. David Taylor, Department of Conservation, Southland Conservancy, advised the study. Michael Skerrett (Te Ao Mārama) championed the need for the research - he initiated and then provided overall guidance of the project.

Introduction: the need for this research

Oreti Beach is enjoyed by many residents and visitors to Southland. Many people drive their cars, utilities and motorbikes a considerable distance along the beach because it is readily accessable and the sand is reasonably firm and gently sloping. Whether they be swimming, picnicking, gathering shellfish or just sight seeing, driving along the beach and sheltering in or near their vehicle is clearly an important part of people's recreation and enjoyment of Oreti Beach. Several of the people interviewed in an earlier study emphasised that driving onto the beach is an important part of the *"Oreti experience"* and *"Southland experience*"[1]. Recreational tourism at Oreti Beach is also economically important for Southland. For example, hundreds of motorbike enthusiasts from around New Zealand congregate in Southland for the New Zealand Beach Racing Championship motorbike races as part of the *Burt Munro Challenge* week[2].

Vehicle traffic on Oreti Beach is at times crowded, moves fast and can be hazardous. The beach supports a nationally significant breeding population and customary harvest of toheroa (*Paphies ventricosa*), an iconic large surf clam. Toheroa are now much less abundant at Oreti Beach than four decades ago and the main nearby population at Bluecliffs (Te Waewae Bay; Figure 1) is declining rapidly and likely to go extinct soon because of habitat degradation[3]. A much smaller colony has established at Orepuki Beach (Figure 1) after translocation there around 50 years ago[4], but the Oreti Beach colony represents the most secure and by far the most important colony in Southland. Although there have been relatively stable numbers of adult toheroa at Oreti Beach in the past decade, the national picture is more worrying and disruption of recruitment is considered a major threat (Williams *et al.* 2013). Oreti Beach is also an important site for yellow belly flounder (*Rhombosolea leporine*) netting in the surf zone. A mātaitai[5] was established at Oreti Beach in 2011 to support sustainable harvesting of toheroa, flounder and other fish. This study was motivated in part to inform management of the mātaitati by kaitiaki (Māori environmental guardians) from the Waihopai Rūnanga who manage the customary harvesting at Oreti Beach.

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[1] Futter & Moller (2009).
[2] www.burtmunrochallenge.com/
[3] Beentjes *et al.* 2006, Beentjes (2010b).
[4] Futter & Moller (2009).
[5] Mātaitai are Māori community-led customary fisheries management areas established under the New Zealand Customary Fisheries regulations 1999 (www.fish.govt.nz/en-nz/Maori/SouthIsland/default.htm).

Phase I research to sustain toheroa at Oreti Beach demonstrated that juveniles are crushed by vehicles driving along the intertidal region of the beach[6]. However, the overall risk to toheroa recruitment could not be measured without a year-round survey of how many vehicles use the beach, how far along and down the beach they go, and how much this traffic overlaps the kōhanga (nursery) area of the beach where juvenile toheroa are concentrated. Until this present study, the only formal study of recreational and vehicle use of Oreti Beach was conducted between 16 December 1998 and 10 February 1999[7]. Use of the beach is likely to increase in future, so firm baseline measures of vehicle use were sought to link to ongoing regular surveys of the toheroa themselves[8] to test potential impacts of people and their vehicles on recriuitment of toheroa.

The first research objectives for Phase II of an overall project to sustain toheroa on Oreti Beach were to *determine year-round volumes of traffic on the beach (number and type of vehicle, how far they travel on the beach on each visit) and why people choose to visit different sections of the beach.*

Understanding why, how many, and when people use different parts of the beach is important for assessing impacts on users of various potential future options for vehicle management. For example, bylaws to restrict the area, season or time-of-day when vehicles drive onto the beach could be considered if vehicles are found to threaten the toheroa stocks. Results of the surveys of recreational and vehicle use of Oreti Beach are described in this report.

The remaining objectives of Phase II of the project were to (i) improve measures of the risk posed to juveniles each time they are run over by a vehicle, (ii) compare the distribution of toheroa and vehicle traffic, and then (iii) simulate the impact of vehicles on overall recruitment of toheroa in different parts of Oreti Beach. This toheroa impact research contribution forms part of *Te Tiaki Mahinga Kai*, a research coalition which works closely together with tangata whenua (local people), Tangata Tiaki, governmental agencies and institutions involved in customary fisheries management. The vision of *Te Tiaki Mahinga Kai* is for "sustained enhancement of the cultural, economic, social and environmental well-being of Māori and New Zealand as a whole through the application of mātauranga and science associated with mahinga kai to modern customary fisheries practices"[9]. The results of toheroa impact assessments are described in a parallel report[10].

[6] Moller *et al.* (2009).
[7] Wilson (1999).
[8] Beentjes et al. (2006); Beentjes & Gilbert (2006a,b; 2010a,b).
[9] See www.mahingakai.org.nz
[10] Moller *et al.* (2014).

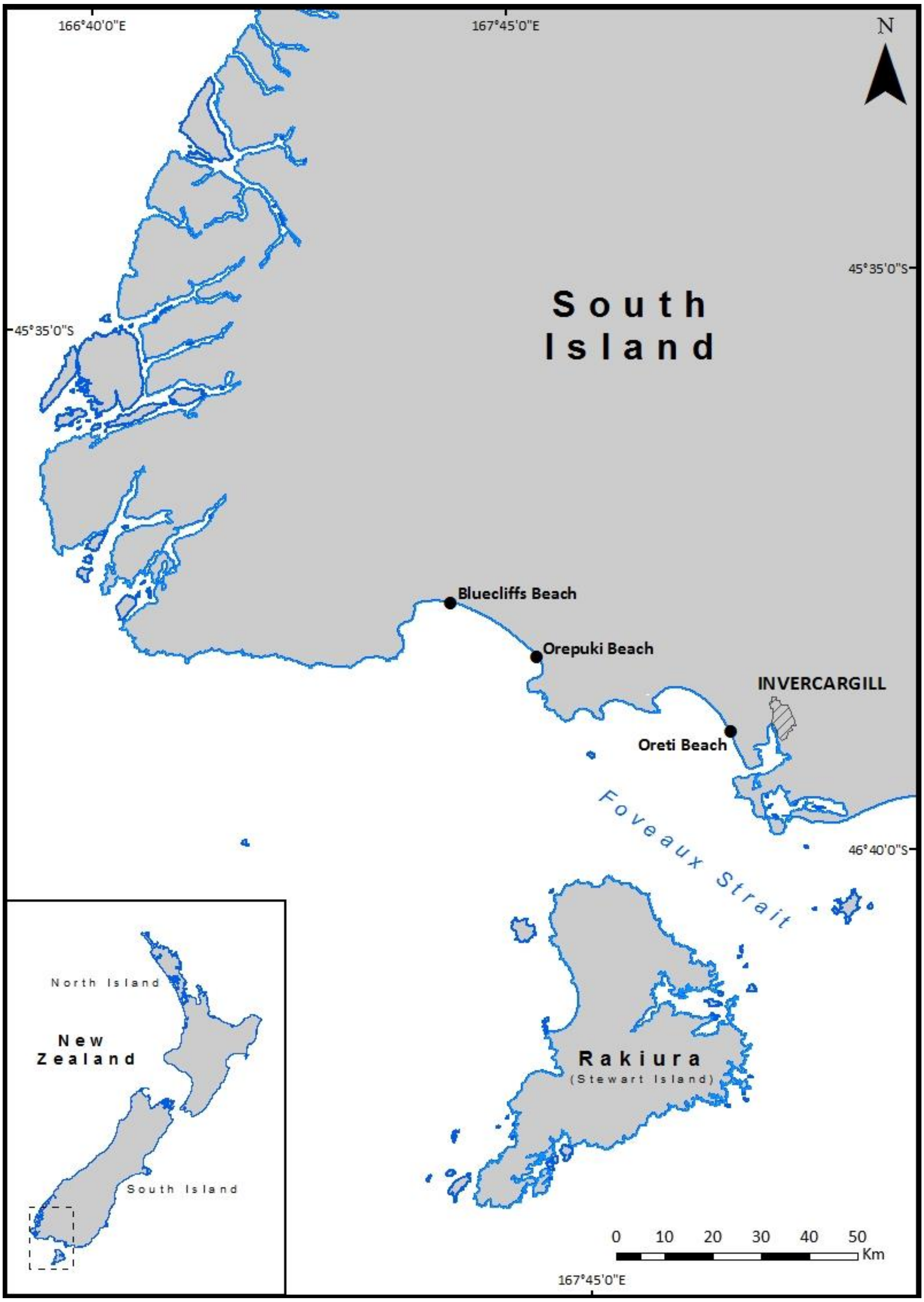

Figure 1: Location of the toheroa study area and two other nearby colonies of toheroa at Bluecliffs Beach and Orepuki Beach.

Study area and methods

Oreti Beach is 29 km long, running southeast to northwest. The main vehicle entrance, at Dunns Rd., is situated 10 km from central Invercargill city (Figure 1)[11]. Apart from a 400 m long gravel patch at about the high water mark just south of North Entrance, the beach is a gently sloping fine-sand beach. The width of the beach (from high to low in spring tides) averages 210 m and the tidal fall is 1.2 – 1.3 m below mean sea level[12]. Toheroa are found over about 18 km of the beach, spread from near the Oreti River outflow in the southeast to the Waimatuku Stream in the northwest (Figure 2). For this reason we concentrated our study of recreation on Oreti Beach on this same 18 km stretch.

Vehicle visits measured by a traffic counter

An automatic traffic counter[13] was placed on the last stretch of the "Main Entrance" (Dunns Road) before it reaches Oreti Beach (Figure 2) between 7th April 2010 and 11th April 2012. An electrical loop buried in the tar sealed road counted the number of vehicles travelling west (towards the beach) or east (towards Invercargill) every 5 minutes. In addition to the Main Entrance, there are two other significant entrances, one being the North Entrance at the end of Ferry Road, 5.9 km north of Main Entrance. The physical ability for vehicles, especially cars, to gain access to the beach via the North Entrance is variable due to soft sand in the entrance and debris washed into the entrance itself. There is also a South Entrance 4.0 km south of Dunns Road that provides access for pedestrians, cyclists and horses from a formed car park situated behind the dunes in the Sandy Point Domain. Infrequent traffic enters the study area from the northwest by crossing the Waimatuku Stream[14] or the extreme south via the "Sandy Point Entrance" (Figure 2). However, most drivers that we interviewed within the study area drove onto the beach via Dunns Road and stated that they intended to leave the same way. We use various inferences to estimate the number of vehicles missed by the automatic vehicle counter in this report. We have analysed and presented

[11] Throughout this report we refer to this as 'Main Entrance'.
[12] Beentjes & Gilbert (2006b).
[13] The counter was a MetroCount™ MC5805 Loop Counter (MC5800 Series RSUs, August 2008). It was programmed with a 'debounce time' so that the second axil of passing vehicle was discounted. Gama Rajapaksa checked the number of passing vehicles against the number of passes registered each time he tended the traffic counter to download data and change batteries (every one to two months). There was a perfect correspondence between the count and the number of observed periods. The sensitivity of the device was set to record passes by all motor vehicles, including motorbikes, but not trailers.
[14] These are mainly four-wheeled drive utilities or motorbikes that have travelled all the way along Oreti Beach from Riverton.

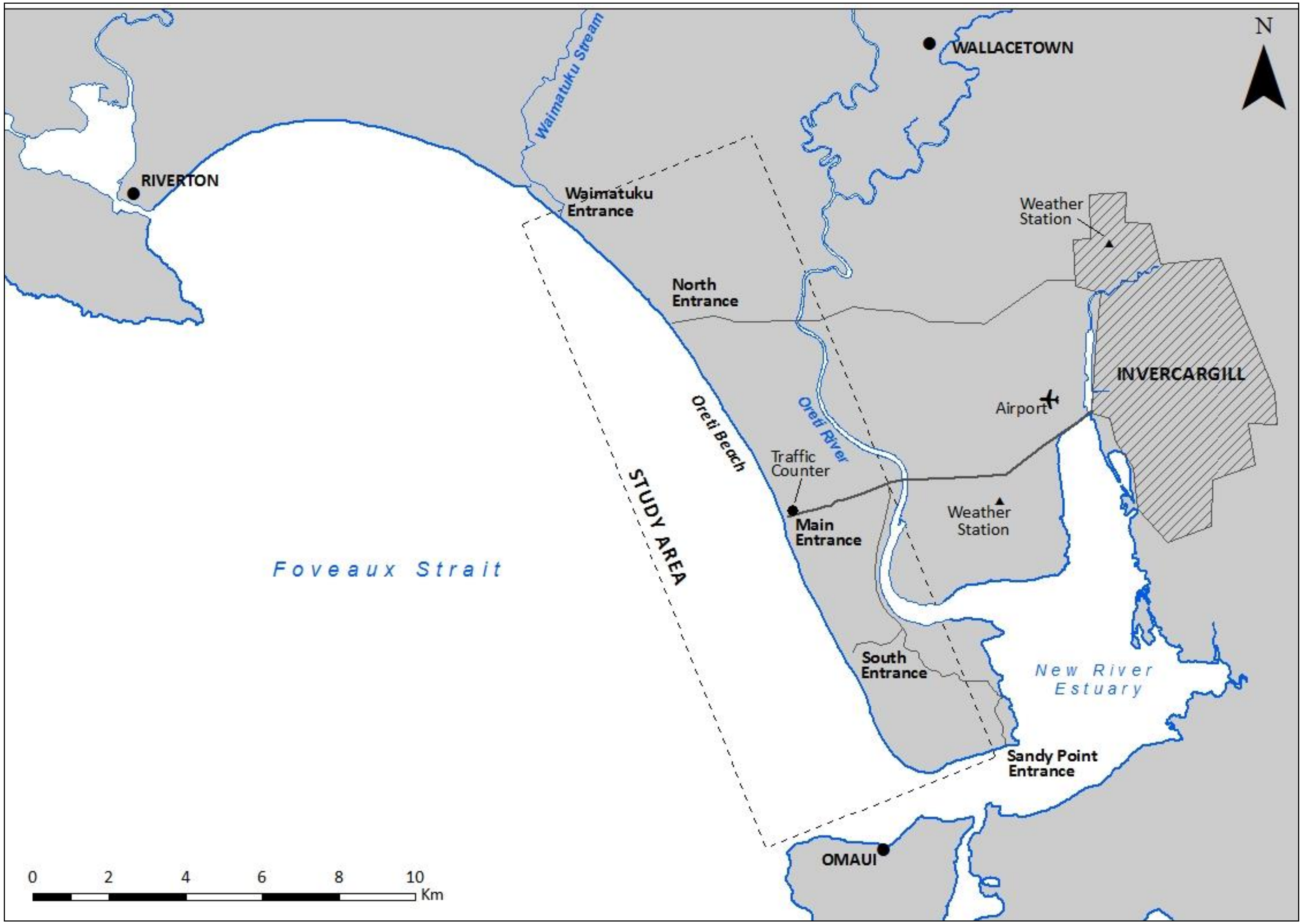

Figure 2: A map of the Oreti Beach study area.

the data using New Zealand's 'Daylight Saving Time' in the summer months and NZ Standard Time for the remainder.

Vehicle counts were missing from one lane[15] during most of the first week in December 2010 when a roading contractor disrupted the loop; and for a day in September 2010[16] and a week in May 2011[17] when batteries failed. Otherwise there were only 6 additional gaps in data which lasted just 5 minutes while the stored data were downloaded and batteries exchanged. Altogether counts were missing from 3,053 (1.1%) out of 211,713 periods (each 5-minutes) throughout the study.

Weather and tide records

Rainfall (mm) was recorded every 10 minutes throughout the study at Environment Southland's rain gauge at 6 Tui Street, Otatara, 5.4 km from Oreti Beach (Figure 2). Wind speed (metres per second), wind direction (degrees) and temperature were recorded at Environment Southland's automatic weather station at Pomona St. in Invercargill which is 12.9 km from the main entrance Oreti Beach[18]. Tide times were determined from an online almanac[19].

Beach observations

We counted and recorded locations and activity of all vehicles and people encountered while we travelled by motorbike in 'circuits' of the complete study area. We rode onto the beach at Main Entrance, then along to one end[20], back and past the main entrance to the other end, and then back again and out the main entrance. Each circuit was therefore around 34 km on the beach itself. The average time per circuit was 1 hour and 27 minutes.

The first circuit was on 18 January 2011, the last on 14 January 2012. The circuits were concentrated in times of the year when we expected most activity and vehicles on the beach, while retaining some sampling during all seasons and times of the week to understand year round variation in use of the beach. We performed three circuits during daylight on most 'sampling days', trying to start one of them near the high tide time, one about mid tide, and one close to low tide time. Sampling days were performed on a Saturday, Sunday and a randomly selected weekday in each 'sampling week'

[15] East bound, traffic leaving the beach between 1515h on 2 December until 1405h on 7 December 2010.
[16] From 1105h on 29 September until 1145h on 30 September 2010.
[17] Between 0530h on 14 May 2011 until 16:05h on 23 May 2011.
[18] Historical weather records for the 1998/99 days surveyed by Wilson (1999) were taken at Invercargill airport, 9.3 km from the main entrance.
[19] http://www.linz.govt.nz/hydro/tidal-info/tide-tables
[20] We alternated whether we first turned south or north in successive circuits.

because most visits occurred in weekend days. We aimed for three sampling weeks per month in the warmer and 'peak' visiting season; two sampling weeks per month in the 'shoulder' months; and one sampling week per month in the 'low' visitor season (Table 1). Mechanical breakdowns forced abandonment of a few circuits and occasionally gales made driving on the beach too dangerous, so a few extra circuits were made up in subsequent weeks to maintain the overall expected sample size for the season[21]. The motorbike deteriorated from extensive use on the beach and sample sizes in the peak season were adequate, so we reduced the sampling in December 2011 and January 2012. Altogether 196 circuits were distributed over 73 sampling days (Table 1). Sampling effort tracked the fluctuation in visitor pressure (as measured by the traffic counter) except that the proportion of surveying done in the peak (summer) months was slightly higher, and that in the low (winter) months correspondingly lower, than the proportion of year round visits by vehicles in those periods (Table 1).

Table 1: Seasonal distribution of surveys of vehicles and activities of people on Oreti Beach, 18 January 2011 to 14 January 2012.

Season	**Low (Winter)**	**Shoulder (Spring, Autumn)**	**Peak (Summer)**	**All**
Months	**June, July, August, September**	**April, May, October, November**	**December, January, February, March**	**18 Jan 2011 – 15 Jan 2012**
Sampling days	16	25	32	73
Circuits	36	72	88	196
% of circuits	18	37	45	100
% of vehicle visits[22]	25	35	40	100

[21] Sampling took place on predetermined days irrespective of weather conditions so that weather effects on activity on the beach were not biased. Apart from these few instances to protect our observer's safety, the circuits were undertaken irrespective of inclement weather.

[22] Measured by traffic counter from 16 January 2011 to 14 January 2012.

The following were recorded during each circuit:

- Counts and locations (using a hand-held GPS)[23] of stationary vehicles and peoples' activities in a single pass "along the beach" (i.e. distance from Main Entrance running south or north) to provide random encounter positions. We plotted the location of these stationary vehicles and people only on the way out from Main Entrance (never on the return) to avoid double-counting.
- Position of moving vehicles "down the beach" (i.e. between the dune line and water level at the first encounter of each vehicle or person/group, and scoring whether they were travelling above the high tide line (immediately adjacent to the dune line where there are no toheroa) or within the shallow water (where toheroa may be actively feeding). We gathered these locations of moving vehicles on both the outward (from the main entrance) and return loop (travelling back towards the main entrance).
- Interviews of users (Appendix 1) at their stationary car about (i) what they are doing, (ii) number in party, (iii) where they live, (iv) whether they drove on the 'other end/side' (ie. north-west, vs. south-east of the beach) before returning to the side they are on now, (v) whether or not that have stopped earlier (on either end of the beach), and if so how many times), and when did they arrived at that place, (vi) whether they intend to go further out from the entrance before they leave or return straight to the main entrance, and (vii) why they come to that part of the beach in particular. Some of that information was scored by us to shorten the interview, which had to take less than 5 minutes so as not to frustrate the beach users. We used flashcards for home location[24] and ethnicity[25] options to speed and canalise answers. We took care to put the interviewees at ease and stated that we were not the "fish police" so that we just needed honest and anonymous answers. A pamphlet explaining the aims of the study was distributed to interviewees and if we recognised the people as regular users we did not approach them more than once.
- Locations and interview responses of people netting flounder (Appendix 2).
- Locations (along and down the beach) and interview responses of people harvesting toheroa (Appendix 3) and where possible a measure of the length of harvested animals and a count of any that were damaged during extraction.
- Positions of toheroa harvesting signs (piles of sand) even if the gatherers had already left.

[23] Garmin GPSmap76CSx, accurate to 3-5m.
[24] Otatara; Invercargill; Bluff; Southland & Rakiura; Otago; Rest of South Island; North Island; Overseas.
[25] European/Pākehā; Asian; Māori; Pacifica; Other.

- Locations of "doughnuts" i.e. areas of disrupted sand where drivers spun they car in tight circles at high speed. Some severe sideward skids rather than complete circles were included in this category.
- Locations of all turning circles left on the sand, or observed as the vehicle turned to return back the way they had come.
- Position of high tide mark and current water when starting the circuit at the main entrance; and repetitions of these pairs of measures at the south/north turning point and at approximately three points on the way back to entrance from each end of the circuit.

All 'vehicles' encountered were graded as follows:

- Car
- Utilities ("Utes") or four-wheel-drive (4WD) vehicle[26]
- Truck
- Minibus
- Bus
- Van
- Two-wheel Motorbike
- Four-wheel motorbike
- Bicycle
- Blow cart
- Other (specified)
- Trailer if present
- Horse
- Horse + sulky

Activities were classified as follows (could be multiple activities for each record):

- Flounder fishing
- Rod/line fishing
- Toheroa harvesting
- Swimming
- Surfing/Windsurfing/Kitesurfing
- Picnicking
- Sunbathing and sand play

[26] These were combined in our analysis and hereafter are refered to as "utes/4WDs"..

- Sitting in parked car (sight-seeing)
- Blow carting
- Dog running from a vehicle (the dogs are running next to the car being driven along the beach)
- Dog walking
- Horse riding
- Other (specified)

GIS and distance calculations

Spatial analyses and map production were carried out in ArcGIS 10.1 using the New Zealand Transverse Mercator projection.

To calculate the distance of each GPS data point down the beach (seaward from the sand dunes), the dune margin was first digitised at a scale of 1:10,000 from Bing Satellite Imagery of the study area captured in March 2008. Using the 'Near' tool in ArcGIS, the “down the beach” distance from each data point to this dune line was calculated.

The “along the beach” (dune-parallel) distance between each data point and the Main Entrance (Dunns Road) was approximated by first dividing the dune margin into a series of straight segments to account for the curvature of the beach (Figure 2). All segments were 1000 m in length with the exception of the three southern-most segments which were shortened to 500 m, 250 m and 250 m segments to allow for the increased curvature of the beach as it turns towards in Sandy Point[27]. At each vertex, lines were constructed perpendicular to the dune line orientation, and shore-level points placed at 20 m intervals along these lines. The along the beach distance within each segment was measured as the distance between each corresponding point (e.g. 20 m, 40 m, 60 m). The distance between each GPS data point and the nearest shore-level point (towards Main Entrance) along the section-dividing lines was first calculated using the 'Near' tool within ArcGIS, and this measurement was then added to the cumulative distances of the dune-parallel lines at the appropriate shore level[28].

[27] These smaller segments were used for calculating the along-the-beach travel distances, but they were combined into a combined segment S8 in all the maps of activities on the beach.

[28] For example, using the 'Near' tool, a data point in segment S4 may have been found to be 376 m from the nearest shore-level point (e.g. 120 m “contour”) on the segment-dividing line between segments S3 and S4. The distances across the S3, S2 and S1 segments at the 120 m shore level are 1009, 1013 and 995 m respectively. Adding these to the distance within the S4 segment gives a dune-parallel distance of 3393 m for this point.

We checked for error from this method of approximating the along the beach distance by comparing it with the distance to the Main Entrance of 10 randomly chosen points in the study area for which we determined the exact distance by tracing a shore-level line exactly parallel to the dune line at its distance down the beach. The differences between the accurate and approximate estimates for the along the beach distances of the 10 points were trivial when scaled against the 18 km long study area (the average difference was just 5.2 m, equivalent to a 0.12% error[29]).

Toheroa abundance and distribution surveys at Oreti Beach

An extensive series of toheroa distribution and abundance surveys have been conducted at Oreti Beach over the past four decades by the Ministry of Fisheries and then the National Institute of Water and Atmospheric research (NIWA). We have linked toheroa harvest activities in our study to the observed distributions and abundance of juvenile, sub-adult and adult toheroa measured in the more standardised surveys conducted in 1998, 2002, 2005 and 2009[30].

Statistical analyses

Exploratory data analysis and graphing were performed in Excel, followed by statistical hypothesis testing in GenStat 14th Edition[31]. The traffic count data were treated as a complete enumeration of visits to Oreti Beach over the two year study, so normal statistical analysis of annual, seasonal, daily and hourly visitor patterns is redundant. However recreational activity and location data gathered during circuits of the beach are subject to the usual survey sampling uncertainty. We used the ANOVA and Chi-Square Tests of Independence within GenStat for statistical hypothesis testing.

[29] The error in the 10 randomly chosen points ranged from 0 m (0%) to 15.3 m (0.34%). We also tested the errors for the most northern and most southern seaward points recorded in the entire study: they were 41 m (0.43 %) and 55 m (0.68%) respectively.

[30] A historical synthesis of all the surveys is provided by Beentjes (2010a). The position of the NIWA transects was reconstructed from the GPS points marking the boundaries between eight sampling 'strata' recorded at Appendix 1 (p 40) of that report, and the southeast to northwest distance along the dune line from those strata boundaries to the start of each transect.

[31] VSN International; www.vsni.co.uk/software/genstat

Results

Number of vehicles visiting Oreti Beach, 2010-2012

Once estimates for the missing data for periods when the traffic counter was not operating were added[32], we estimate that total number of vehicles visiting Oreti Beach via the Main Entrance between 10 April 2010 and 9 April 2011 was 96,088; and that 90,859 vehicles visited between 10 April 2011 and 9 April 2012 (Table 2). This gives an average of 256 vehicles per day visiting Oreti Beach via Main Entrance over the two years of the study. The number of vehicles per day varied between 42 and 1587.

Table 2: Total vehicles and number per day recorded by traffic counter at Main Entrance.

	Time period		
	10 April 2010 to 9 April 2011	*10 April 2011 to 9 April 2012*	*Whole period*
Total vehicles	96,088	90,859	186,947
Average number of vehicles per day	263	248	256
Maximum number in a day	1587 (31/10/2010)	1401 (26/12/11)	1587
Minimum number in a day	42 (22/11/10)	55 (29/2/12)	42

Daily, seasonal and annual variation in traffic

Around twice as many vehicles passed through the Main Entrance to Oreti Beach in the summer months than during the winter (Figure 3). Peak visitor numbers occur on Sundays, though numbers are also higher on Saturdays compared to week days (Figure 4). The number of visits is also slightly higher earlier than later during the working week during the peak season, perhaps because people working over the weekend take their break on Monday and Tuesday.

[32] We did not need the eastbound data disrupted by the grader between 2nd and 7th December 2010 for this calculation. Estimates for the day in September 2010 and week in May 2011 when the battery failed were obtained by substituting the average number of vehicles entering at the same time of the day in the three days before and after each gap.

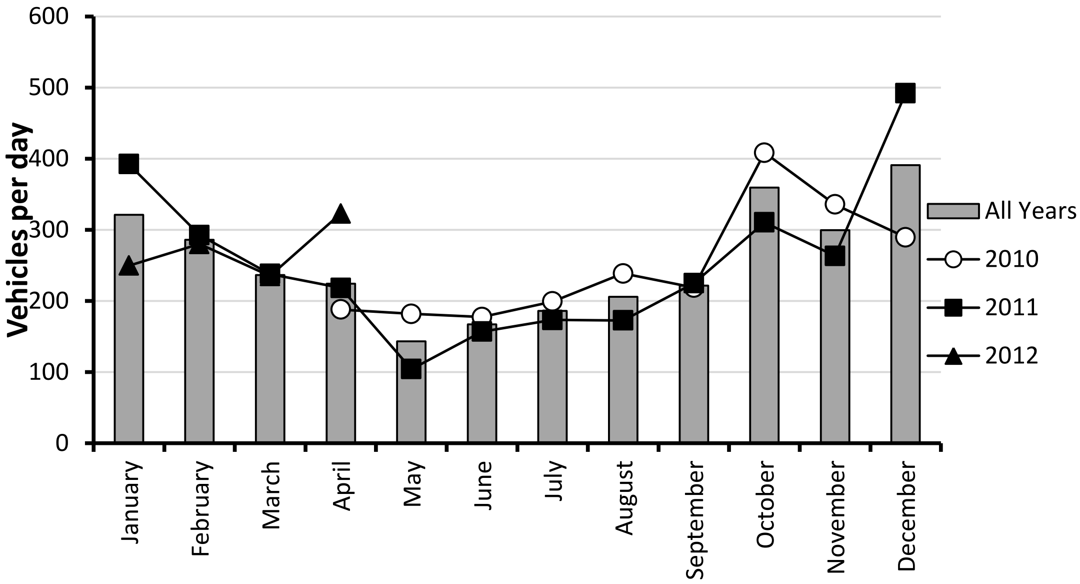

Figure 3: Average number of vehicles per day entering Oreti Beach via the Main Entrance in each month of the study.

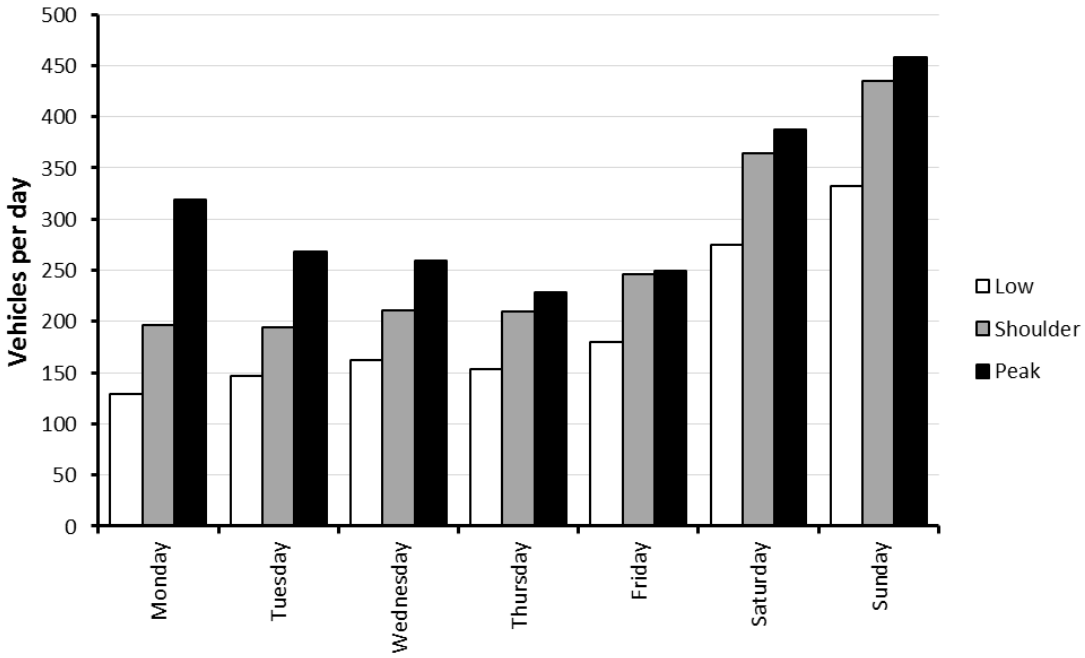

Figure 4: Average number of vehicles entering Oreti Beach via the Main Entrance on each day of the week during each of the visiting seasons.

Diurnal variation in traffic

Most vehicles arrived between 2 and 4 pm and there was a much wider spread in arrival times during the longer daylight during the peak (summer) season (Figure 5). Overall 90.3% of the vehicles entered during daylight and 9.7% at night, whereas 87% of vehicles leave during daylight and 13% at night. This discrepancy reflects the arrival of a large number of visitors in the early evening and twilight hours during the peak and shoulder months, which then leave during the legal hours of darkness (our definition of the transition from day to night). There is a small but steady trickle of visits throughout the night, but in reduced numbers between midnight and dawn. The diurnal pulse in the number of vehicles leaving the beach lags the fluctuation in numbers entering by approximately 2 hours (Figure 6), suggesting that each visit is for around two hours on average.

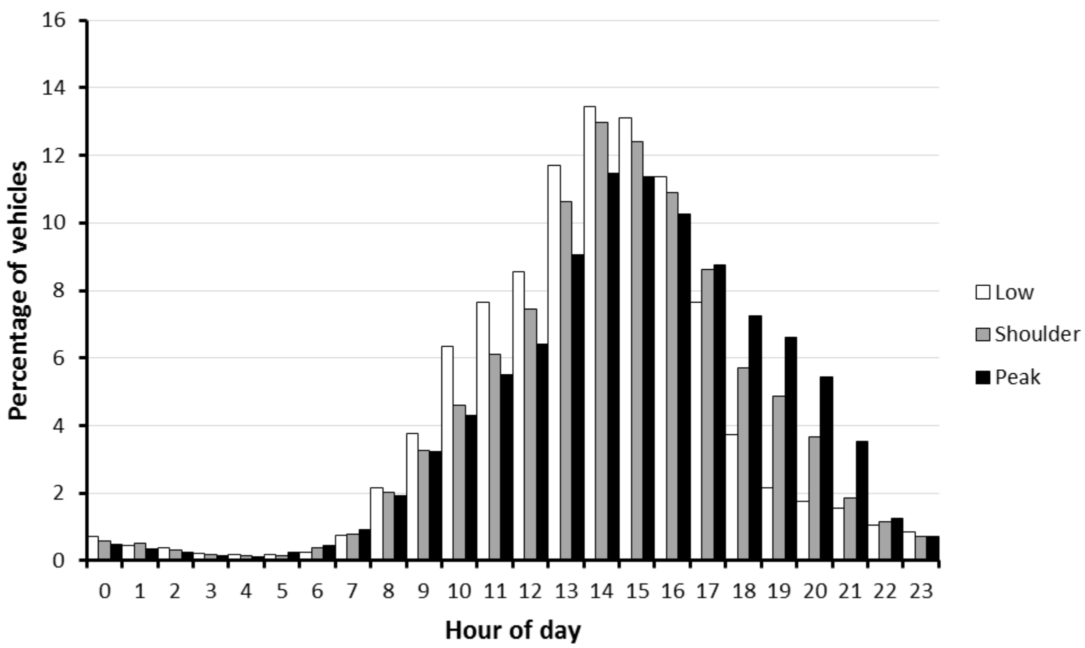

Figure 5: Percentage of vehicles entering Oreti Beach via the Main Entrance in each hour of the day for each visitor season.

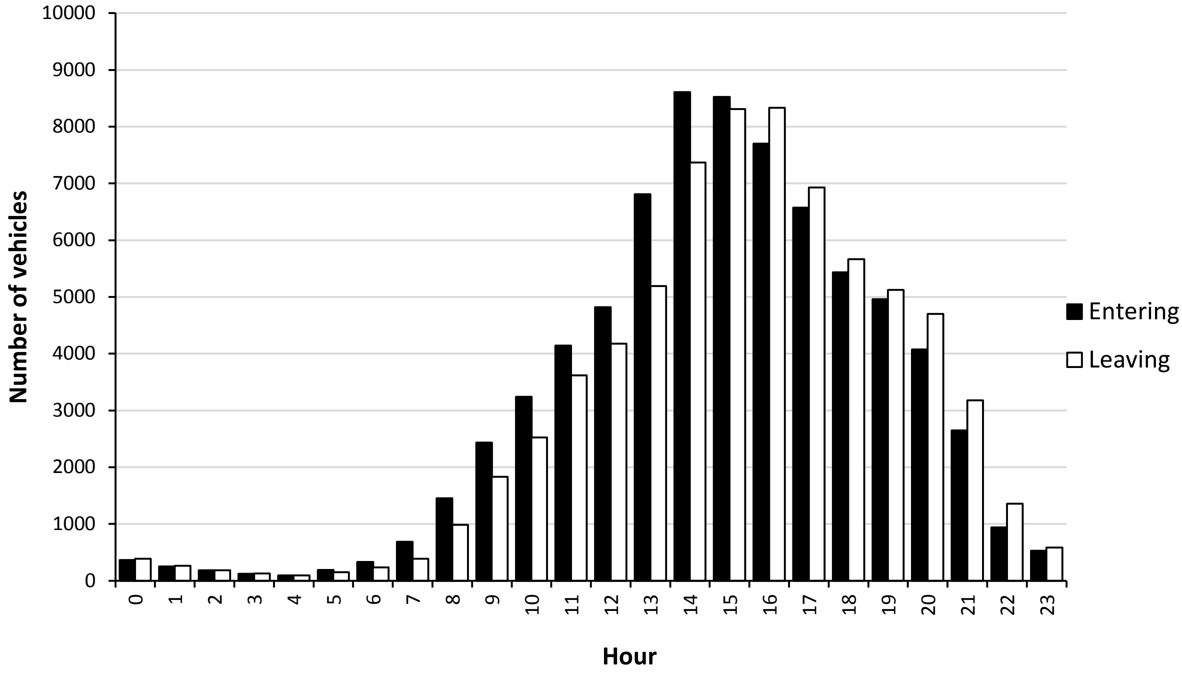

Figure 6: Number of vehicles entering and leaving Oreti Beach via the Main Entrance in each hour of the day during the peak visitor season.

Influence of tidal cycle on traffic

Slightly more vehicles visit the beach just before low tide and during the incoming tide than when the tide is falling (Figure 7), perhaps because the sand is firmer in the latter half of the tidal cycle and people wanting to travel along the beach are more secure when driving on the middle and lower intertidal zone than in the soft sand nearer the high tide mark. Also some of the recreational activities depend on a low tide time (e.g. harvesting toheroa adults that are distributed low on the beach, or blow carting over the firm and wide beach surface). However, the time of the tide had only very slight influence on visitor numbers during daylight, and was irrelevant at night, compared to the strong influence of season and time of day on visitor numbers (compare Figure 7 with Figures 3-6).

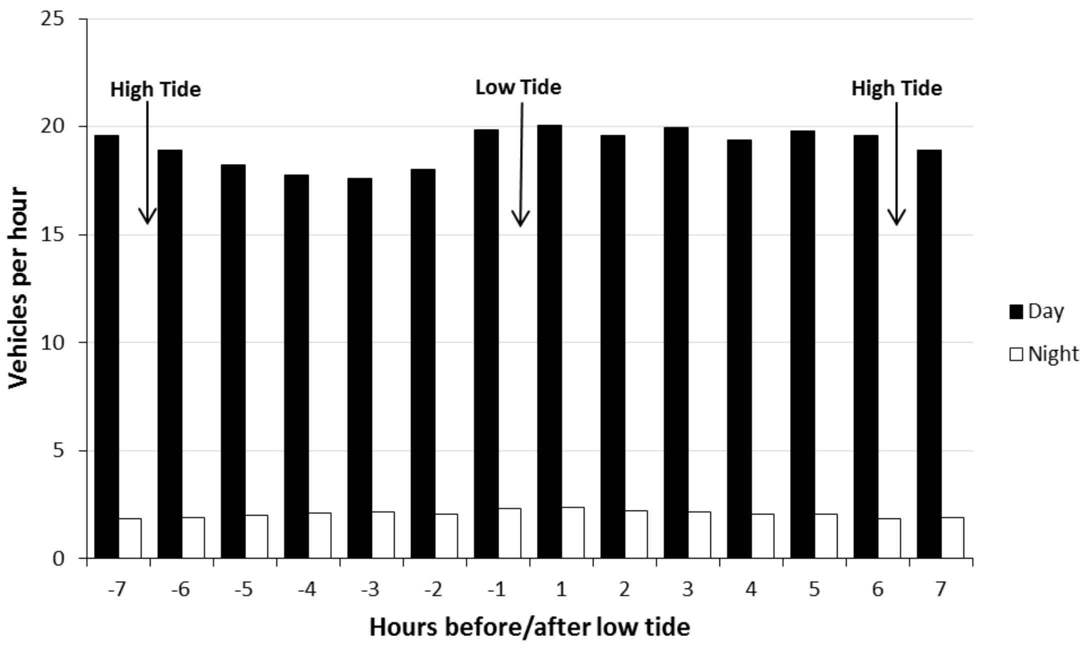

Figure 7: Number of vehicles entering Oreti Beach via the Main Entrance in each hour of the tidal cycle during all months of the study.

Influence of weather on traffic

Many more vehicles visit Oreti Beach during warmer weather (Figure 8). The number of visits climbs sharply when the temperature exceeds 15°C, and plateaus once temperature exceeds 25°C. Even moderately warm temperatures (15° – 20 ° C) are sufficient to trigger more visits to the beach in the winter months, whereas people are more selective of warmer days in the shoulder and peak periods (Figure 8). The average air temperature during the main period of beach visits (10 am till 5 pm) fluctuated seasonally (Figure 9) in close parallel with the overall average number of visits per day throughout the study (Figure 3). Temperature probably explains some of the inter-annual variations in visitor numbers – for example, unusually high number of visits in April 2012 correlates with warmer weather that month; and both visits and temperatures were higher in November 2010 than in 2011 (Figure 3 cf. Figure 9). However, temperature variation cannot explain some other inter-annual fluctuations which we suppose relate more to wind and rain influences – for example, there were many more visits in January 2011 than in 2012, yet average temperature was about equivalent between the years (Figure 9) and both rainfall (Figure 12) and wind (Figure 13) were even slightly lower in 2012.

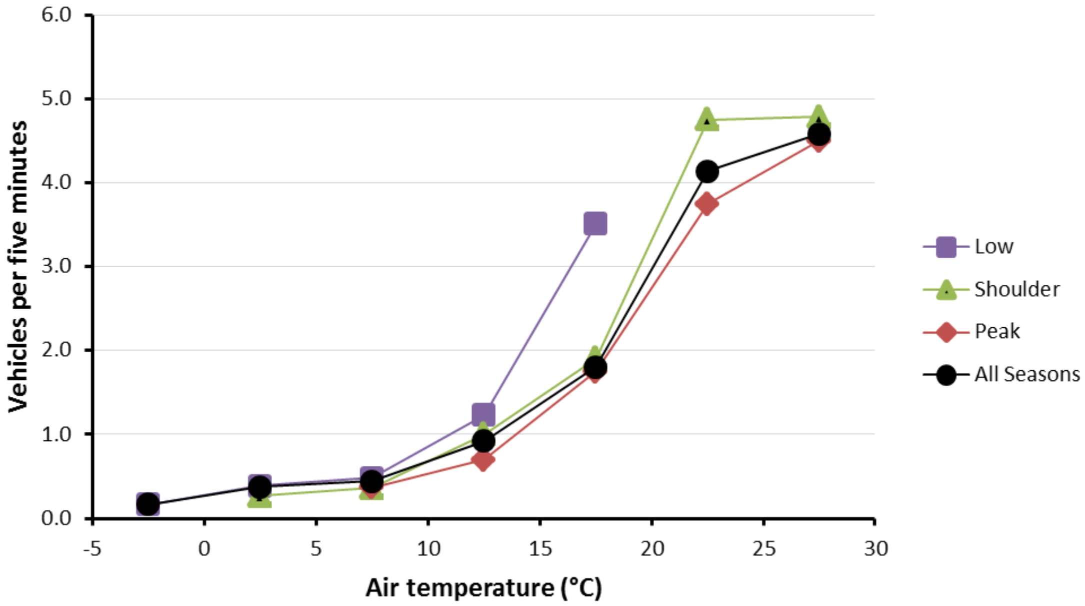

Figure 8: Effect of air temperature on the average number of vehicles entering Oreti Beach per five-minute interval via the Main Entrance between 10 am and 5 pm for each season.

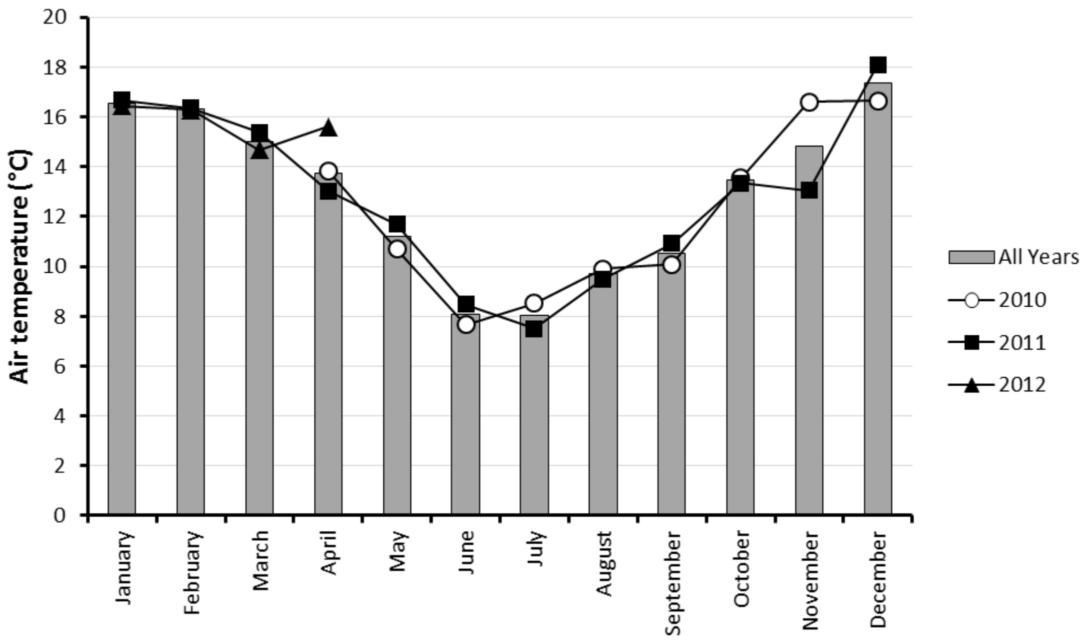

Figure 9: Average day time (10 am – 5 pm) air temperature in each of the months in this study.

Rainfall, wind speed, wind direction and wind chill (an interaction of temperature and wind speed) are additional factors that interact in a complex and confounding way with diurnal and seasonal variation in visitor numbers. For example:

- Although southerly and westerly winds together predominated overall during this study, northerly and easterly winds became more frequent in the shoulder and low visitor seasons, and westerly and southerly winds are more frequent in the peak visitor season (Figure 10).
- Average number of visits declines from westerly (highest), southerly, easterly, to northerly (lowest) wind conditions, presumably because of this seasonal shift in wind direction (Figure 11).
- Wind speeds were lower in winter months during our study (Figure 13).
- Wind speed increased considerably throughout the day time to be much higher in the main late morning and afternoon period of visits to the beach, but this effect was very much more damped for when a westerly wind was blowing (Figure 14). This suggests that a sea breeze effect operates except in westerly conditions.
- Increasing wind speed was associated with declines in visits when a southerly wind was blowing, but little coupling was seen for wind from other quarters (Figure 15).
- Higher wind speeds are associated with warmer air during northerly winds, and colder air during southerly winds.
- Rainfall (Figure 12) is associated with decreased visits in the shoulder season, but there is no correlation at other seasons.

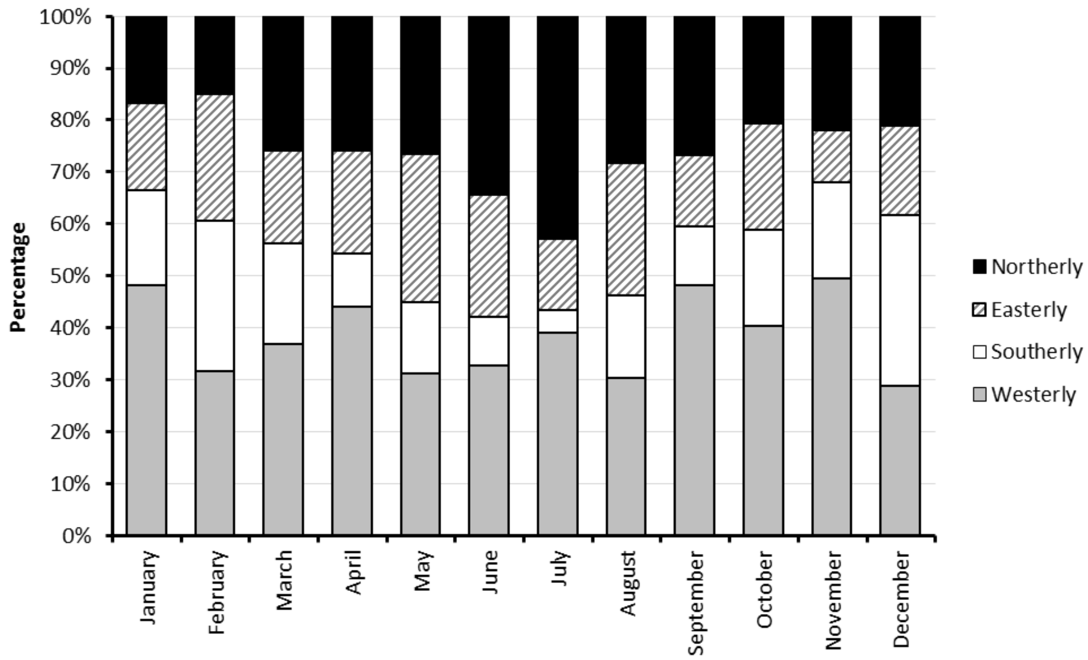

Figure 10: Frequency of different wind directions in each month of the study during day light hours only.

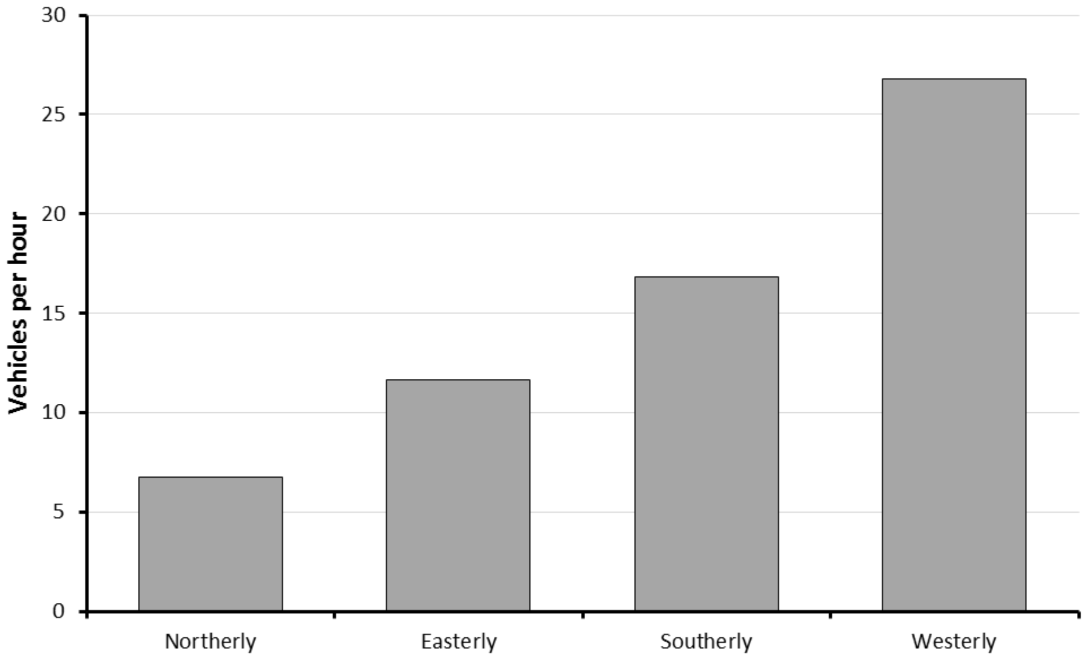

Figure 11: Average rate of vehicle visits during daylight in different wind directions.

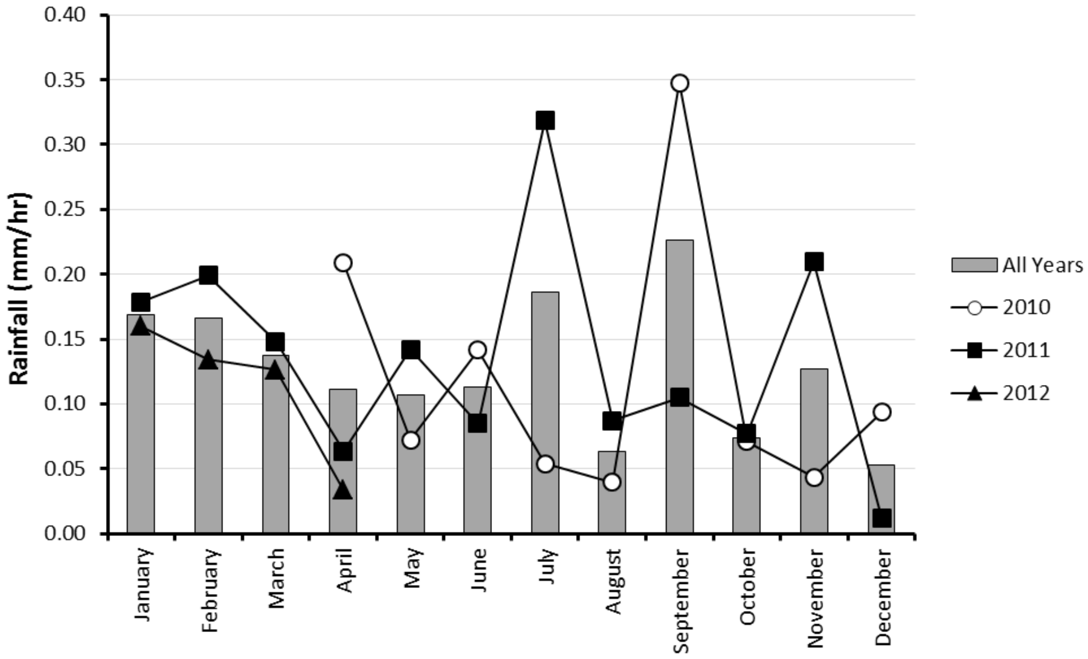

Figure 12: Average rainfall in each month of the study during day light hours only.

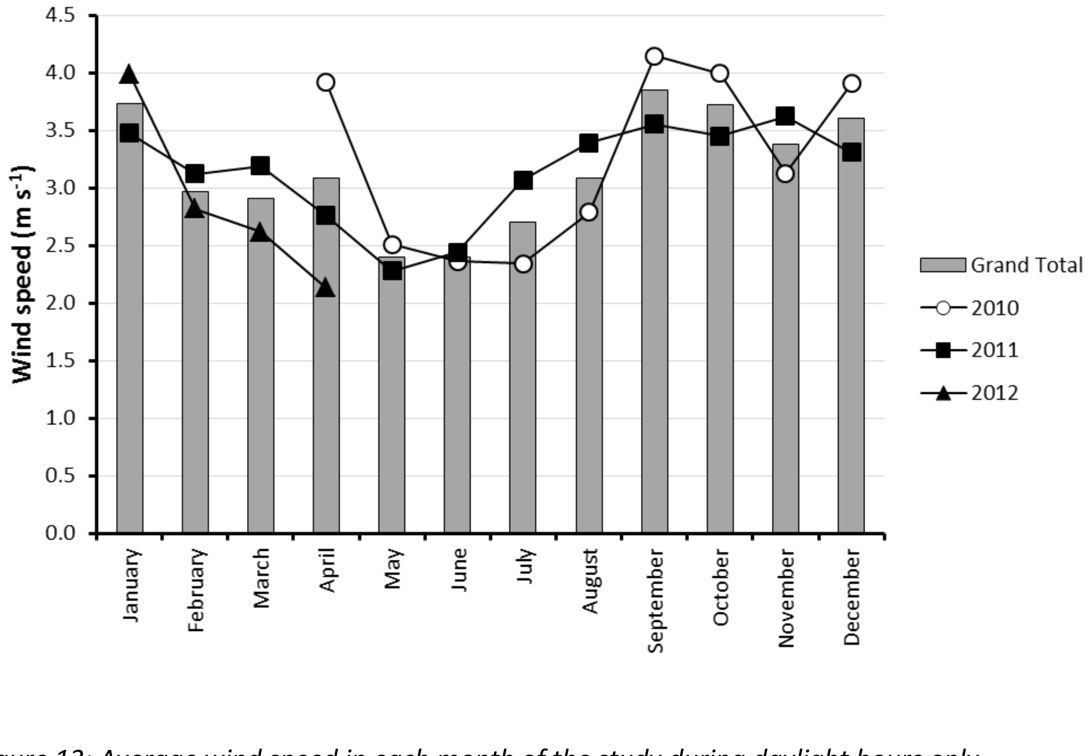

Figure 13: Average wind speed in each month of the study during daylight hours only.

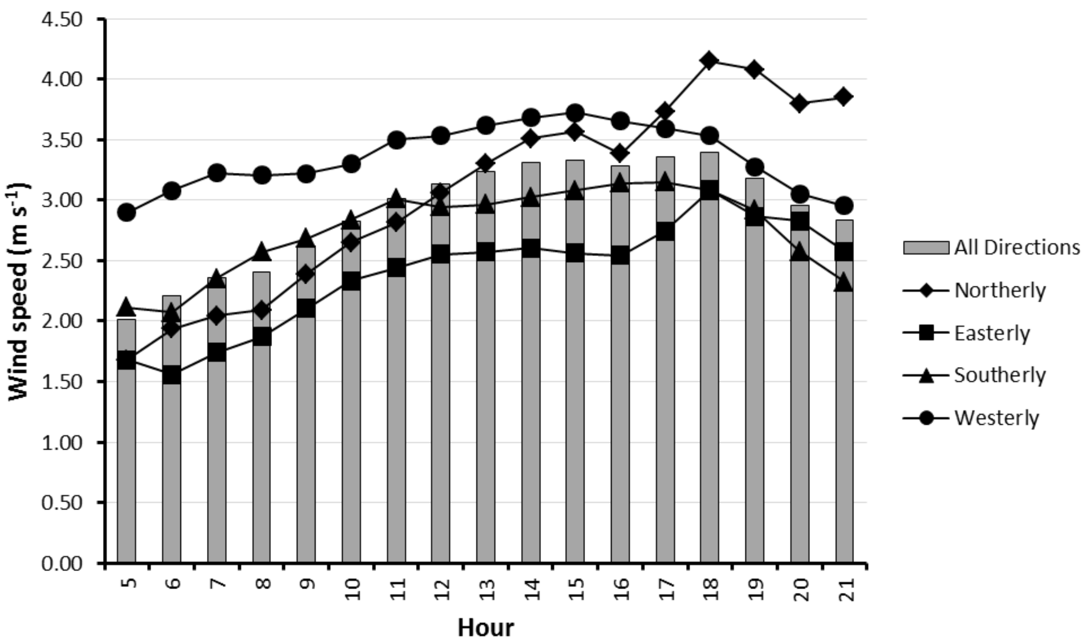

Figure 14: Average wind speed in each daylight hour during the peak season.

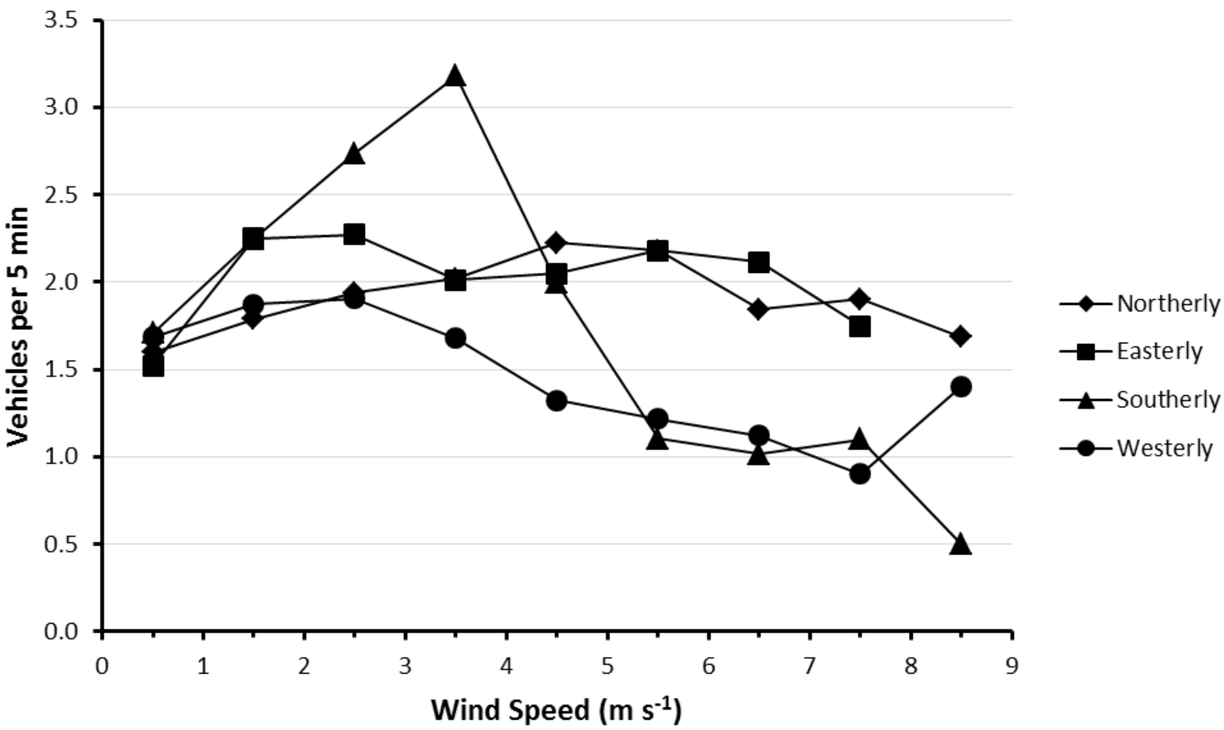

Figure 15: Average rate of vehicle visits between 10 am and 5 pm in different wind strength and directions during the shoulder season.

Use of different entrances to the beach

There are a number of locations along Oreti Beach where vehicles can enter or exit the study area, with Main Entrance being the only site consistently clear of sand and accessible to non-4WD vehicles. The North Entrance is also frequently passable. Additionally, 4WD vehicles and motorbikes can enter or exit the beach from further along the beach to the north or south, or in some places through the sand dunes.

Of 5,097 observations of vehicles and their tracks during this study, only 28 (0.5%) records observe vehicles entering or leaving using an entrance other than Main Entrance and North Entrance, with most of these leaving or entering across the Waimatuku Stream. Entry and exit via the Waimatuku Stream have been ignored as a minor source of error in all the subsequent analyses.

Interviewees reported where they entered and where they intended to leave (Figure 16). Occasionally vehicles enter via another entrance, and we even interviewed a single user south of Main Entrance who had entered via North Entrance. However the majority come and go from the same entrance and stay relatively close to where they came onto the beach[33]. Most beach users visit only one site on the beach, with only 17.5% of interviewed beach-users visiting two or more areas of the beach.

The North Entrance is a significant point of access to Oreti Beach. To estimate the flow of vehicles entering Oreti Beach via the North Entrance, hence missed by the traffic counter, we can look at the proportion of stationary vehicles parked within one kilometre of each entrance[34]. Altogether, of the cars parked within 1 km of the beach entrances, 96.3% occurred around Main Entrance, with 3.7% parked around North Entrance. A higher proportion of utes/4WDs appear to be using North Entrance, with 17% of utes/4WDs parked near the beach entrances occurring around North Entrance, and 83% around Main Entrance[35].

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[33] Selection of interviewees was non-random and fitted in near the end of circuits or extremes of the study area when higher priority duties had been done in time. Interviews tended to predominate near the North Entrance end of the study area where the Waimatuku River often forced vehicles to turn back. Therefore we cannot use the interviews as reliable estimates of the proportion of vehicles entering via North rather than Main Entrance.

[34] We make the assumption that vehicles entering at each entrance behave in a similar manner, i.e. most park close to the entrance with a small number travelling further afield. In reality, this may lead to an under-estimation of utes/4WDs using the North Entrance, as we have shown that utes/4WDs tend to regularly travel further along the beach, and North Entrance is often only accessible to utes/4WDs.

[35] Moller *et al.* (2014) use a different method to disentangle the Main and North Entrance flows. They looked at the proportion of turning circles in segments N3-N6 and the stated entrance of interviewees between N6 and N10 to estimate the proportion of each vehicle type entering at North Entrance. Four percent of cars and 20% of utes/4WDs were estimated to enter Oreti Beach via North Entrance.

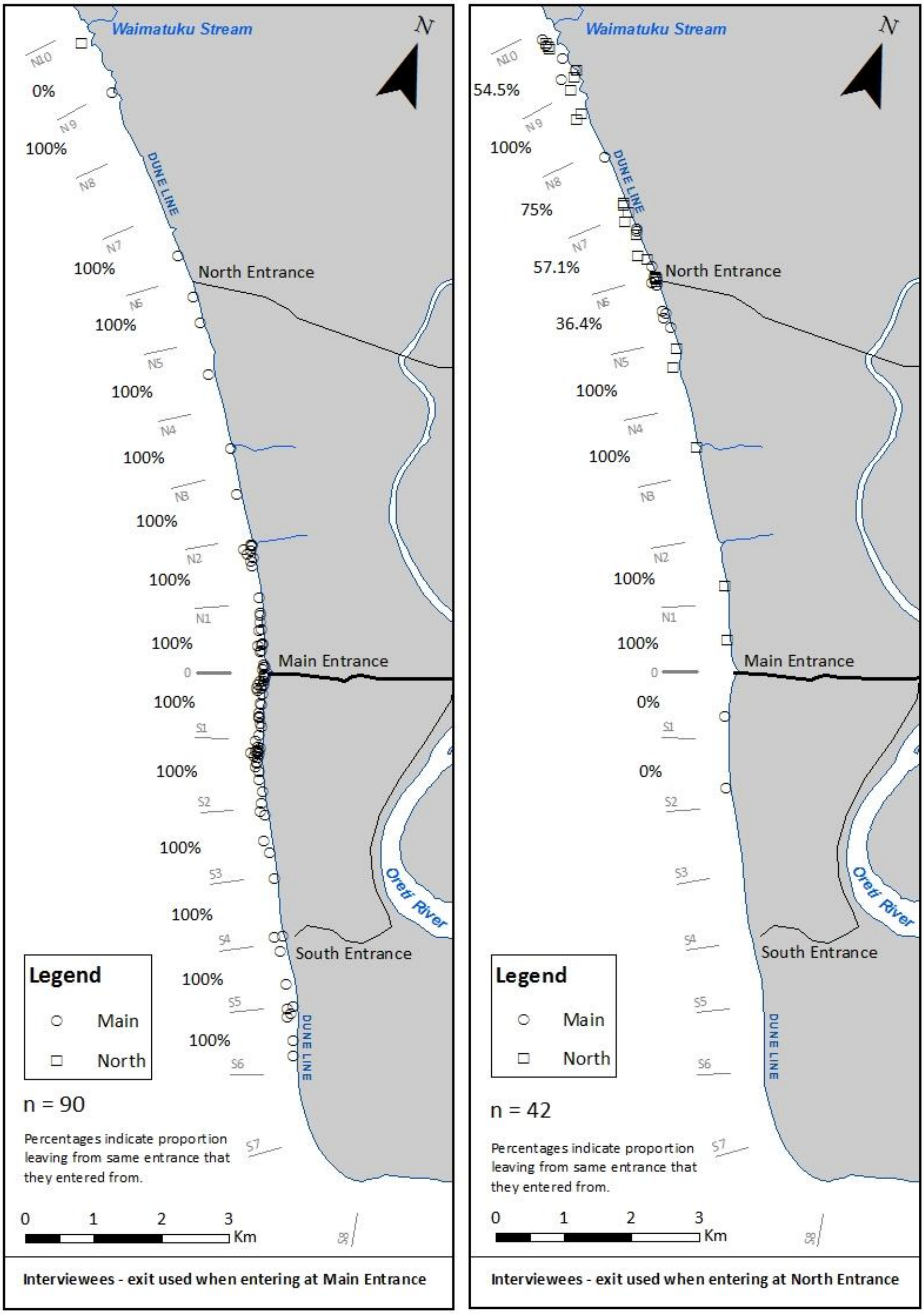


Figure 16: Map showing intended exit to be used by interviewees that had come onto the beach via Main Entrance (left) and North (right) Entrance.

Type of vehicles visiting Oreti Beach

A variety of different types of vehicle were observed using Oreti Beach, with cars (51.4%) and utes/4WDs (35.9%) accounting for most observations (Figure 17). Vans and minibuses constituted 5.7% of all interceptions, while motorcycles (2- and 4-wheeled) represented only 2.5% of vehicles. 6.3% of vehicles using Oreti Beach were towing a trailer.

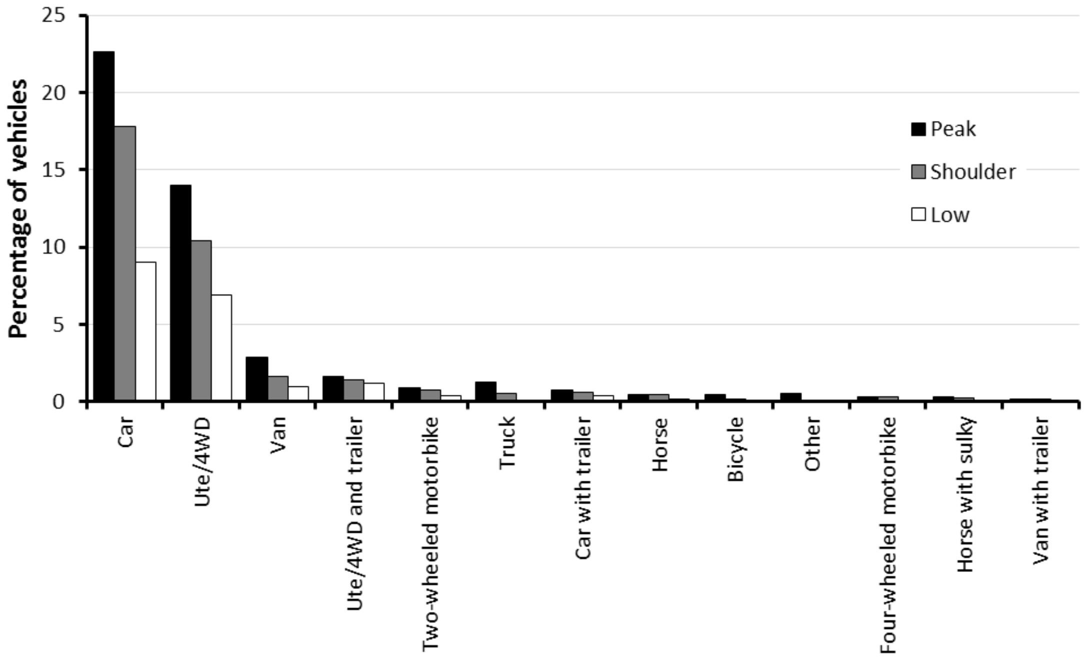


Figure 17: Percentage of each vehicle type observed using Oreti Beach. 'Other' vehicles types include buses, caravans, blow carts and mobility scooters.

Distribution of vehicles along Oreti Beach

During the course of the study, 3307 vehicles (stationary and moving) were observed on Oreti Beach. The majority (64%) of these vehicles were sighted within one kilometre north or south of Main Entrance. Seventy-seven precent occurred within two kilometres either side of Main Entrance (Figure 18). The distribution of vehicles was slightly skewed to the north, with only 4.7% of vehicles occurring beyond two kilometres south of Main Entrance compared to 18% in the area further than two kilometres north of Main Entrance. Small peaks in vehicle abundance are associated with North Entrance and Waimatuku Stream.

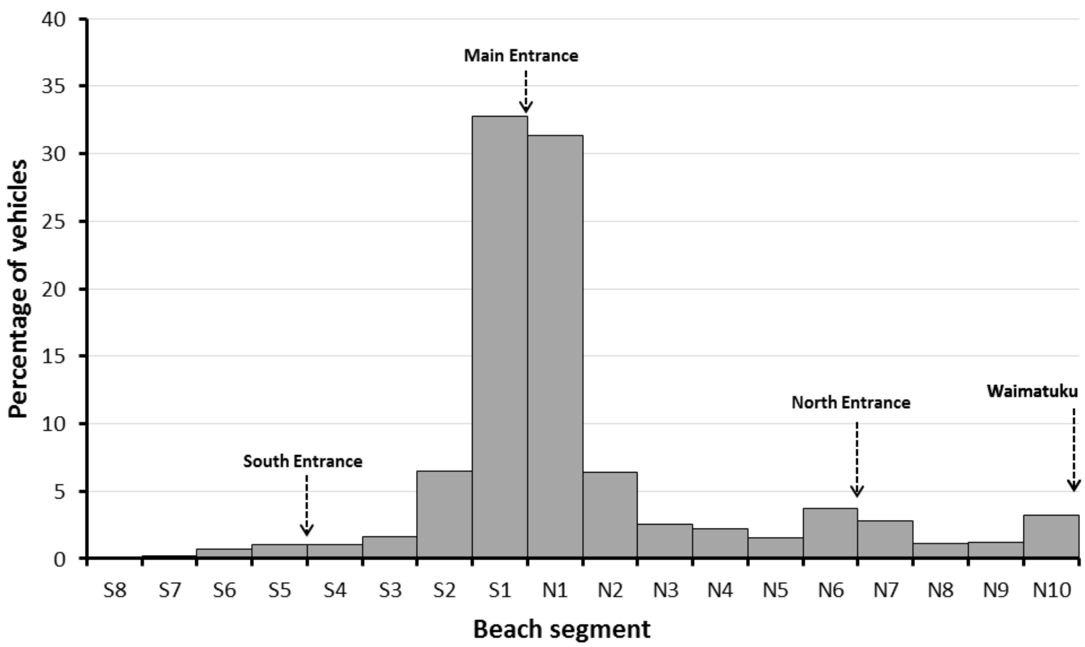


Figure 18: Distribution of all observed vehicles on Oreti Beach during the course of the study. 'Beach segment' refers to kilometre divisions south (S) and north (N) of Main Entrance.

The distribution of cars along Oreti Beach (Figures 19a and 20) closely mirrors the distribution for all vehicles (Figure 18), although cars are even more prevalent around Main Entrance with 78% and 88% within one and two kilometres of the entrance respectively. Although utes/4WDs are also concentrated around Main Entrance (47% within 1 km, 65% within 2 km), they were more commonly sighted further along the beach than cars (Figures 19b and 21). The sand is soft and often treacherous for non-4WD vehicles in many parts of the beach. This may largely restrict cars and other non-4WD vehicles to certain parts of the beach. The distribution of motorbikes (Figures 19c and 22) varies considerably from other vehicles, with observations being largely uniform throughout the beach north of Main Entrance. Very few motorbikes (7%) were observed south of Main Entrance. Motorbikes were predominantly used as a recreational activity, rather than simply as a means of transport to and along the beach, with 87% of motorbikes intercepted as moving vehicles compared to 31% of four-wheeled vehicles. Other types of vehicles (Figure 23) occurred in small frequencies along the length of the beach.

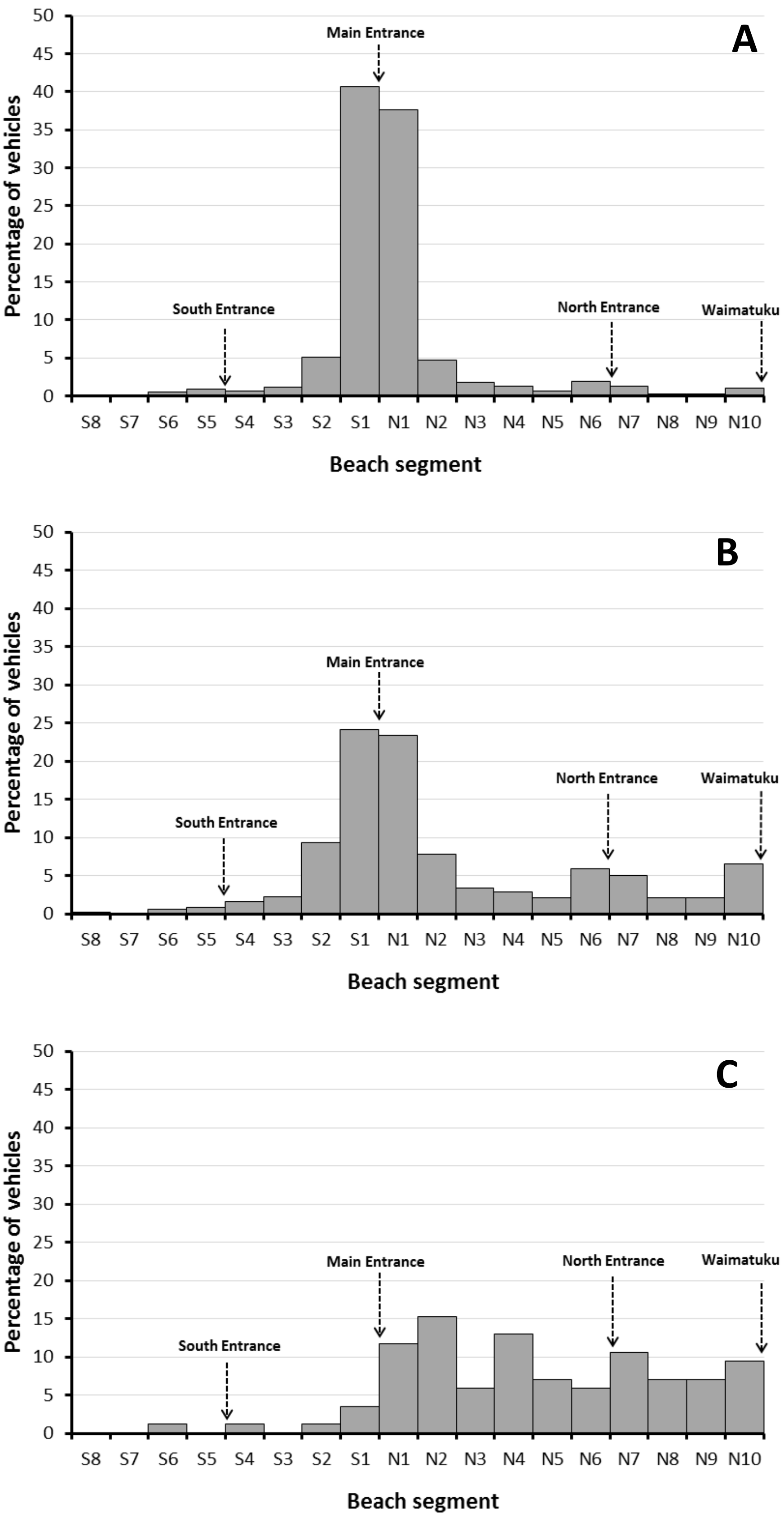


Figure 19: Distribution of all observed a) cars, b) utes/4WDs and c) motorbikes on Oreti Beach during the course of the study. 'Beach segment' refers to kilometre divisions south (S) and north (N) of Main Entrance.

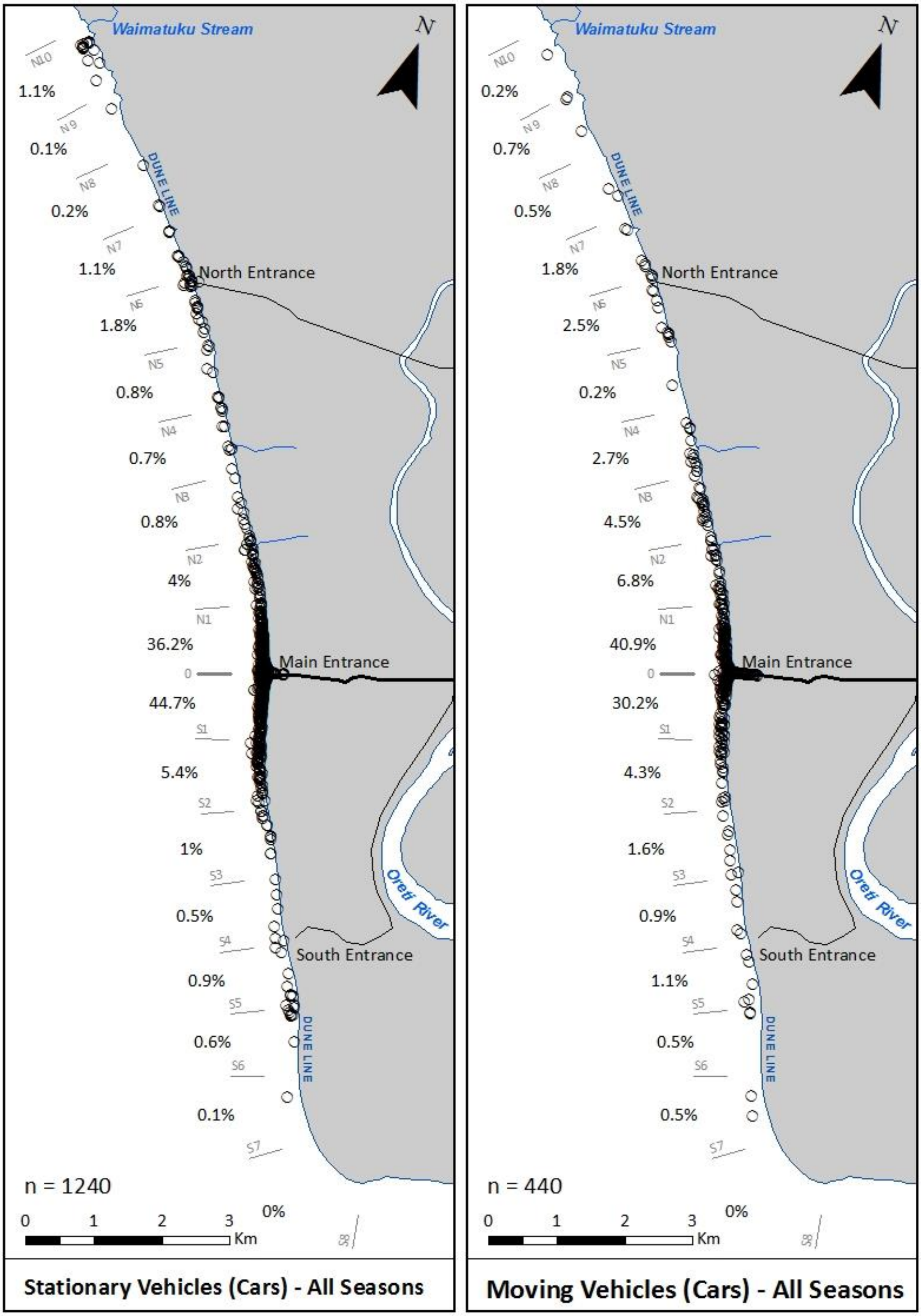
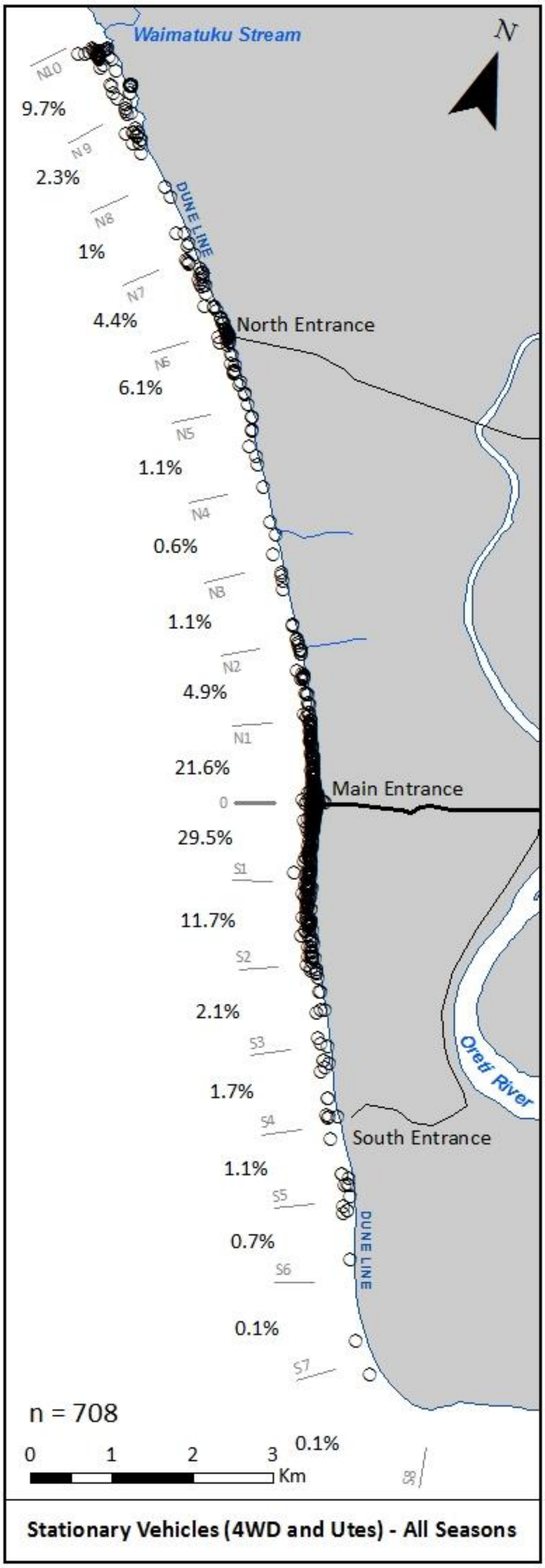


Figure 20: Distribution of all stationary (left) and moving (right) cars observed on Oreti Beach during the course of this study. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.



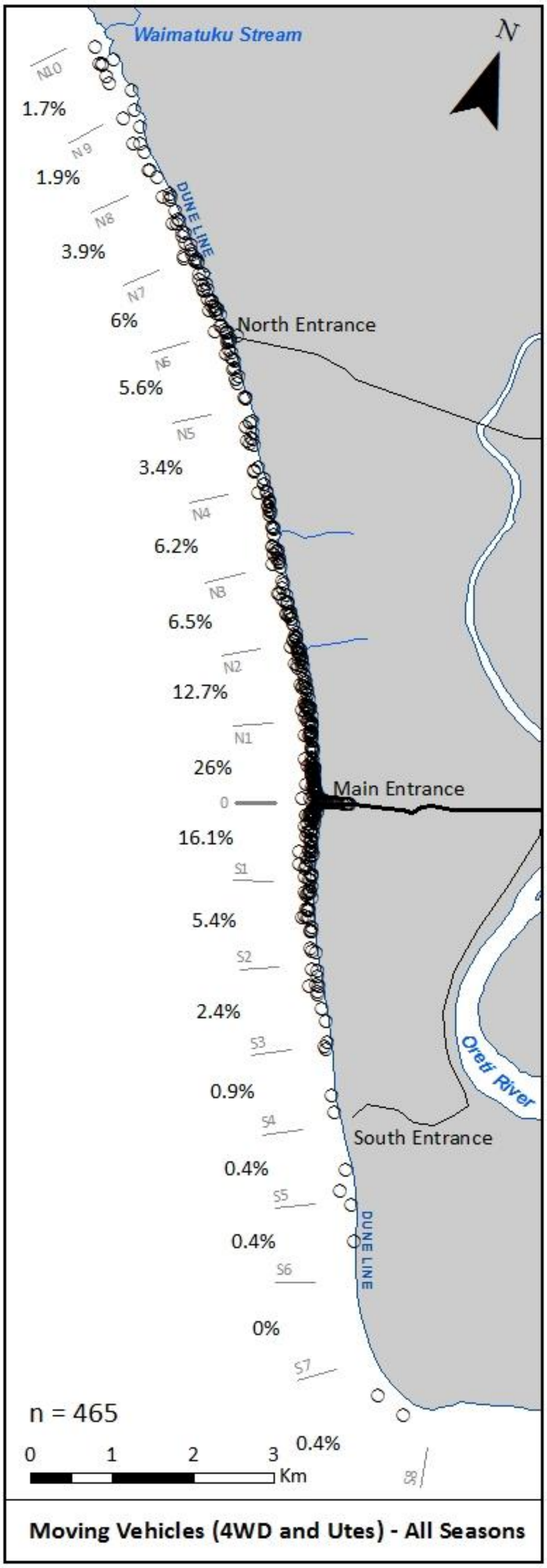


Figure 21: Distribution of all stationary (left) and moving (right) utes and 4WDs observed on Oreti Beach during the course of this study. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

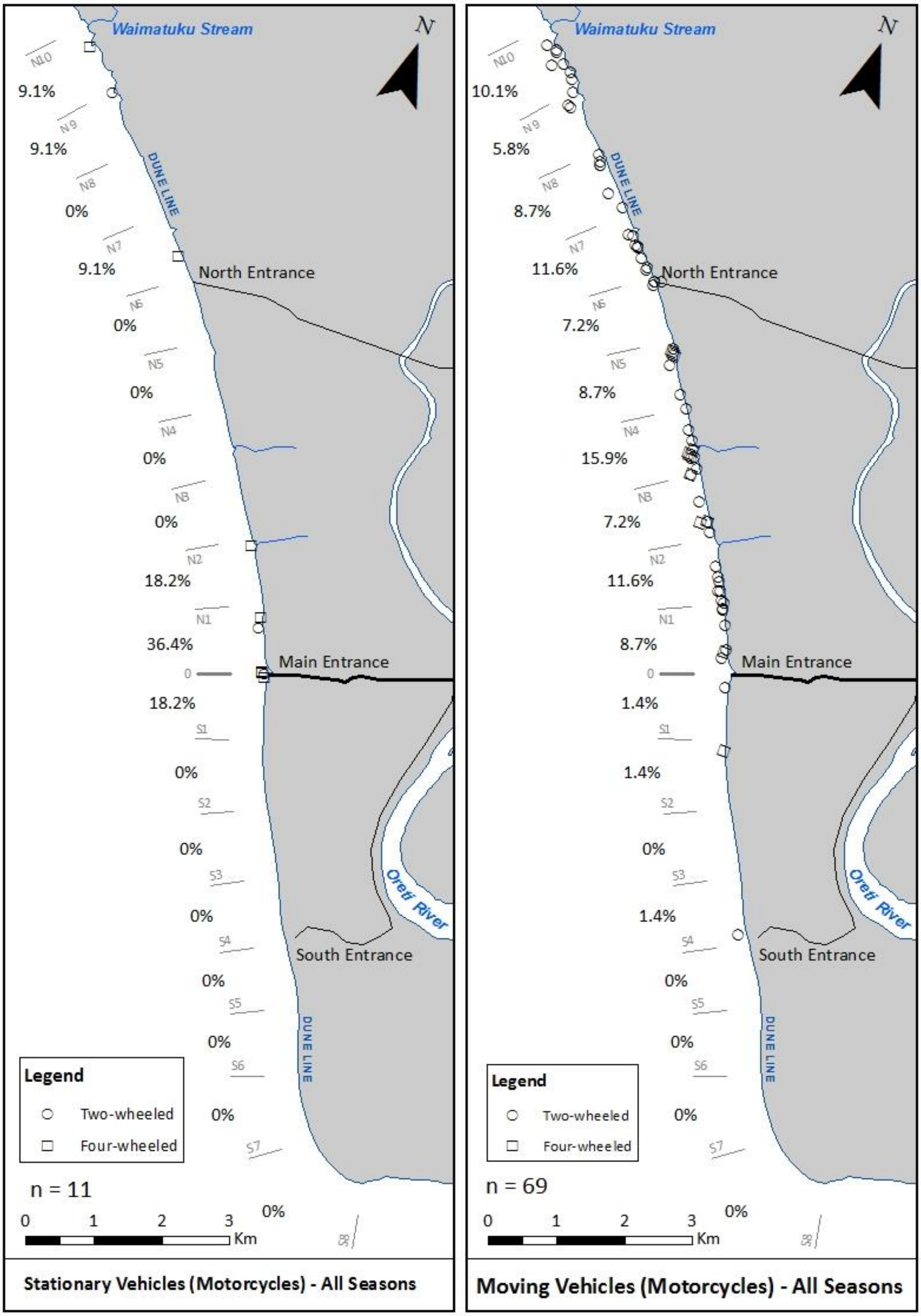


Figure 22: Distribution of all stationary (left) and moving (right) motorcycles observed on Oreti Beach during the course of this study. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

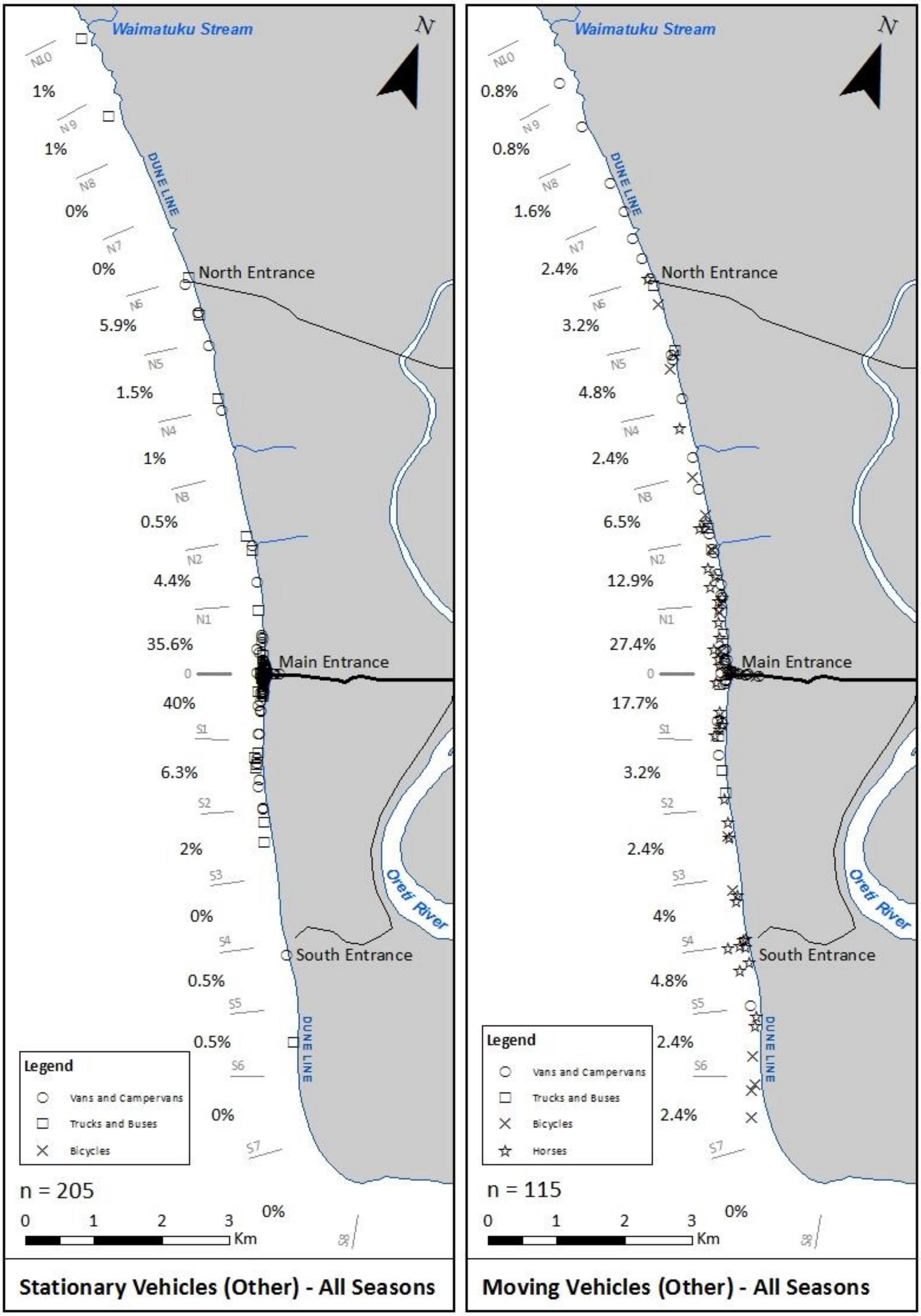


Figure 23: Distribution of all other stationary (left) and moving (right) vehicles observed on Oreti Beach during the course of this study. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

Distribution of vehicles down Oreti Beach

Vehicles were observed at distances ranging from zero to 341 metres down the beach from the dune line, with an average distance of 42.7 m (95% C.I. 40.6 – 44.9). Eighty six percent of vehicles occurred within 100 m of the dune line (Figure 24). Tide level was the main determinant of the distance of vehicles both down and along the beach.

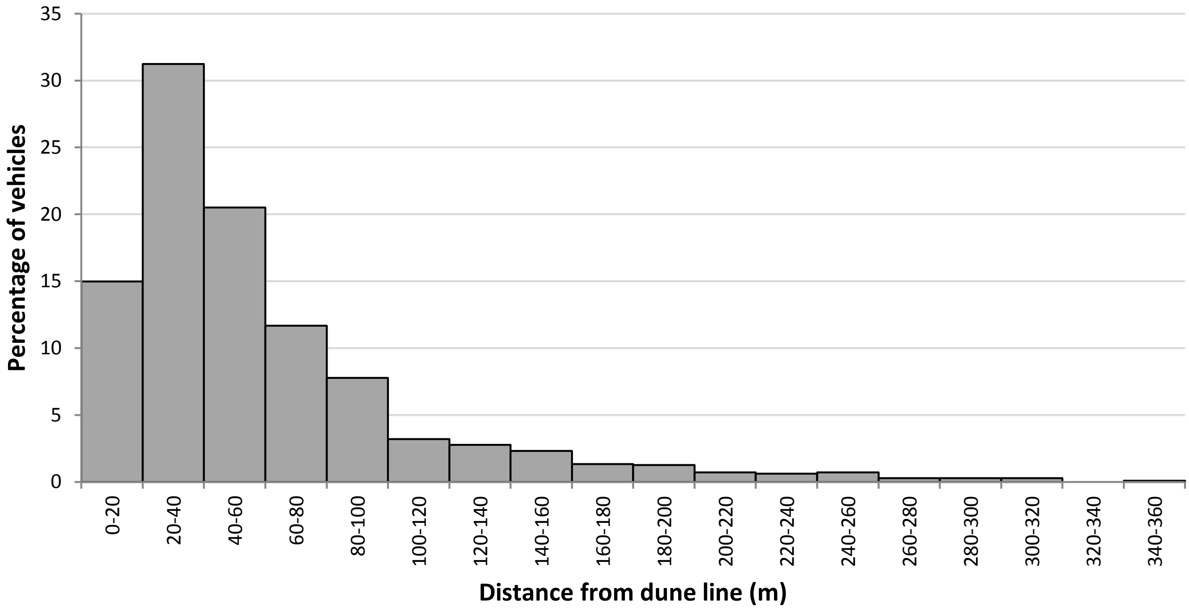


Figure 24: Distribution of vehicles down beach (seaward) from sand dunes.

Doughnuts

"Doughnuts" are circular skid-marks on the beach caused by sustained loss of traction. Often these consisted of several tight overlapping and complete turning circles, with the spray of sand demonstrating that the vehicle had spun at considerable speed. Some extremely tight half turning circles with a large spray of sand were included. This reckless "thrill riding" was occasionally seen during the day by both motorcycles and four-wheeled vehicles, but fresh marks on the sand in mornings suggest that it is common at night around Main Entrance. Accidents where vehicles have rolled over on Oreti Beach have been recorded and Police have expressed their concern about this type of hazardous driving on the Beach. Our recording of doughnuts was incidental, so the count is incomplete. Nevertheless we plotted 116 instances along the length of the beach, with concentrations around Main and North Entrance (Figure 25).

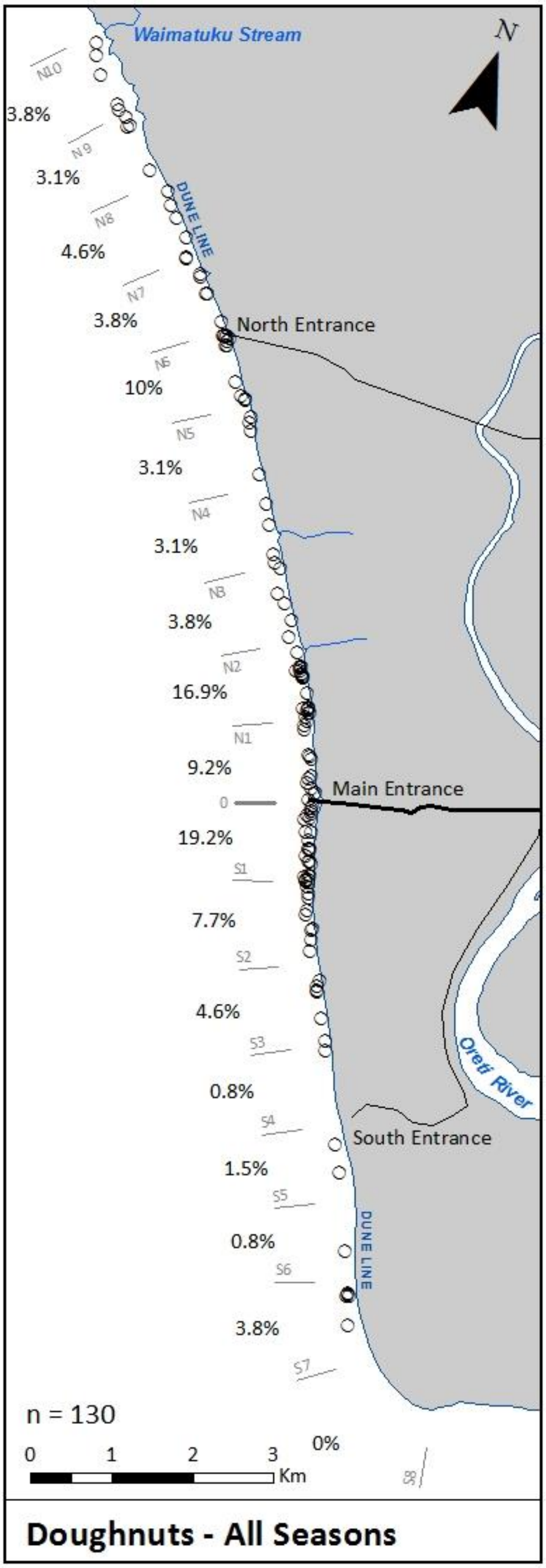


Figure 25: Distribution of 'doughnuts' along Oreti Beach. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

Users of Oreti Beach

Interviews were carried out on 144 parties using Oreti Beach. The average age of beach users was 37 years. Males represented 80% of beach users and females 20%. Most major activites, especially motorbiking fishing/gathering, were being done by males (Figure 26). Dog walking and 'sitting in car' were relatively equally participated in by males and females.

European/Pākehā represented 82% and Māori 14%. Pacifica, Asians, Indians and other ethnicities accounted for 4% of beach users.

Most visitors to Oreti Beach came from Invercargill (69%) with a further 20% from elsewhere in Southland (Figure 27). Eleven percent of those interviewed were visiting Oreti Beach from further afield, representing visitors to the region.

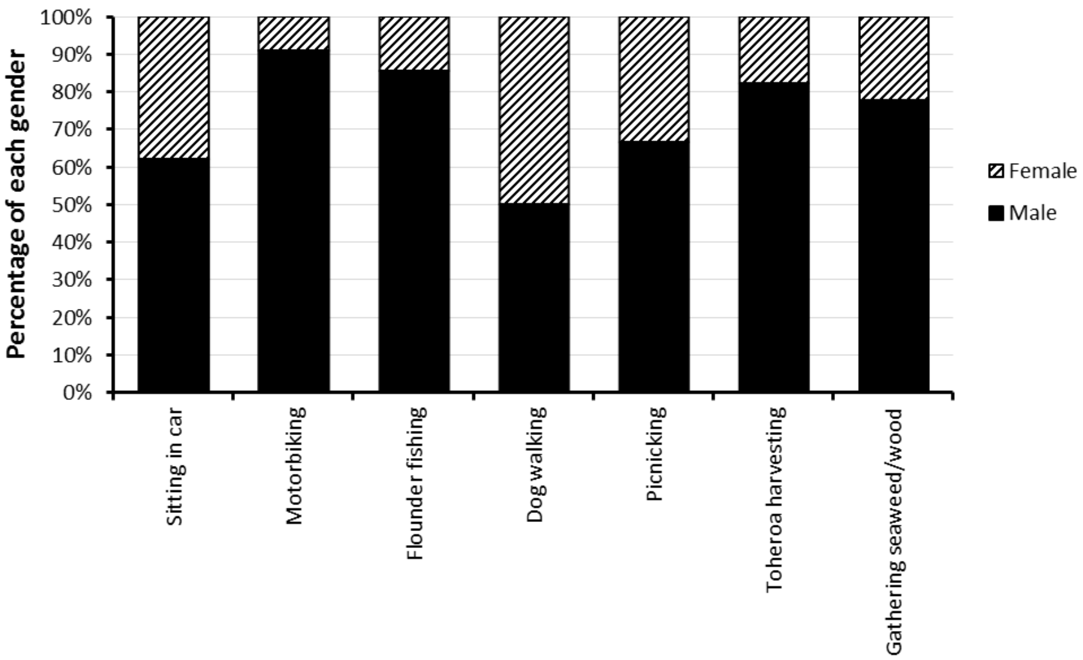


Figure 26: Percentage of male and female participants in major activites at Oreti Beach. Activites shown are those participated in by five or more interviewees.

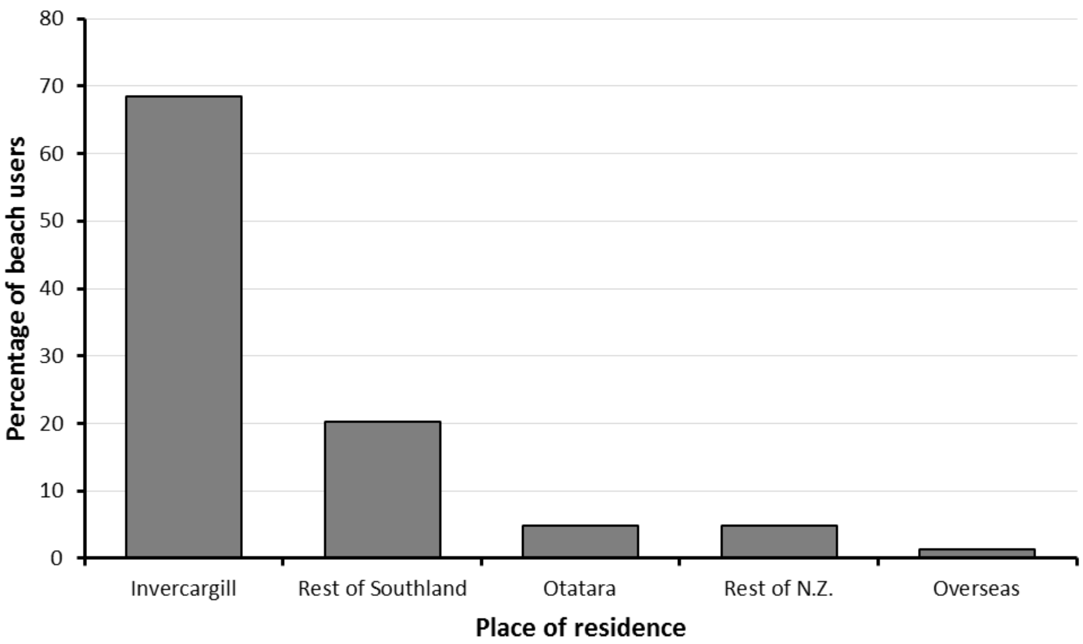


Figure 27: Place of residence of 144 interviewed users of Oreti Beach.

Recreational activity at Oreti Beach

Types of activity, 2011/2012

Users of Oreti Beach were observed undertaking 31 different activities throughout the study, although only 15 of these were observed on more than 10 occasions each (Figure 28, Appendix 4). 'Sitting in car' was the most common activity (25.8%).

Most activities displayed a drop-off in occurrence from peak to low season (Figure 29). Swimming, camping and cycling predominantly occurred in the warmer peak season, whereas gathering of seaweed/wood was more common in winter (low season). Whitebaiting was carried out entirely in the low and shoulder seasons, corresponding to the legal open time for the fishery. Motorbiking, although more common in warmer seasons, occurred relatively evenly throughout the year.

With the exception of racing, dangerous driving and occasional dumping of large quantities of rubbish, there was little sign of public nuisance on Oreti Beach; rather people were obviously much enjoying the beach, often with friends and family.

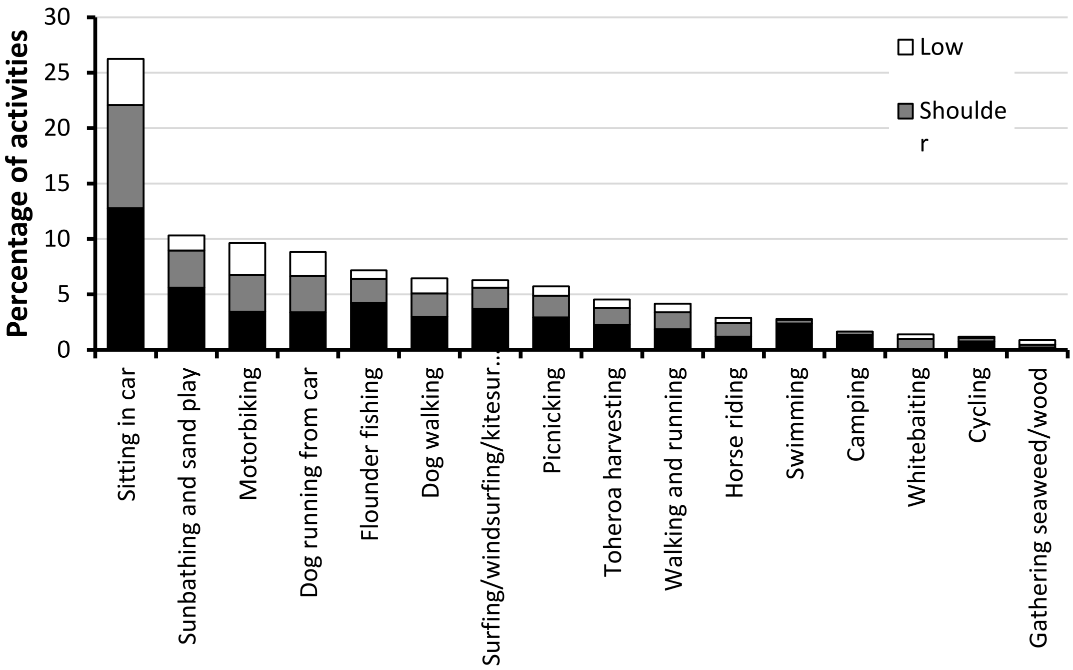


Figure 28: Proportion of each main activity observed at Oreti Beach during the course of the study.

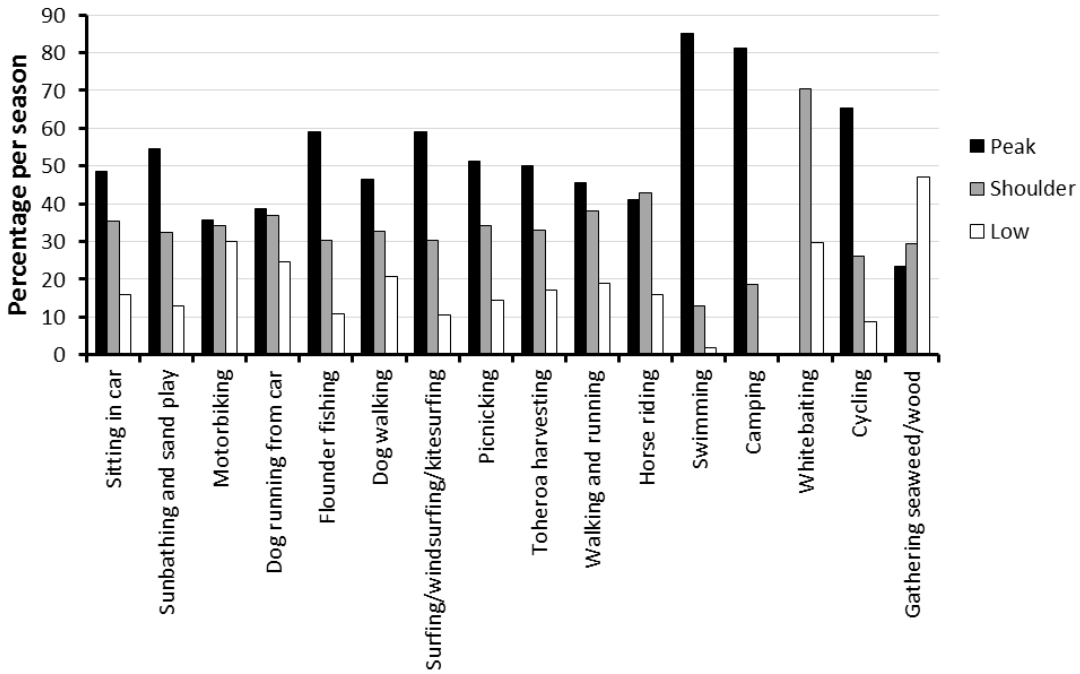


Figure 29: Proportion of each main activity by season.

Distribution of activity along Oreti Beach

Activity along Oreti Beach is predominantly centred around Main Entrance (Figure 30), with 58% of all activities occurring within one kilometre either side of the entrance and 73% occurring within two kilometres. The frequency of activities tapers off with increasing distance from Main Entrance, with the exception of slight peaks in activity around the North Entrance and the Waimatuku Stream. Slightly more activities occur north (54%) of Main Entrance than south (46%).

Most of the activities occurred relatively evenly both north and south of Main Entrance (Figure 31). These included sitting in car (Figure33), sun-bathing and sand play (Figure 33), picnicking (Figure 34), toheroa harvesting (Figure 36), walking and running (Figure 39), swimming (Figure 35), horse riding (Figure 38), camping (Figure 34), gathering seaweed and wood (Figure 34), cycling and dog-walking. Four activities occurred predominantly north of Main Entrance, namely motorbiking (Figure 37), dog running from car (Figure 39), windsurfing/surfing/kitesurfing (Figure 35) and whitebaiting (Figure 34). Flounder fishing was the only activity to predominantly occur south of Main Entrance (Figure 36). Rod/line fishing, although only recorded on six occasions, occurs predominantly around Main Entrance (Figure 40). Table 3 summarises the distribution of the main observed activities.

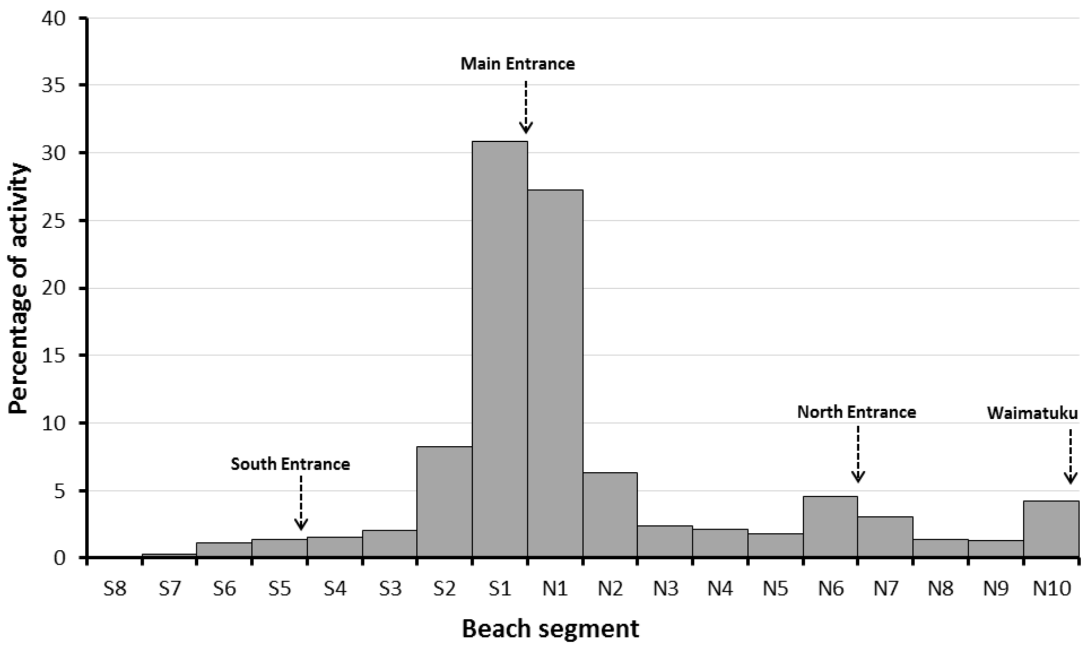


Figure 30: Distribution of all activity along Oreti Beach. 'Beach segment' refers to kilometre divisions south (S) and north (N) of Main Entrance.

Some activities occurred close to the Main Entrance, whereas others occurred at greater distances along the beach (Figure 32). Sitting in car, sunbathing and sand play, windsurfing/surfing/kitesurfing, picnicking, walking and running, swimming and camping all occurred close (<1.5 km) to the Main Entrance on average. Motorbiking, dog running from car, flounder fishing, toheroa harvesting, cycling and gathering seaweed and wood occurred at moderate distances (1.5 - 6 km) from Main Entrance on average. Whitebaiting occurred at an average distance of 9.7 km north of Main Entrance (at Waimatuku Stream).

None of the main activities displayed any significant variation in distribution along the beach between seasons.

Flounder fishing at Oreti Beach

The above more general overview of all activities at Oreti Beach is now complemented in the next two sections by a more detailed exploration of flounder fishing and toheroa gathering, the two main customary harvests within the upcoming mātaitai. When time allowed (45% of flounder fishing trips), we interviewed flounder fishers and toheroa gatherers (Appendix 2 and 3 – the interview forms) and measured their catch.

Flounder fishing is a common pastime of Oreti Beach users, observed 139 times throughout the course of the study. On 63 of these occasions, the fishers were approached and questioned about their fishing trip.

Most (62%) flounder fishing trips were carried out by two people, although up to eight were recorded fishing at times. The time spent fishing varied between 10 and 140 minutes with a mean of 47 minutes. The number of drags completed per trip varied between 1 and 6, with a mean of 2.3. The average length of each drag was 17 minutes. In most cases, however, the flounder fishing was not complete at the time of the interview, so the time spent fishing and the number of drags for the complete fishing expedition is likely to be greater than these figures. However the rate of capture, part duration of the expedition, and number of drags per hour can all be used as relative indices of fishing effort and success in future comparisons[36].

[36] We recommend that the forms used for this survey are modified to include a score of whether the fishing had been completed at the time of interview. This will allow data from future surveys to be analysed more precisely for completed expeditions only.

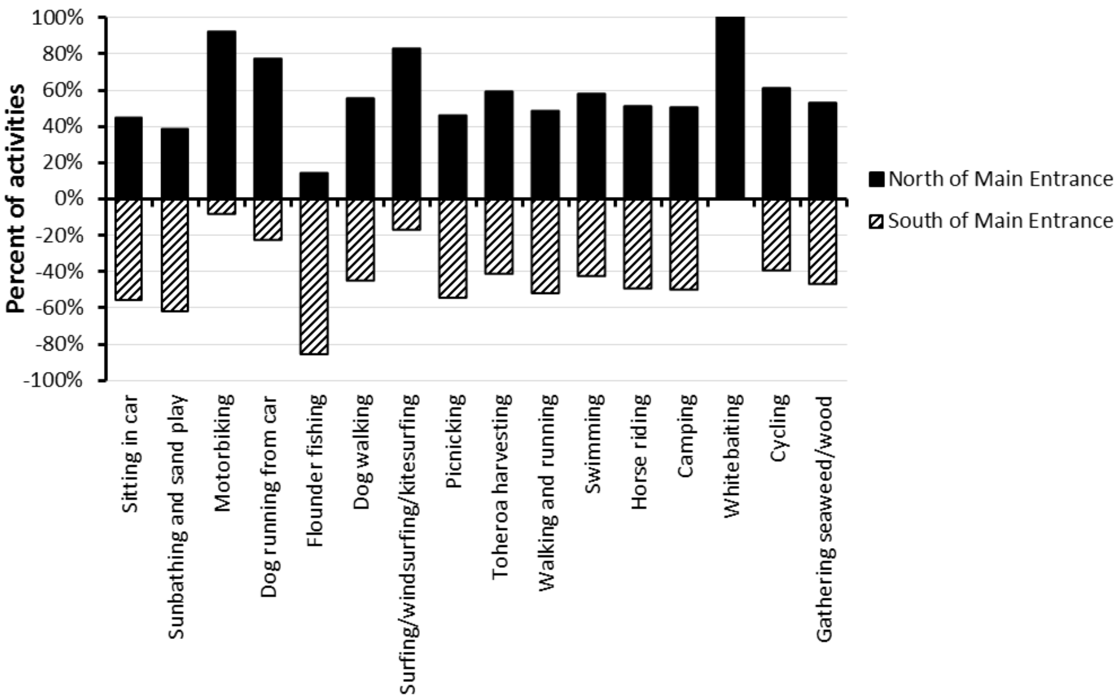


Figure 31: Proportion of each main activity occurring north and south of Main Entrance. Negative percentages below the x axis indicate proportion of each activity conducted south from Main Entrance.

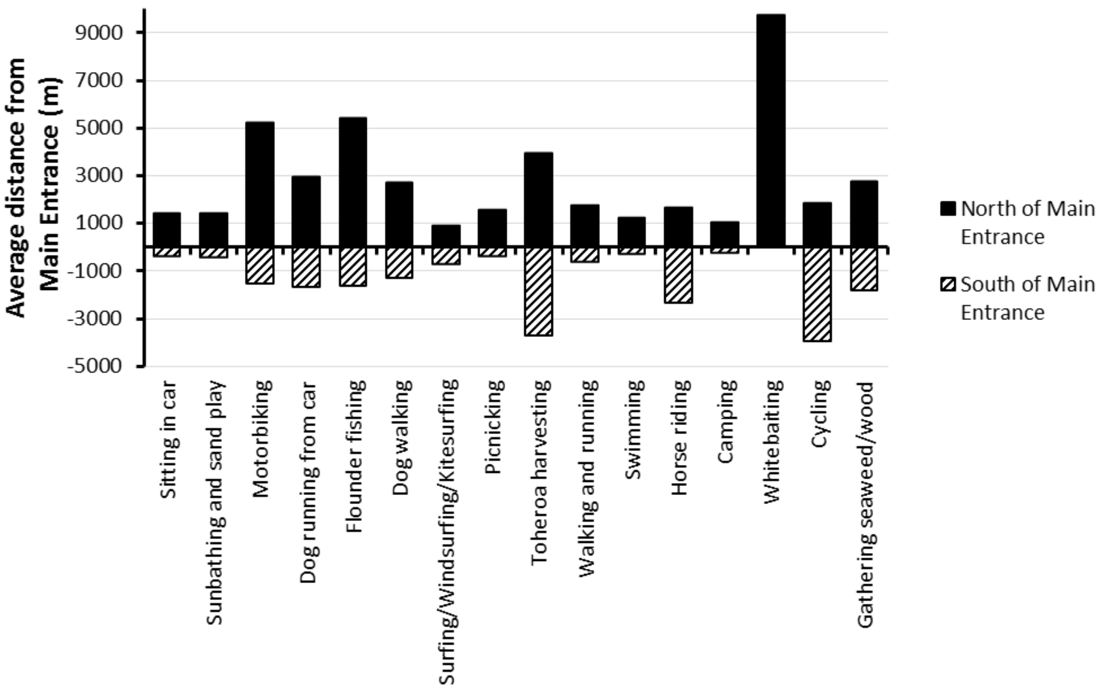


Figure 32: Average distance north and south of Main Entrance for each main activity. Negative distances below the x axis indicate distance travelled south from Main Entrance.

Table 3: Summary of distribution patterns for main activities.

Activity	Main areas	Secondary areas	Main reasons for choosing site (from interviews)	Comments
Sitting in car	Near Main Entrance (north and south)	Near North Entrance Waimatuku Stream	- Fewer people here - Habit - Close to entrance - Sand soft beyond here - Gap in parked cars - Randomly chosen	
Sunbathing and sand play	Near Main Entrance (north and south)	Near North Entrance	- Fewer people here	
Motorbiking	Scattered along beach mostly north of Main Entrance		- Fewer people here - Good sand	
Dog running from car	North of Main Entrance	Near North Entrance	- Fewer people here	- Scattered occurrences along the length of the beach except the far ends. - Distribution along beach is probably indicated by distribution of four-wheeled turning circles.
Flounder fishing	South of Main Entrance (mostly 1-2 km from entrance)	North Entrance	- Best place for flounder - Always go here - Word of mouth	
Dog walking	North and south of Main Entrance	Near North Entrance	- Fewer people here - Fewer dogs here	
Surfing/Windsurfing /Kitesurfing	Near Main Entrance (north and south)	Near North Entrance	- Wind is good here	
Picnicking	Near Main Entrance (north and south)		- Fewer people here - Better sand	

Toheroa harvesting	Scattered along beach with concentrations around Main, North and South Entrances		- Best place for toheroa - Always go here - Word of mouth - Saw toheroa holes in sand	- This is in contradiction to results of interviews by Futter and Moller (2009) that frequently refer to the southern end of the beach as the main/best site and where most have traditionally harvested. - Southern and northern extremes of study area not used for toheroa harvesting.
Walking and running	Near Main Entrance (north and south	Near North Entrance	- Fewer people here - Randomly chosen	- Scattered occurrences along the length of the beach.
Swimming	Near Main Entrance (north and south)	Near South Entrance	- Less seaweed here	-Mapped swimming positions were probably underestimated on crowded days when it became difficult to match people/activities to particular vehicles.
Horse riding	Scattered along beach with concentrations around Main, North and South Entrances		NO PEOPLE INTERVIEWED	
Camping	Near Main Entrance (north and south)		NO PEOPLE INTERVIEWED	
Whitebaiting	Waimatuku Stream		- Stream is good for whitebaiting	- The Waimatuku Stream is the only location in the study area where whitebaiting was observed.
Cycling	Near Main Entrance (predominantly north)	South of South Entrance	NO PEOPLE INTERVIEWED	
Gathering seaweed/wood	Near Main Entrance (north and south)		- More seaweed/wood here	

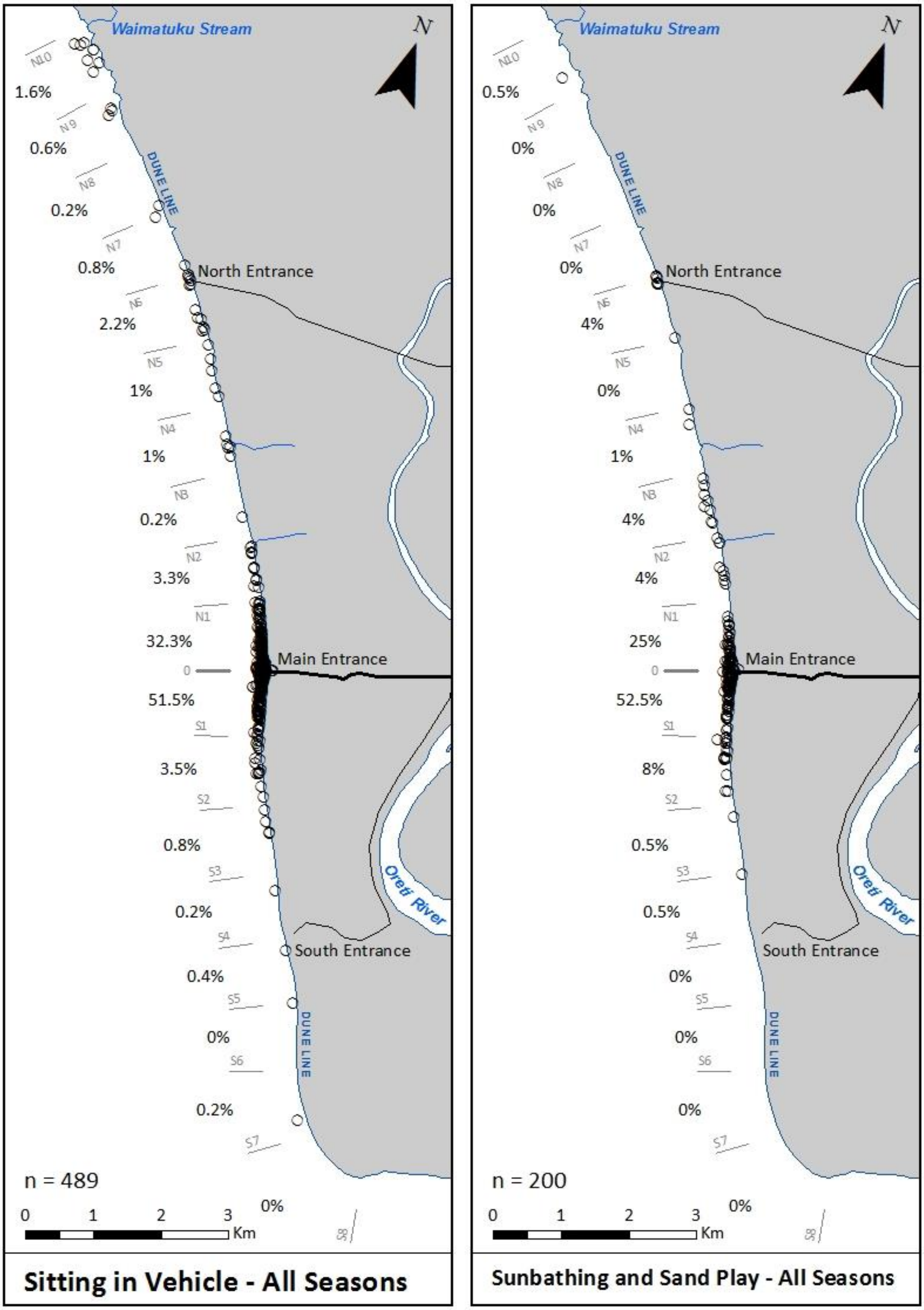


Figure 33: Distribution of 'sitting in vehicle' (left) and 'sunbathing and sand play' (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

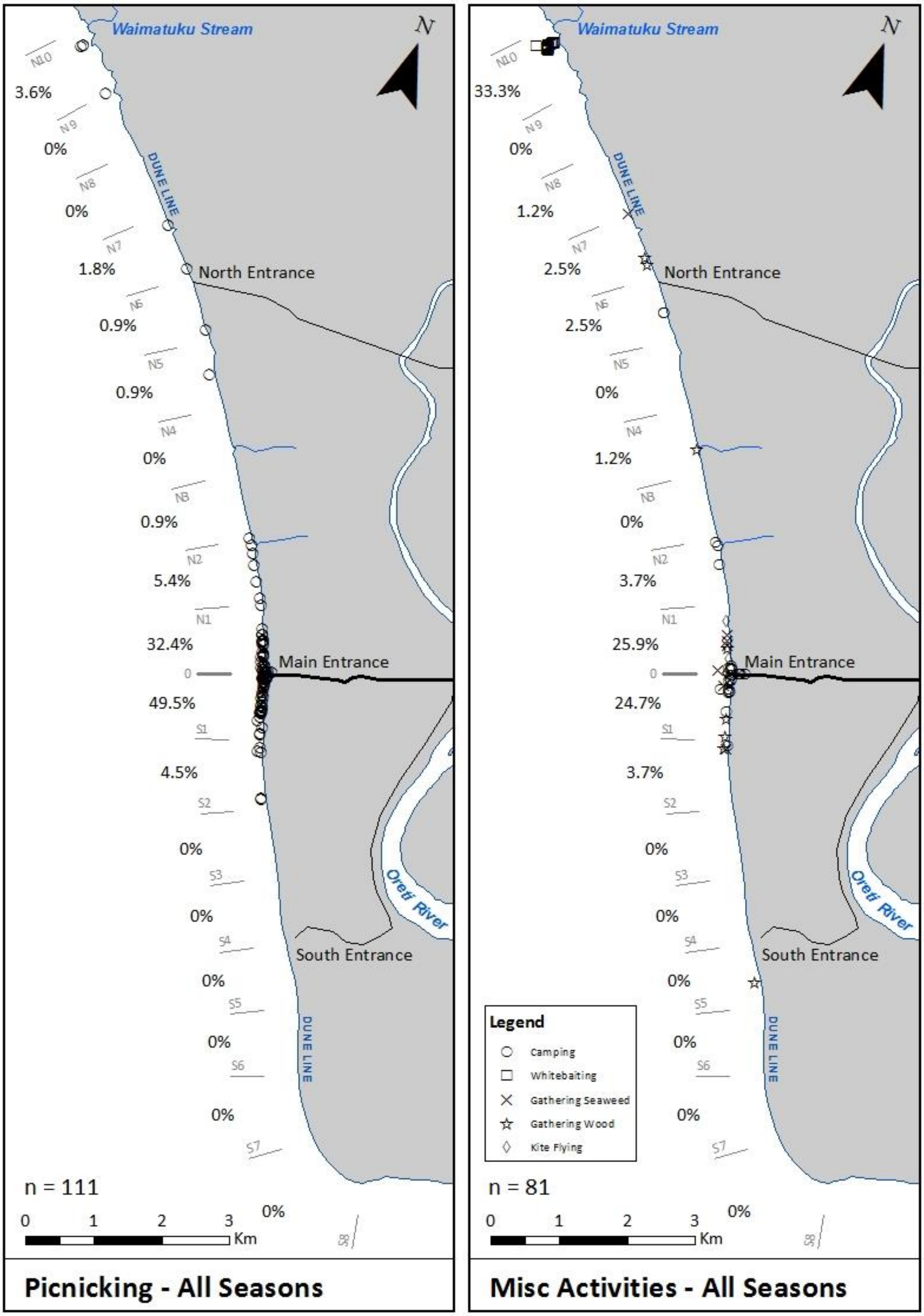


Figure 34: Distribution of 'picknicking' (left) and 'miscellaneous activities' (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

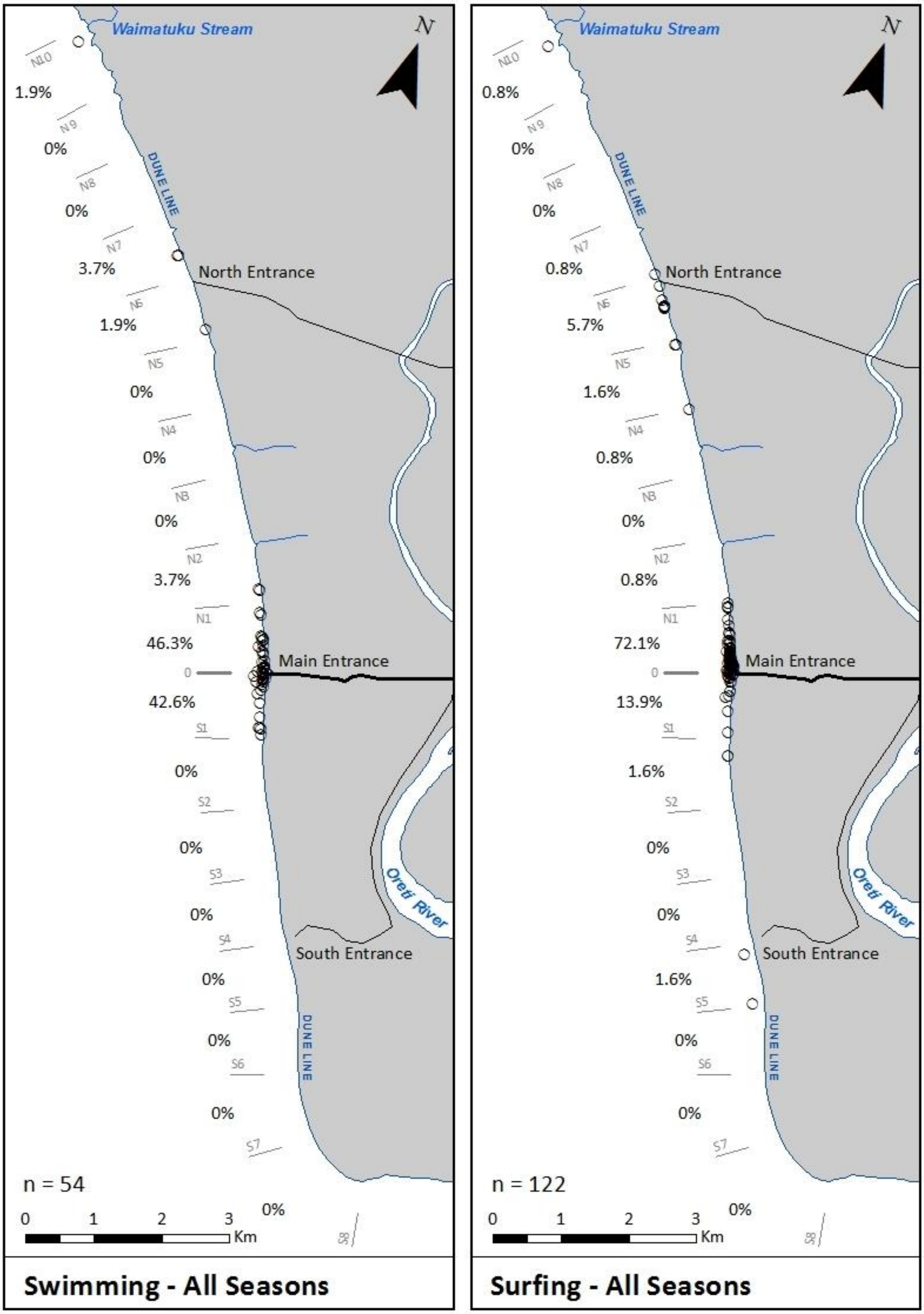


Figure 35: Distribution of 'swimming' (left) and 'surfing' (including windsurfing and kitesurfing) (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

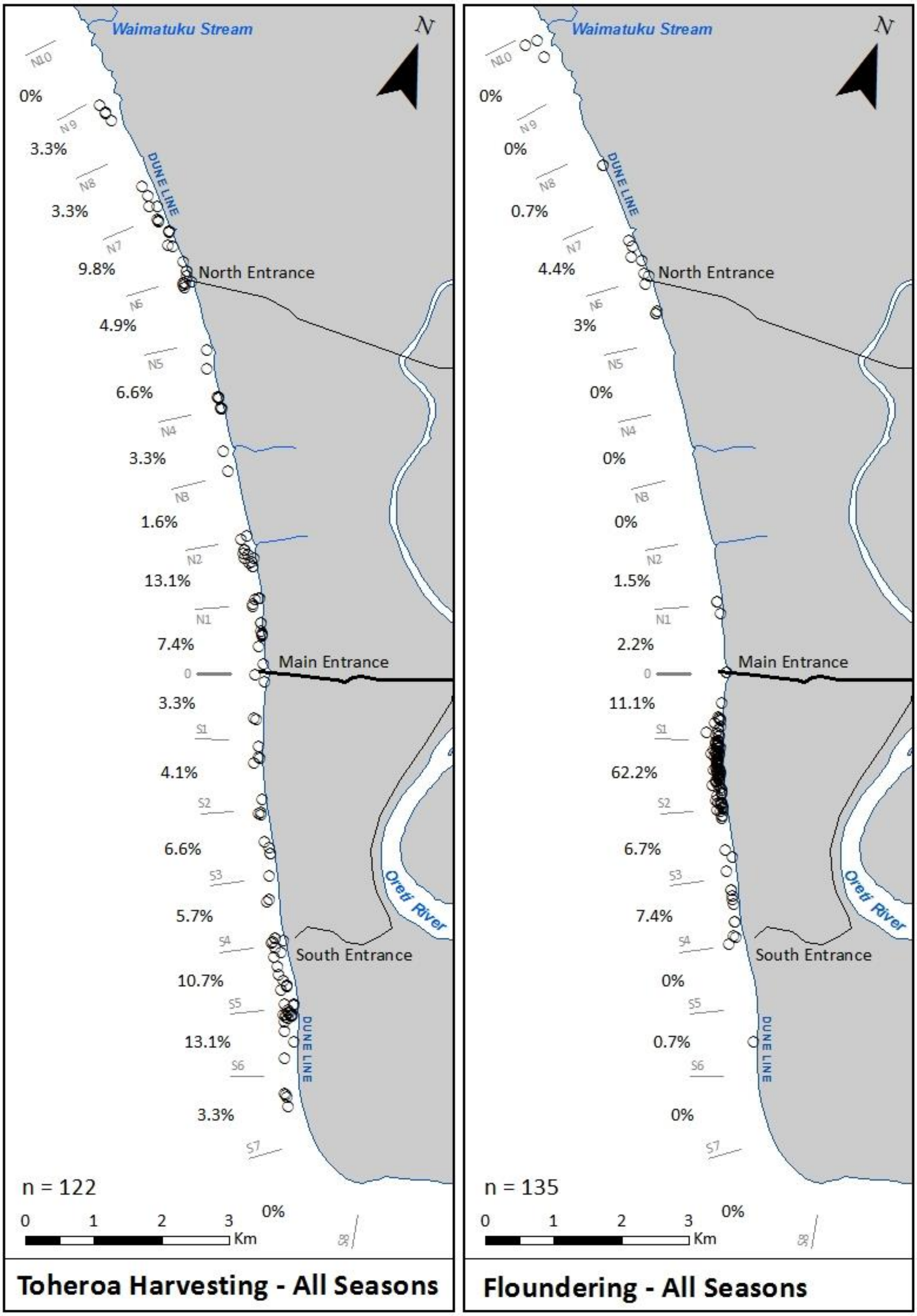


Figure 36: Distribution of 'toheroa harvesting' (left) and 'flounder fishing' (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

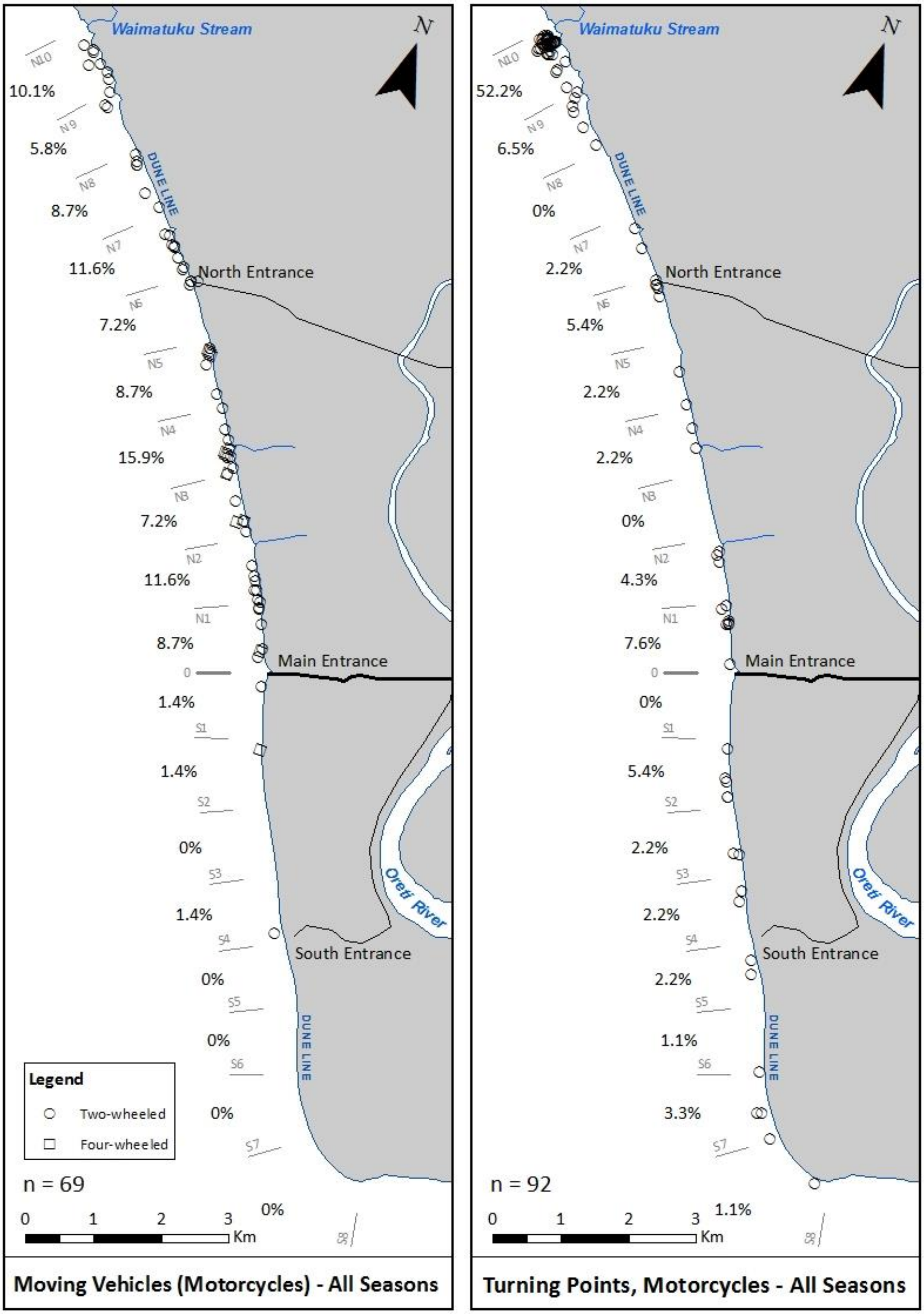


Figure 37: Distribution of moving motorcycles (left) and motorcycle turning points (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

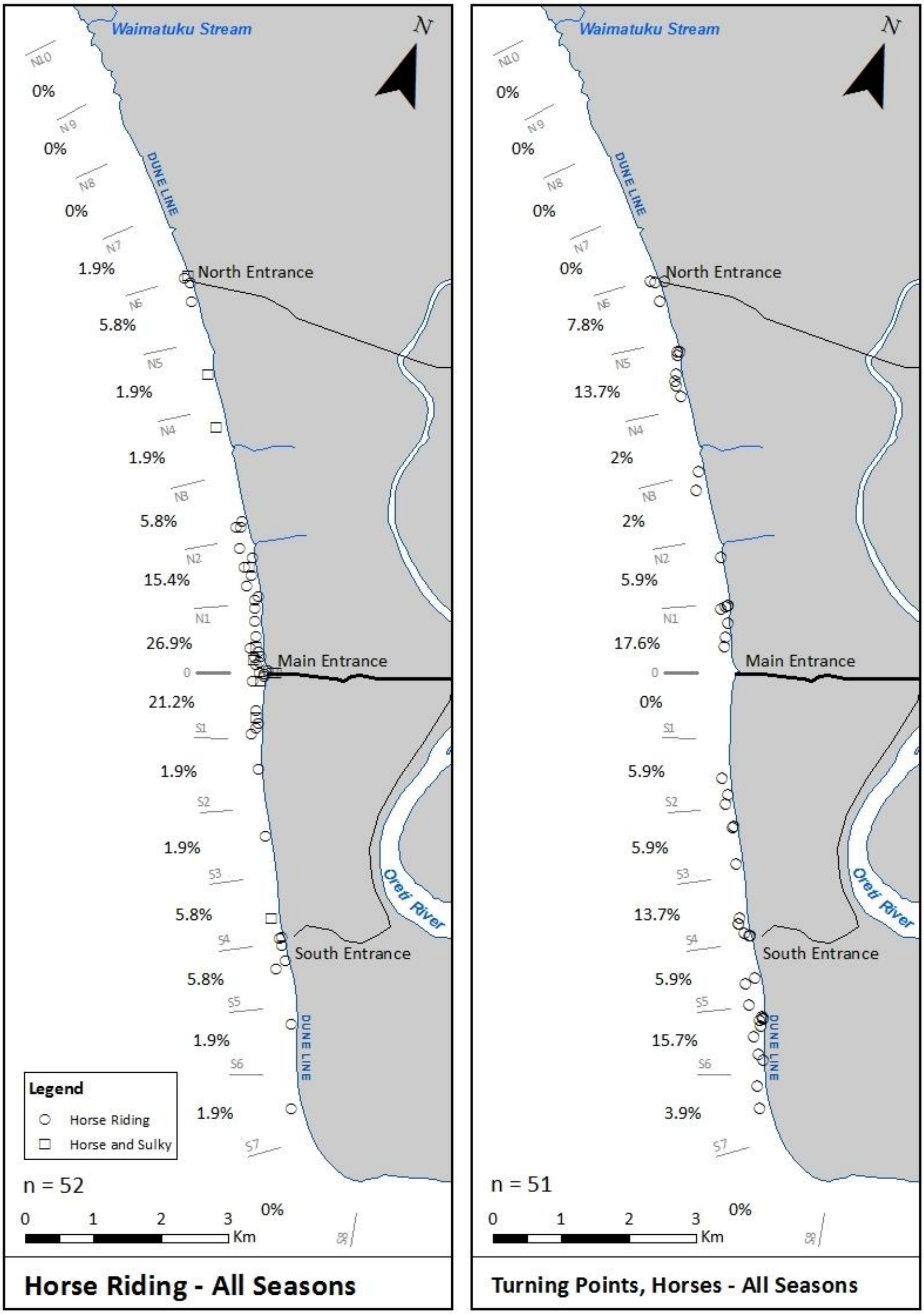


Figure 38: Distribution of 'horse riding' (left) and 'horse turning points' (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

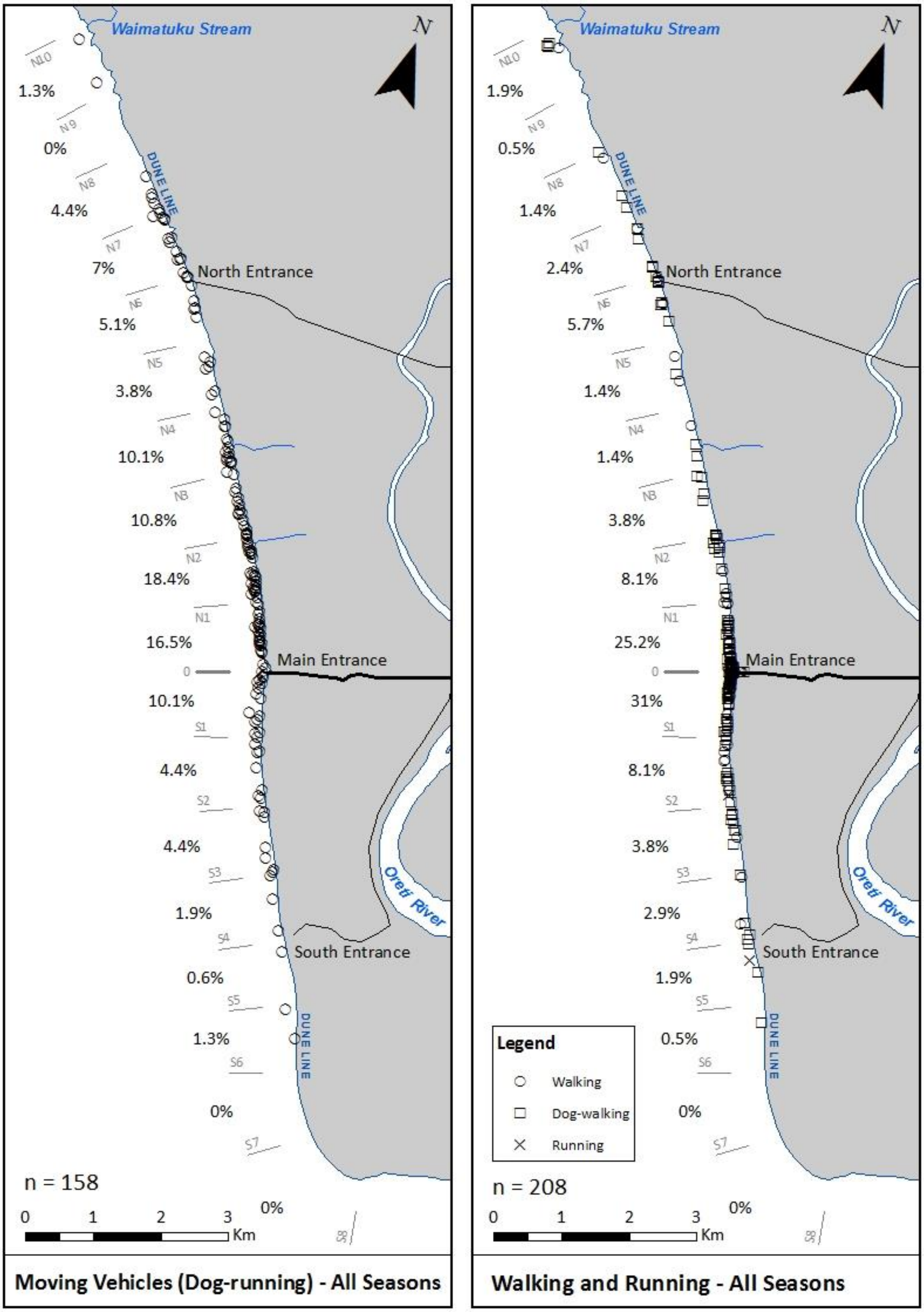


Figure 39: Distribution of 'dog running from car' (left) and 'walking and running' (right) along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

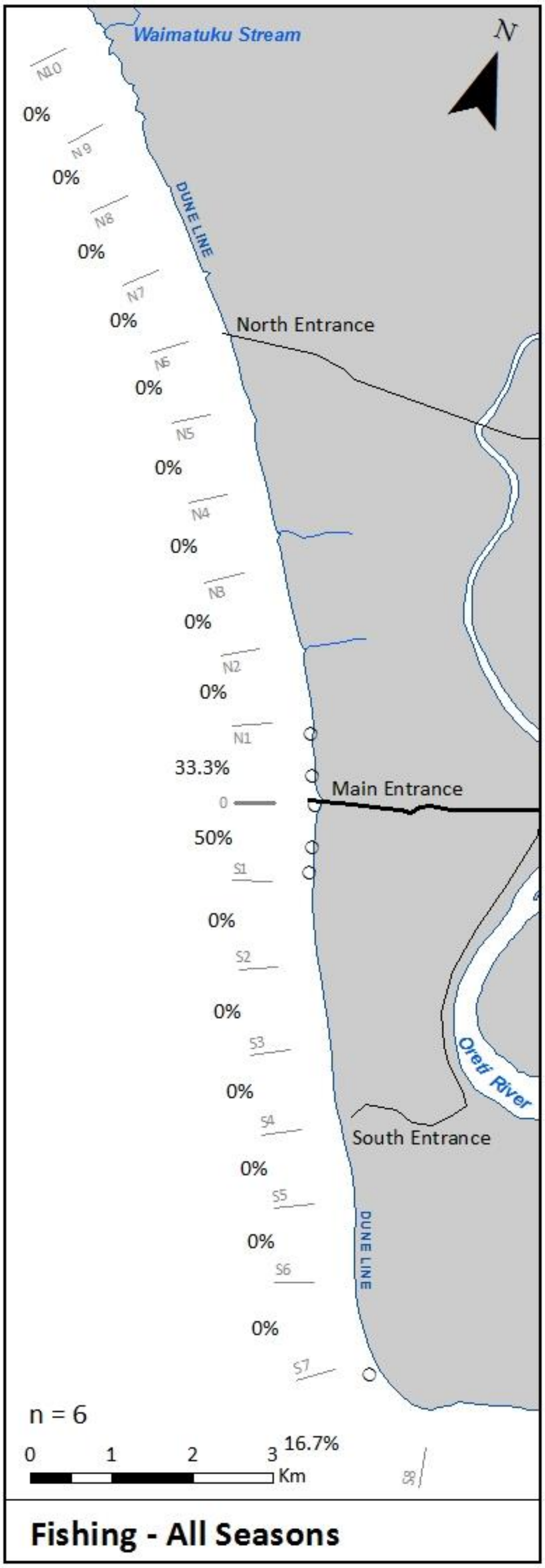


Figure 40: Distribution of 'rod and line fishing' along Oreti Beach between 18 January 2011 and 14 January 2012. Percentages indicate proportion of occurrences within each one-kilometre segment of beach.

At the time of interview, the total number of flounder caught varied between 0 and 72 with a mean of 15. None of the fishers had exceeded the legal bag limit of 30 flounder per person fishing per day and only one party (1.6%) caught the limit. Again, as the interviews were often conducted midway through their fishing trip, this does not give a full indication of catch numbers.

The catch per unit effort (number flounder kept per metre of net per hour) varied between 0 and 10.2 with a mean of 1.1 (S.D. 1.68, 95% C.I. 0.65 – 1.57). The majority (65%) of trips caught less than 1 flounder per metre of net per hour (Figure 41).

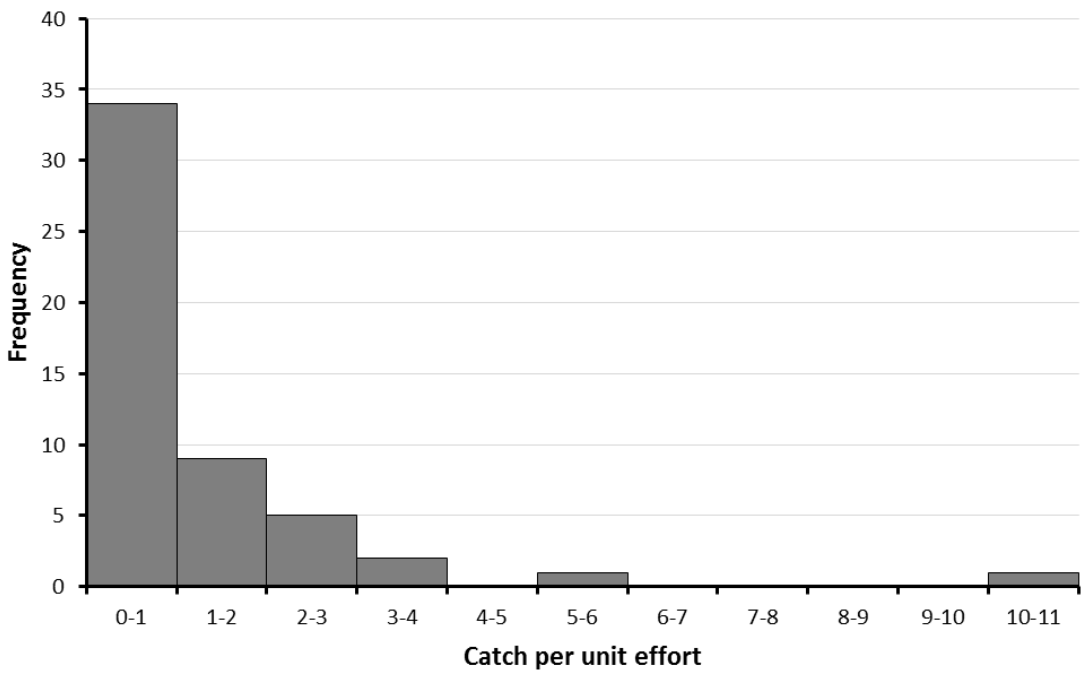


Figure 41 – Catch per unit effort (number of flounder kept per metre of net per hour) for 52 flounder fishing trips observed at Oreti Beach throughout the study.

Flounder were caught and released on 25 of 63 occasions (39.7%), with a mean number released of 2.4 (S.D. 6.38, 95% C.I. 0.84 – 4.05). Twenty four fishers reported that the reason for releasing was because they were too small, whilst three stated that it was because they were 'diamonds'[37] or 'white-bellied'.

Fishers were questioned about their past flounder fishing experiences at Oreti Beach[38]. The number of flounder fishing trips carried out in the preceding three years varied between 2 and 101 with a mean of 6.9 (95% C.I. 5.29 – 8.95). Half of the interviewees had fished for flounder less than five times in the past three years, 81% less than 15 times (5 per year) (Figure 42). A small number of flounder fishing parties fished for flounder more than ten times per year at Oreti Beach.

Of the 667 flounder fishing trips carried out by interviewees at Oreti Beach in the past three years, only 14 times (2.1%) had the flounder catch had been examined by fisheries inspectors.

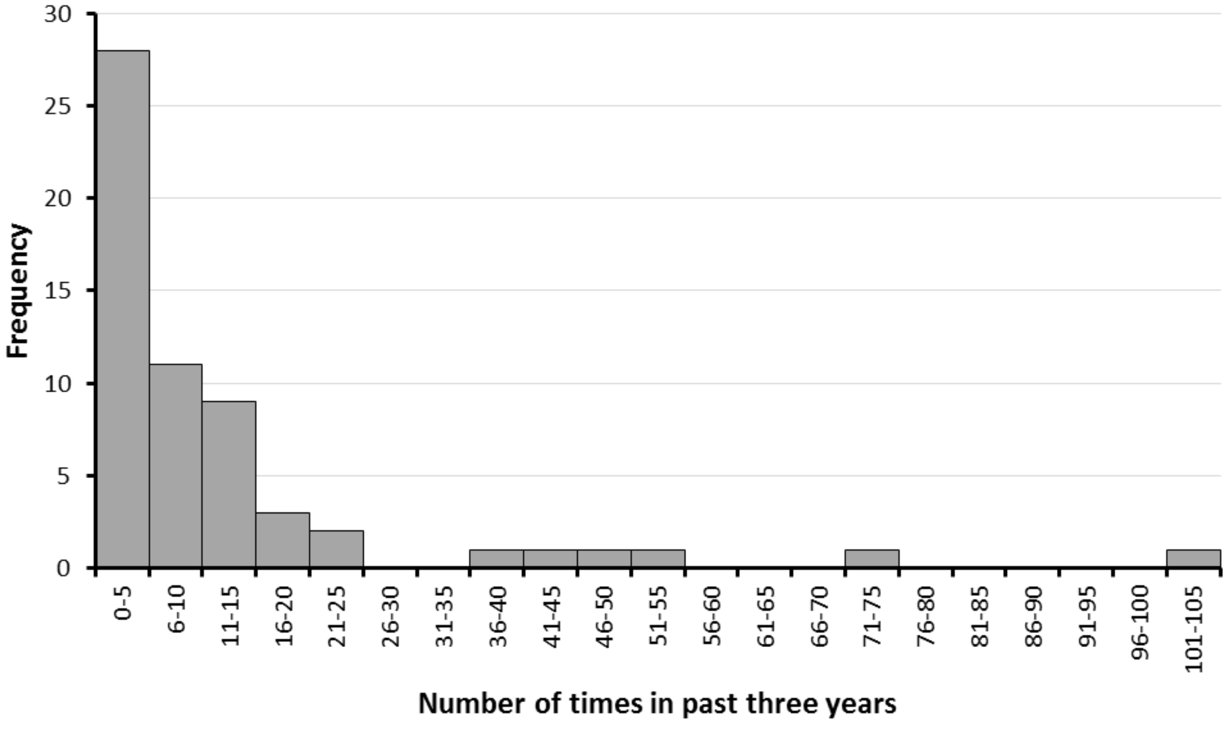


Figure 42: Number of flounder fishing trips carried out at Oreti Beach in the last three years by 59 interviewed parties.

[37] Although not clear, "Diamonds" are thought to refer to small/juvenile sand flounder.
[38] Including the fishing trip that they are currently undertaking.

Toheroa harvesting at Oreti Beach

Toheroa harvesting was observed 88 times throughout the course of the study. On 54 (61%) of these occasions, the fishers were approached and questioned about their activity.

The number of people in each party actively gathering toheroa varied between 1 and 15 with a mean of 4.2.

Altogether, 418 harvested toheroa were measured from 31 parties. Size varied between 99 and 138 mm with a mean of 117.8 mm (S.D. 7.16, 95% CI 117.1 – 118.5). Size distribution was evenly spread around the mean (Figure 43). Only one toheroa (0.24%) was smaller (99 mm) than the 100 mm minimum size that is normally stipulated on the Customary Authorisations by the Waihopai kaitiaki[39]. Five (1.2%) of toheroa were damaged upon collection.

The size distribution of harvested toheroa is broadly similar to that discovered for adult toheroa (>100 mm) at Oreti Beach in a 2009 survey of the population (Figure 43). However the harvesters tended to avoid the relatively small ones (100-104 mm) and clearly found relatively fewer of the very large (and rare) ones. The difference between the harvested and population size frequency distributions is statistically significant[40] but relatively slight from an ecological stand point. The selection seen at Oreti Beach is the opposite of that reported for the Taitokerau beaches where the kaitiaki are concerned that people are preferentially targeting the very large breeding stock[41].

The catch per unit effort (number of toheroa kept per person fishing per minute) varied between 0 and 1 with a mean of 0.29 (S.D. 0.26, 95% C.I. 0.22 – 1.36). Twenty-seven percent of parties had harvested less than 0.1 toheroa per person per minute (Figure 44).

[39] The previous Minimum Legal Size during MFish 'open days' was 100mm. Some kaitiaki interviewed in Phase I of this study (Futter & Moller 2009) considered that traditional Māori fisheries management did not normally set Minimum Size Limits and in some circumstances advocated targeting the middle sized fish in order to leave the larger breeders to reproduce (Moller & Lyver 2011). The Customary regulations allow the Tangata Kaitiaki to impose whatever limit they wish, but in the meantime have carried forward the previous Minimum Size requirement.

[40] Chi-square test, 2x9 table, p = 0.008).

[41] See Smith (2013) and Williams *et al.* (2013).

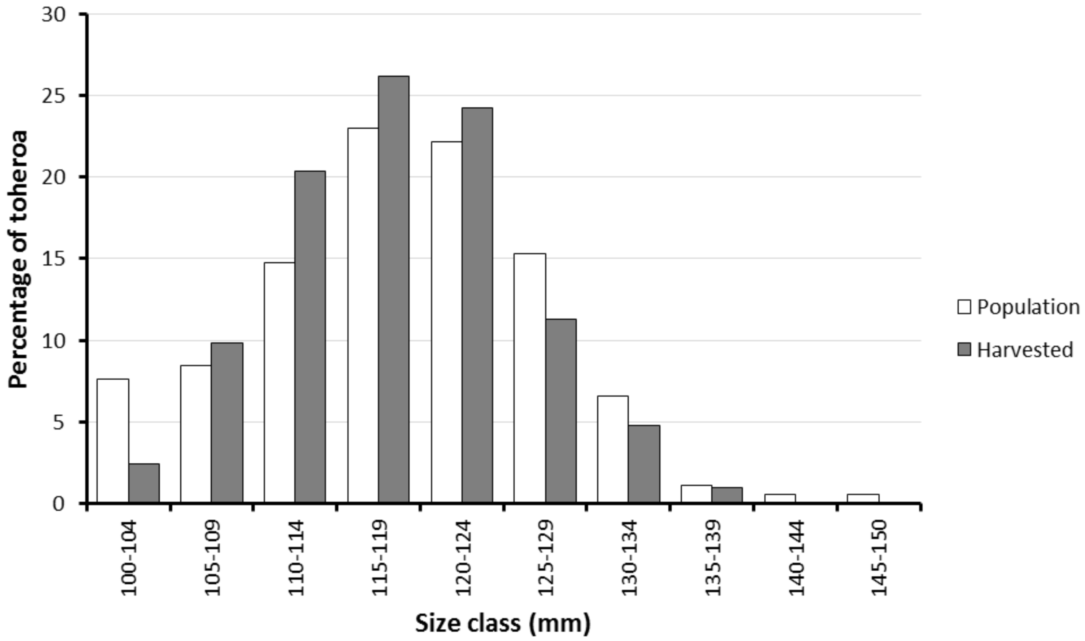


Figure 43: Size distribution of adult toheroa (>100 mm) at Oreti Beach in this study (harvested) and in a population survey carried out by NIWA in 2009 (Beentjes, 2010).

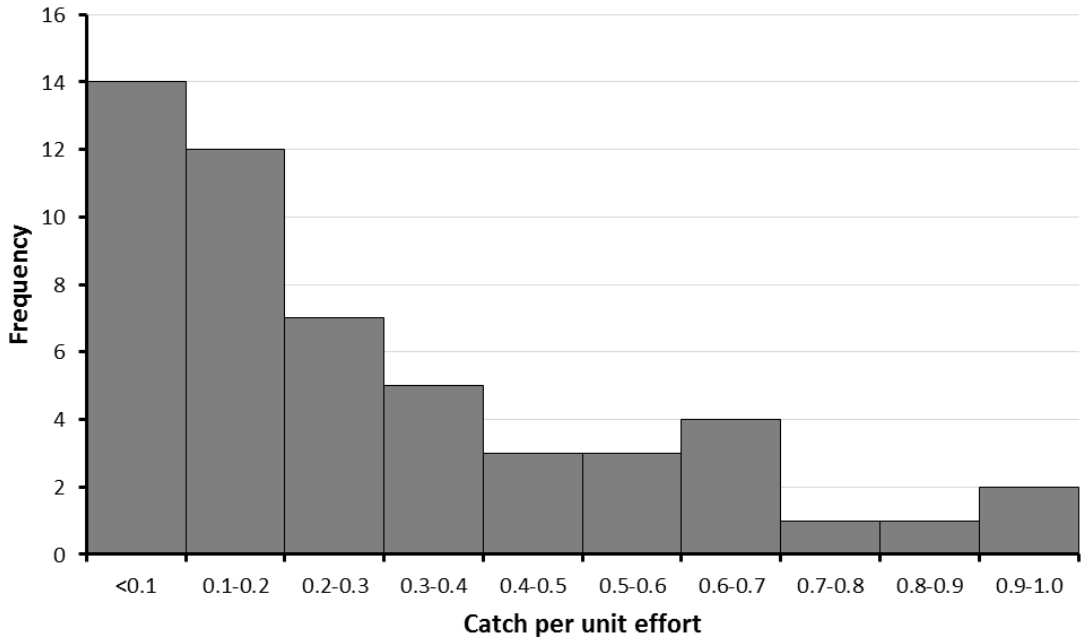


Figure 44: Catch per unit effort (number of toheroa kept per person fishing per minute) for 52 toheroa harvesting trips observed at Oreti Beach throughout the study.

Three-quarters of interviewed parties had released some toheroa after harvesting, with an average of 17 toheroa put back per party.

Toheroa harvesters were questioned about their past toheroa gathering experiences at Oreti Beach[42]. The number of toheroa gathering trips carried out in the preceding three years varied between 1 and 13 with a mean of 2.8 (95% C.I. 2.4 – 3.2). Ninety percent of those interviewed had undertaken five or fewer toheroa harvesting trips in the last three years and two parties (3.6%) were participating in their first toheroa harvesting trip (Figure 45).

The toheroa catch had been examined by fisheries inspectors on three (2.7%) of 113 occasions over the past three years.

At least 45 of 54 (83%) interviewed parties in this study had a valid authorisation to collect toheroa, whilst one (2%) didn't. The remaining eight parties were not asked whether they had a permit or not. Only one party had exceeded the maximum number of toheroa allowed by their permit (permit for 20; they had collected 21). Many interviewed parties were still in the process of harvesting so these results do not necessarily indicate compliance to authorised harvest quantity.

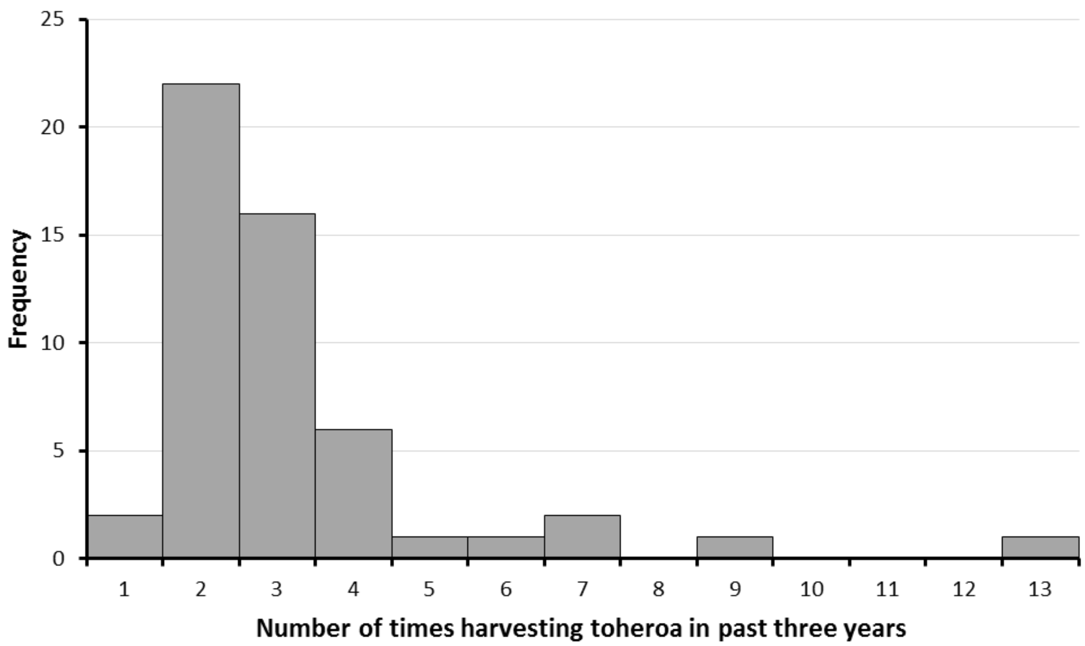


Figure 45: Number of toheroa harvesting trips carried out at Oreti Beach in the last three years by 52 interviewed parties.

[42] Including the harvesting trip that they are currently undertaking.

Discussion

Reliability of this study

This study of the recreational use of Oreti Beach represents the largest study to date, with traffic monitored across the seasons for two years and recreational activity for one. Many data were collected throughout the study, providing a powerful and thorough assessment of the use of the beach. A few small gaps in the data have little effect on the results of this study. It has provided good baseline to measure future changes against. However, all the observations of beach users in this study were made within daylight hours, so little is currently known about the activities of the 10% of visitors to the beach that occur at night.

The automatic traffic counter captured a reasonably full picture of recreational rhythms at Oreti Beach, but it will have underestimated the number of visits overall. The biggest source of underestimation is lack of monitoring of entries via North Entrance. There was also a trickle of horse and foot traffic, and entry by four-wheel-drive vehicles and motorbikes at the extremes of the study area (Sandy Point and Waimatuku Stream). The traffic counter was also calibrated to exclude trailers.

Estimating the vehicles entering via North Entrance was problematical – but best estimates put it at around 4% of the total volume of cars and 17% of the total volume of utes/4WDs. When scaled against the bigger difficulties of accurately estimating the scale and type of recreational activity on Oreti Beach, the error is of little concern. Future studies of traffic volumes entering Oreti Beach should attempt to quantify the traffic coming onto the beach at North Entrance by either (i) placing a traffic counter on the road there (as well as at Main Entrance), (ii) randomly sampling beach users about which entrance they used, or (iii) doing visual spot checks and counts of the traffic at North Entrance to make compared comparisons with automated traffic counts at Main Entrance at the same time and weather conditions.

Stratification of sampling (three seasons, weekends + one week day) and adjusting sampling effort to match expected fluctuations in visitor activity, effectively optimised research investment for this study. Similarly, forcing circuits into a balanced sequence of top, mid and low tide periods will have improved the representativeness of the data gathered. Certain activities requiring extensive travel down the beach or specific conditions (e.g. exposed lower stretches of the beach to reach adult toheroa) requires low tide conditions, even though the bulk of variation in overall visits is unaffected by tide times. In retrospect we regret that we did not do more interviews and that these were not chosen in a formal random stratified way in different sections along the beach. We recommend that any future surveys invest more in such interviewing. In our study we prioritised gathering detail information on vehicle movements to allow prediction of their impacts on toheroa recruitment.

An overview of the recreation and associated traffic on Oreti Beach

This study has shown that Oreti Beach is an extremely popular recreational site, receiving a large volume of visits from many people from Southland and further abroad. Almost 100,000 vehicles visit Oreti Beach each year (250 per day on average), equating to more than 200,000[43] people visiting the beach annually. The number of visitors to the beach fluctuated predictably according to season (more in summer than winter), the day of the week (more in the weekend than weekdays) and especially the time of day (most in the afternoon, few at night). Climatic factors also played an important role in driving variation in the number of beach users, although the relationship is complex. Temperature was most important with many more people visiting the beach on warmer days. Wind strength and direction also appear to influence the number of beach-goers and is a key consideration in retaining permission to take vehicles on to the beach.

Cars and utes/4WDs account for the majority of vehicles using Oreti Beach, with most entering via Main Entrance. Traffic and recreational use was moderately more concentrated to the north of Main Entrance, mainly because of the location of North Entrance in the northern part of the beach, and the attraction of this area to drivers of 4WDs and motorbikes. Whitebaiting occurs exclusively at the Waimatuku Stream at the northern end of the study area.

A large majority of the vehicles driving onto Oreti Beach stay within 1 km either side of Main Entrance. This traffic is mostly associated with swimming, picnicking, sand play and sightseeing, activities which could be conducted almost anywhere on the beach. Other popular activities are reasonably spread along the beach, with the exception of flounder fishing which is concentrated between one and two kilometres south of Main Entrance, and whitebaiting at the northern end. Dispersal of activity away from the Main and North Entrances for some activities is probably partly related to people wanting to get away from the crowds concentrated at the entrances during hot summer days. Areas of soft sand may stop non-4WD vehicles from venturing far from the beach entrances.

[43] Based on average number of people per vehicle visiting Oreti Beach reported by Wilson (1999): 2.3 on weekdays and 2.7 in the weekend.

The value of Oreti Beach for recreation and lifestyle in Southland

Oreti beach is used for a huge array of recreational activities, with 31 different past-times observed during this study. Although many of these are concentrated around access points, in particular Main Entrance, others are focussed in different parts of the beach or scattered relatively evenly along the length. Most activities were more frequently carried out in peak season than in shoulder and low seasons.

Being able to drive onto and along Oreti Beach is clearly important to many beach users, both as a means of getting to a chosen locality and as an activity itself – simply sitting in the car was the most commonly partaken activity. Some of the activities require transport of reasonably heavy or bulky gear (e.g. flounder fishing). The ability to use the car as a means of shelter on this exposed and windy coastline (see Figure 13), ensures that visitors to Oreti Beach can enjoy the environment year-round. Even in the middle of winter, more than one hundred vehicles were visiting the beach on most days. Any restriction of vehicle access to the beach is likely to affect a lot of people and significantly devalue their experience, particularly during high winds that predominate in summer. Our study has measured associations between weather and the number of visits, not how long each visit lasted. It is extremely likely that the same inclement conditions that deter visits on some days and seasons also reduces the duration and quality of those visits that do occur.

Oreti Beach is the most frequently visited coastal site in Southland (Wilson, 1999), making it an important attraction for both local and foreign tourists. It is also a significant financial asset to the Southland region, with the annual Burt Munro Challenge attracting many thousands of visitors to the beach and bringing in $1.1 million to the region[44].

Fishing at Oreti Beach

Fishing (particularly toheroa harvesting, flounder fishing and whitebaiting) is an important past-time for many beach users and supporting their needs will be a prime focus of the incoming Oreti Beach Mātaitai Management Committee based in the Waihopai community. In contrast to most other activities, fishing was not concentrated around the beach entrances but rather was focussed in areas that are the best, or at least perceived to be the best, for getting a good catch.

[44] This is an unofficial figure from Venture Southland for the2008 challenge. A comprehensive analysis of the financial benefit to the region is underway.

People catching flounder and toheroa were often approached and questioned about their fishing trip. Most of the interviewed fishers only sporadically fished at Oreti Beach, although a small number of parties regularly fish at the beach. The latter group of enthusiasts are the ones that would be most affected by any restrictions on vehicle access and most likely to object. If restrictions were contemplated, consultation with them to find joint solutions and alternatives will be important to retain community support. Toheroa harvest is obviously very successful along the entire length of Oreti Beach (Figure 36), even though the strong-hold of the breeding population is in the extreme southern end[45] and traditional harvesting was concentrated there[46].

Less than 3% of previous trips had been assessed by fisheries officers. Similarly low levels of surveillance have been recorded at the East Otago Taiāpure and at two southern mātaitai (*Te Waka a Te Wera* at Rakiura and *Puna Wai o Tōriki* at Kaka Point)[47]. This low level of surveillance is of minor concern at Oreti because compliance was apparently high for toheroa harvesting at least (only 1 of 46 parties did not have a customary authorisation, only 0.24% of the toheroa were undersized). Clearly the customary fishing regulations are working effectively and this corresponds with general support appreciation of the process recorded in interviews in 2008[48]. It was also pleasing to detect very few damaged toheroa in the buckets, demonstrating that unintended damage to the fishery by using implements to extract the adults is at a low level. Nor is the concern of many kaitiaki from Taitokerau that preferential harvesting of larger toheroa is impairing recruitment apparently relevant at Oreti Beach – a slight avoidance of the smallest authorised size class is offset by no capture of the very largest size classes available (Figure 43).

As most of the parties interviewed were midway through fishing, a full indication of total catch and compliance with limits is not known. A further study could investigate these fisheries in more detail. However the information reported here starts to provide a benchmark against which future changes in stock and fisher's success can be measured. It is clear that fishing success is very patchy (Figures 41 and 44), so a large number of repeated samples will be needed to detect longer term trends in stocks. Coupling reporting of catch to authorisations is mandatory, and if catch-per-unit effort records were added, this could provide an inexpensive albeit coarse indication[49] of trends in the fishery. However, by far the most reliable population monitoring method for toheroa is the regular

[45] Beentjes (2010a).
[46] Futter & Moller (2009).
[47] McCarthy *et al.* (2013).
[48] Futter & Moller (2009).
[49] Moller *et al.* (2004) shows that CPUE must be calibrated and can mislead, but it is often used by traditional knowledge holders to assess stock health.

transect count method performed by NIWA for the Ministry of Primary Industries. Such long term and standardised survey databases have already proved valuable in this report and its companion report for assessing risks of vehicles to toheroa recruitment. We recommend that these surveys are maintained at all cost as part of a professional risk management strategy that can simultaneously protect a threatened species, maintain an iconic customary harvest for Māori and minimise disruption to valuable recreational opportunities at Oreti Beach. All these goals are fundamental to the Southland experience and the region's identity and ecology.

Challenges for managing recreation on Oreti Beach

Effective management of recreation is essential to ensure that all users can continue to enjoy Oreti Beach in the future. As the population continues to grow, it is likely that the number of people and vehicles visiting the beach will also increase. Both the total number of registered cars in New Zealand and the number of cars per person has increased steadily since 1970 (Figure 46)[50]. Similarly, the total number of licensed vehicles for the Invercargill region has increased from 83,942 in 2000 to 100,872 in 2012 (Figure 47).

Transport modelling cannot predict overall vehicle growth with much accuracy because vehicle purchases are closely related to GPD fluctuations and exchange rates that affect car prices. However modelling clearly shows that the number of vehicles per household has not reached saturation level yet and that anywhere from a further 22 – 36% increase in car ownership can be expected[51]. Interestingly, the traffic counts obtained in this study were approximately 20% less than those recorded by Wilson (1999) for the corresponding summer period from 1998-1999. Although this decrease could represent a true decline in traffic use, it may equally have been a result of a number of other factors. Both Wilson's and this study showed that on warmer days, traffic using Oreti Beach increased substantially. Table 4 shows that the 1998-1999 summer had a slightly warmer mean daily maximum temperature, and several more days exceeding 20^{o}C. This may account for some of the discrepancies in traffic volume. The results of this study also suggest that other climatic factors may influence the number of beach users. For example, stronger winds or more frequent rain may account for the observed decline in traffic between the two studies. Finally, the traffic counters used in the different studies may have been calibrated differently so that they measured a different range of vehicles. Further studies are required to determine the inter-annual trend in vehicle numbers using Oreti Beach.

[50] Conder (2009).
[51] Conder (2009).

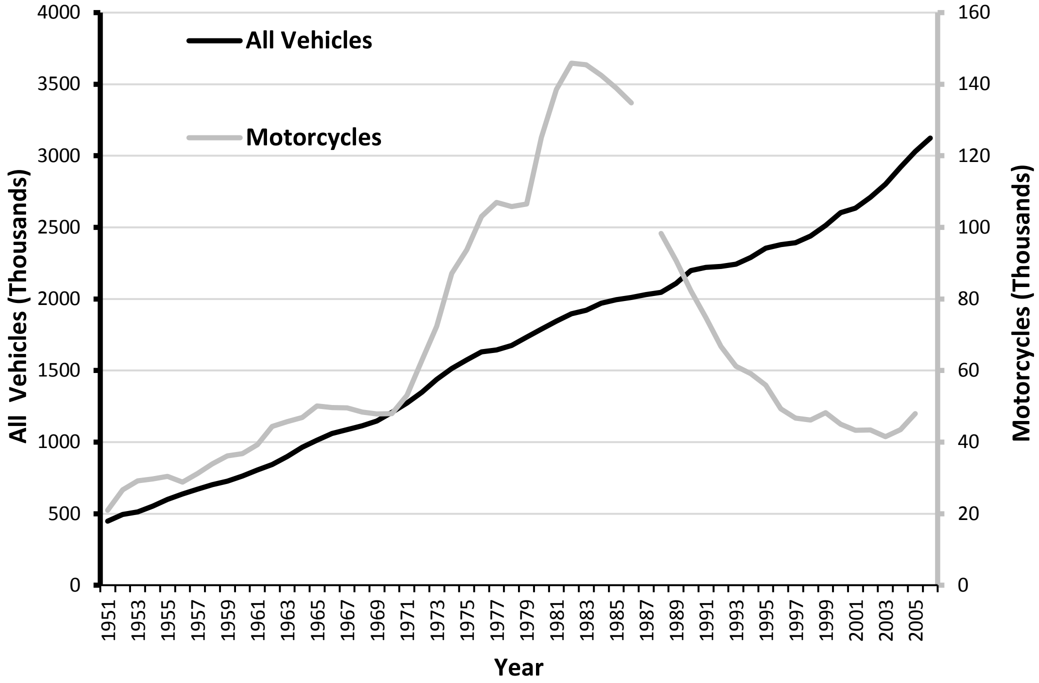


Figure 46: Number of licensed vehicles in New Zealand per year, 1951-2005. [*Source:* Graphed from data in Appendix A of Conder (2009)].

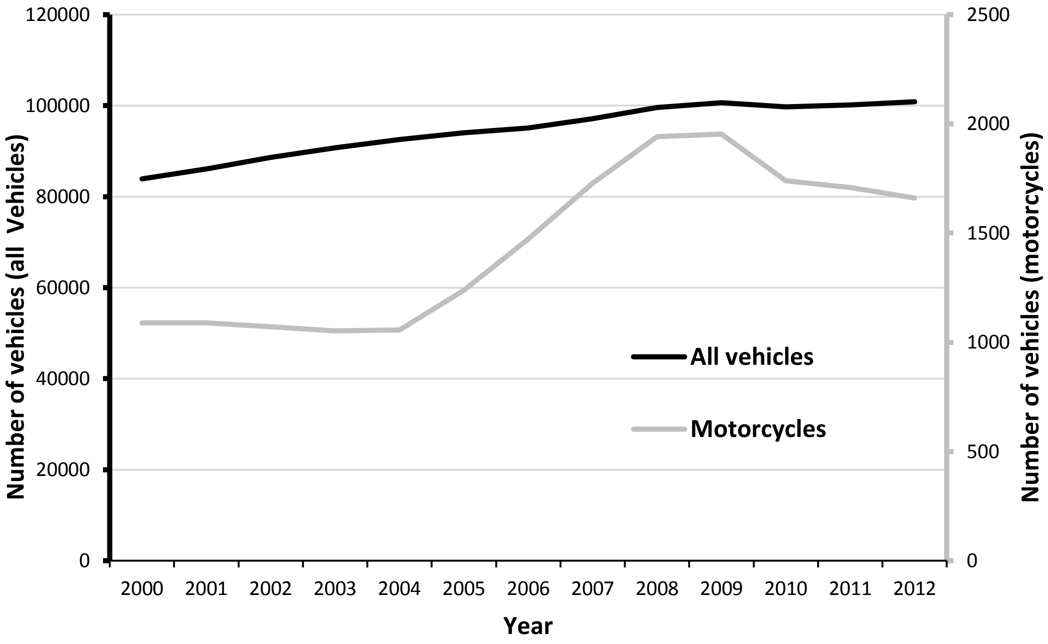


Figure 47: Number of licensed vehicles in the Invercargill region, 2000-2012. [*Source:* Data supplied by New Zealand Transport Authority, *in litt.* 2013].

Table 4: Number of vehicles entering Oreti Beach Main Entrance between 16 December and 9 February, mean daily maximum temperature and number of days exceeding 20^{o}C.

	1998-1999 (Wilson, 1999)	2010-2011	2011-2012
Number of vehicles	23,384	18,228	17,922
Mean daily maximum temperature (^{o}C)	19.8	19.4	19.2
Number of days exceeding 20^{o}C	25	20	21

Although not measured in national vehicle registration statistics, it is probable that the proportion of 4WD vehicles is increasing, a view expressed by kaitiaki in interviews conducted in 2008[52]. In this study we showed that 4WD vehicles appear to travel more frequently along the beach, whereas cars tend to most commonly stay near to beach entrances (Figures 19a cf. 19b; 20 cf. 21). If the proportion of 4WD vehicles continues to increase, recreational pressure will increase in more remote parts of the beach.

There are several potential safety and quality of experience challenges associated with recreational use of Oreti Beach. A small but not insignificant number of beach users are obviously breaking the 30 km/h speed limit and are using the beach for doing “doughnuts” and racing (see Figure 25). Although illegal in itself, these activities also pose a significant annoyance and risk to other beach users, particularly in times and places that are crowded with people and other vehicles. Preventing these activities and mitigating the risk to other users is a key issue in the future management and education initiatives. Managing the recreational fisheries at Oreti Beach is also an important issue as recreational pressure is most likely to increase in the future. We recommend that this survey, using slightly enhanced methods, is repeated every 8-10 years at the very least to monitor recreational needs and impacts at Oreti Beach. More frequent surveys may be necessary if declines in toheroa or visitor complaints and accidents increase.

[52] Futter and Moller (2009).

Further studies are needed to assess the current state of the fisheries, so as to provide a baseline for effective management in the future. The impact of vehicles on toheroa recruitment is the potentially most significant ecological threat on the beach and is the subject of the companion report to this one. The steady increase in vehicle registrations suggests that vehicle pressure will continue to increase in the long term at Oreti Beach and other toheroa colonies around New Zealand. It is therefore prudent to thoroughly assess the risks now and get prepared if necessary. There is likely to be increasing pressure of vehicle-based recreation on Oreti Beach and existing smaller risks may become more important if other threats to toheroa populations trigger further declines like those observed in the second half of last century[53]. It is therefore paramount that the regular MPI surveys of toheroa are maintained at their present frequency as part of a professional risk management strategy that will simultaneously protect a threatened species, maintain an iconic customary harvest for Māori and minimise disruption to valuable recreational opportunities at Oreti Beach. All these goals are important ingredients for safeguarding Southland's lifestyle, identity and ecology.

[53] Williams *et al.* (2013).

References

Beentjes MP (2010a). Toheroa survey of Oreti Beach, 2009, and review of historical surveys. *New Zealand Fisheries Assessment Report* 2010/6. 40 p.

Beentjes MP (2010b). Toheroa survey of Bluecliffs Beach, 2009, and review of historical surveys. *New Zealand Fisheries Assessment Report* 2010/7. 42 p.

Beentjes MP, Carbines GD & Willsman AP (2006). Effects of beach erosion on abundance and distribution of toheroa (Paphies ventricosa) at Bluecliffs Beach, Southland, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 40: 439-453.

Beentjes MP & Gilbert DJ (2006a). Bluecliffs Beach 2005 toheroa survey: yield per recruit and review of historical surveys. *New Zealand Fisheries Assessment Report* 2006/37. 46 p.

Beentjes MP & Gilbert D J (2006b). Oreti Beach 2005 toheroa survey: yield per recruit and review of historical surveys. *New Zealand Fisheries Assessment Report* 2006/36. 47 p.

Conder T (2009). Development and application of a New Zealand Car ownership and traffic forecasting model. *NZ Transport Agency Research Report 394*. 166pp.

Futter JM & Moller HM (2009). Mātauranga, monitoring and management of Toheroa (*Paphies ventricosa*) in Murihiku. *He Kōhinga Rangahau No. 7.* University of Otago, Dunedin. [Online at: www.mahingakai.org.nz/publications]

McCarthy A, Hepburn C, Scott N, Schweikert K, & Moller H (2013). Local people see and care most? Severe depletion of inshore fisheries and its consequences for Māori communities in New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems*. DOI: 10.1002/aqc.2378.

Moller H, Berkes F, Lyver PO'B & Kislalioglu M (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society* 9(3): 2. [online] URL: http://www.ecologyandsociety.org/vol9/iss3/art2.

Moller H & Futter JM (2009). A monitoring protocol to measure impacts of sudden die-back events on populations of Toheroa (*Paphies ventricosa*) on Southland beaches. *He Kōhinga Rangahau* No. 6. 30 pp. University of Otago, Dunedin. [Online at: www.mahingakai.org.nz/publications].

Moller H & Lyver PO'B (2011). Using traditional ecological knowledge for improved sustainability: case studies from four customary wildlife harvests by Māori in New Zealand. In: Hughes, C. (Ed.). *Indigenous People and Biodiversity Conservation*. Conservation International, Arlington.

Moller JA, Garden C, Moller SI, Beentjes M, Bradley D, Skerrett M, Scott D, Stirling FF, Moller JS, Moller H (2013). Impact of vehicles on recruitment of toheroa on Oreti Beach, Southland, New Zealand. *Ecosystems Consultants Report 2014/2*. Online at: http://www.ecosystemsconsultants.co.nz/project/conserving-a-taonga-species-and-recreation

Moller JS, Moller SI, Futter J, Moller JA, Harvey J, White H, Stirling FF & Moller H (2009). Potential impacts of vehicle traffic on recruitment of Toheroa (*Paphies ventricosa*) on Oreti Beach, Southland, New Zealand. *He Kōhinga Rangahau* No. 5. 60 pp. University of Otago, Dunedin. [Online at: www.mahingakai.org.nz/publications].

Smith S (2013). Factors influencing the abundance of Toheroa (*Paphies ventricosa*) on Northand Beaches: perspectives from the beach. Report to NIWA for MPI project TOH200703, by Environmental Assessments & Monitoring (EAM) Ltd. 22pp.

Williams JR, Sim-Smith C, Paterson C (2013). Review of factors affecting the abundance of toheroa (*Paphies ventricosa*). New Zealand Aquatic Environment and Biodiversity report No. 114. 76 p.

Wilson K (1999). Recreational use of Southland's Southern Coast. Summer of 1998/99. *Southland Regional Council Publication* No. 1999-5. 42 pp.

Appendix 1: Questionnaires used when interviewing all recreational users of Oreti Beach

1. Which entrance to the beach did you use?
2. Did you drive onto the other end of the beach before coming this way? (Yes / No)
3. Is this your first stop on the beach? (Yes / No)
4. If you stopped elsewhere before coming here, why did you stop and why did you shift?
5. How long have you been stopped at this spot? (minutes)
6. Will you head straight back to the same entrance when you leave this spot (Yes / No)
7. If not, where do you intend to go next and will you stop along the way again?
8. Why did you come to this side of the beach rather than the other?
9. Why did you stop here on the beach rather than going further away or stopping closer to where you entered?
10. Usual residence of the interviewee
11. Usual residence of the others in the party
12. Age and gender of those in the party
13. Ethnicity of those in party
14. Comments

Appendix 2: Questionnaire used when interviewing flounder fishers

1. Total number of people in party
2. Number of people actively netting
3. Length of net and size of mesh
4. Time arrived at site
5. Minutes at site gathering
6. Number of nets dragged
7. Number of flounder caught so far
8. Number of flounder put back
9. Reasons why put back
10. How many times have you dragged flounder nets on Oreti Beach in the last three years?
11. Amongst all those times, how often has a Ministry of Fisheries officer inspected your catch?
12. Full beach-user questionnaire completed (Yes/No)
13. Comments

Appendix 3: Questionnaire used when interviewing toheroa harvesters

1. Total number of people in party
2. Number of people actively gathering
3. Harvesting method
4. Time arrived at site
5. Minutes at site gathering so far
6. Number of toheroa gathered so far
7. Number of toheroa put back
8. Reasons why put back
9. Number of toheroa damaged but not retained
10. Any measured specimens? (Yes/No)
11. How many times have you gathered toheroa in the last three years?
12. Amongst all those times, how often has a Ministry of Fisheries officer inspected your catch?
13. Full beach-user questionnaire completed (Yes/No)
14. Where you aware it was a permitted activity?
15. Number of toheroa allowed on their permit
16. Comments

Appendix 4: Distribution of activities along Oreti Beach

Activity	Percent of records north of main entrance	Percent of records south of main entrance	Mean distance north of main entrance (m)	Mean distance south of main entrance (m)	Number of observations
Sitting in car	44.4	55.6	1431	377	509
Sunbathing and sand play	38.5	61.5	1422	417	200
Motorbiking	92.0	8.0	5208	1508	187
Dog running from car	77.2	22.8	2937	1676	171
Flounder fishing	14.4	85.6	5385	1623	139
Surfing/Windsurfing/Kitesurfing	55.2	44.8	2708	1264	125
Windsurfing/Surfing/Kitesurfing	82.8	17.2	879	718	122
Picnicking	45.9	54.1	1587	398	111
Toheroa harvesting	59.1	40.9	3924	3709	88
Walking and running	48.1	51.9	1762	607	82
Swimming	57.4	42.6	1211	280	54
Horse riding	57.5	42.5	1637	2324	40
Camping	50.0	50.0	1049	219	32
Whitebaiting	100.0	0.0	9698	n/a	27
Cycling	60.9	39.1	1865	3942	23
Gathering seaweed/wood	52.9	47.1	2744	1798	17
Surf life-saving	11.1	88.9	12	73	9
Scientific research	0.0	100.0	n/a	4420	7
Kite-flying	83.3	16.7	207	71	6
Rod/Line fishing	33.3	66.7	580	2156	6
Wedding	100.0	0.0	78	n/a	3
Blow carting	33.3	66.7	56	1017	3
Commercial food operator	0.0	100.0	n/a	9	1
Launching boat	0.0	100.0	n/a	66	1
Doughnuts	100.0	0.0	154	n/a	1

Contractor	100.0	0.0	5374	n/a	1
Car surfing	100.0	0.0	275	n/a	1
Police activity	100.0	0.0	90	n/a	1
Party	100.0	0.0	559	n/a	1
Target shooting	0.0	100.0	n/a	4695	1
Photo shoot	100.0	0.0	6291	n/a	1