New Zealand Wastewater Surveillance Programme COVID-19

Monthly Report: December 2023

Weeks ending 10 December to 31 December 2023

Report prepared 18 January 2024

Key Trends & Insights

For December, SARS-CoV-2 levels in wastewater averaged 5.81 million genome copies per person per day (GC/p/d) compared to 5.77 GC/p/d in November. During this period SARS-CoV-2 levels were highest in the week ending 17 December at 7.63 million GC/p/d.

100%	53% – 68%	JN.1
Sites (45/45) where SARS-CoV-2 was detected	NZ population covered by wastewater testing in December	Most prevalent variant detected (49%)

- In December 2023, 192 samples were collected across Aotearoa. SARS-CoV-2 RNA was detected in 192/192 (100%) samples from 45/45 (100%) sites.
- Due to the holiday period, samples were only collected from a few sites in the week ending 31 December 2023, resulting on population coverage dropping to 53% that week.
- While there were notable fluctuations evident in December 2023, the overall trend shows that following a sustained increase in SARS-CoV-2 RNA quantities in wastewater since August 2023, this has levelled off at a moderately high level this month.
- By the end of December, the JN.1 variant, detected in NZ at the beginning of November 2023, replaced the XBB family of lineages as the predominant circulating variant in NZ wastewater. The estimated national percentage of JN.1 steadily increased through December from 17% in week 48 to 49% in week 51.

National Results

National SARS-CoV-2 levels in wastewater and reported cases

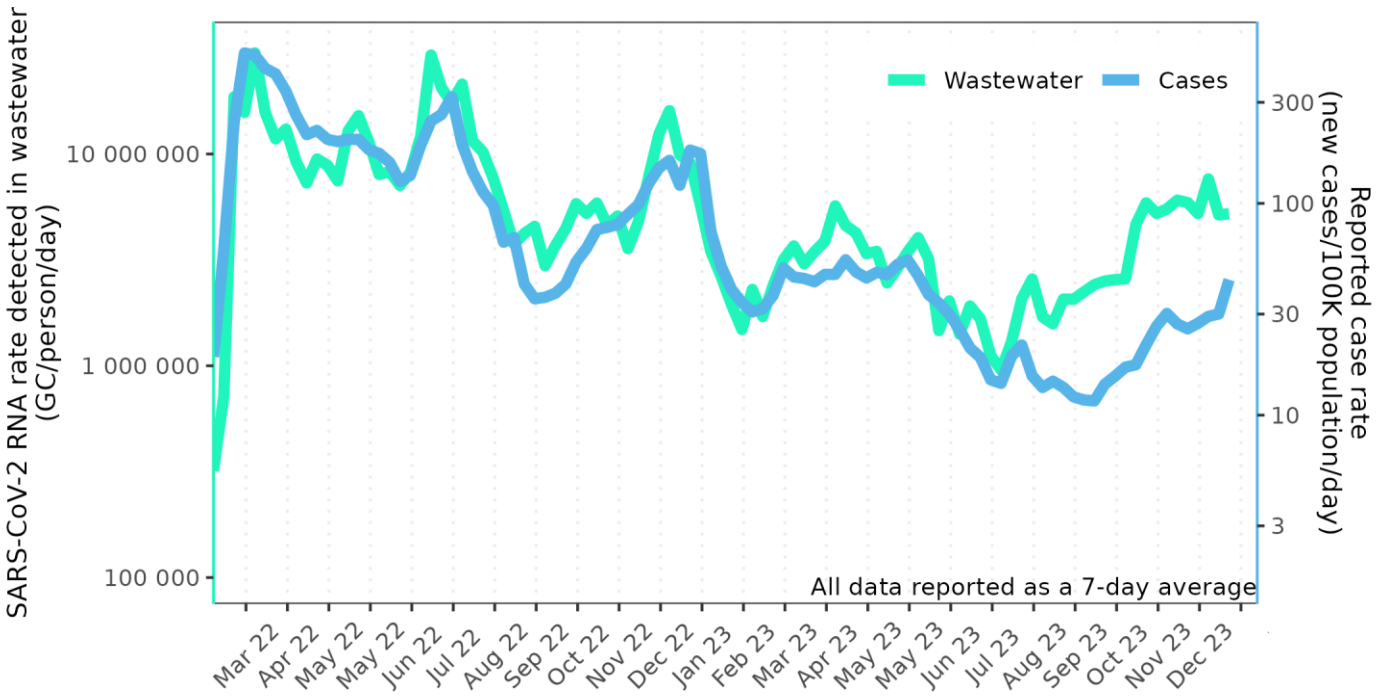

Figure 1. National timeseries of estimated SARS-CoV-2 wastewater rate (GC/person/day, green line) and reported case rate (new cases/100,000 population/day, blue line) on a $\log_{10}$ scale.

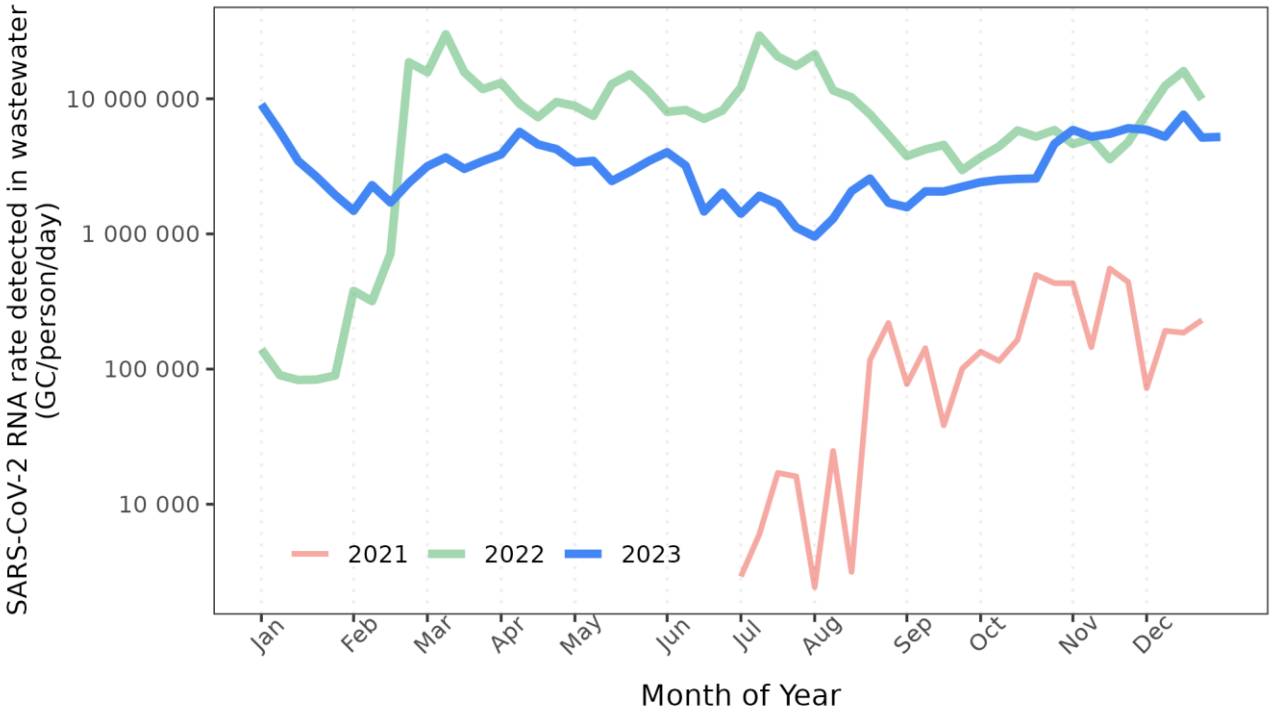

Figure 2. National timeseries of estimated SARS-CoV-2 wastewater rate (GC/person/day)

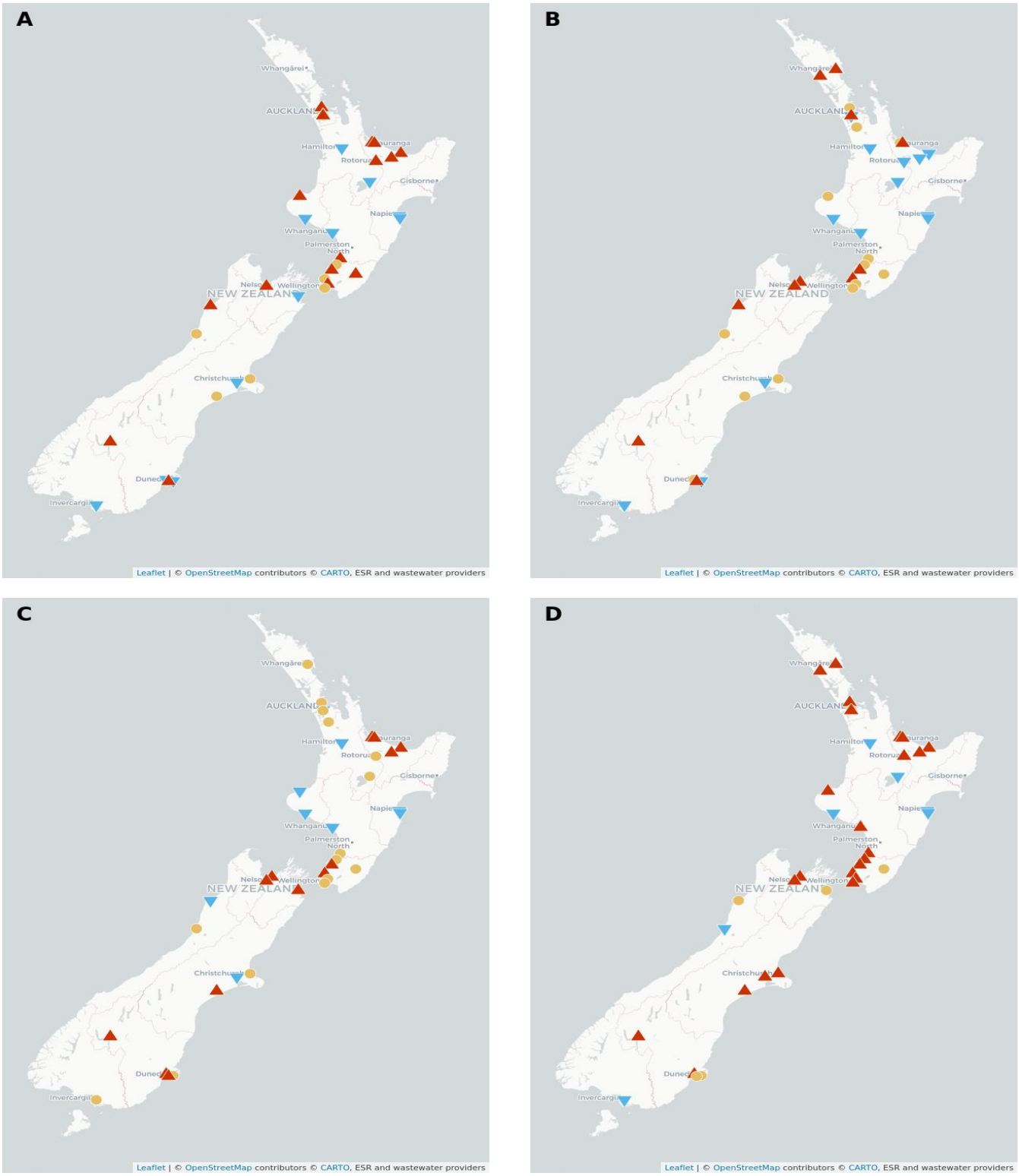

Figure 3. Comparison of SARS-CoV-2 levels for the week ending 24 December 2023 compared to levels measured: A) 1 week ago; B) 2 weeks ago; C) 4 weeks ago; D) 12 weeks ago. Only sites with results for both time points are included. When the viral quantity is 30% or more higher this is labelled as increased (red up arrow on map). When the viral quantity is 30% or more lower, this is labelled as decreased (blue down arrow on map). If viral levels have changed less than this in the compared weeks, this is labelled as no change (yellow circle on map). Interactive map of weekly results available publicly at https://www.poops.nz/

Variant Analysis

Results from four weeks of sampling (weeks 48 to 51) from up to 20 sentinel wastewater sites (Table 1) across New Zealand are reported.

The XBB family of lineages (which includes EG.5, HK.1.2, HK.3 and JD.1.1) was the predominant linage group at the beginning December but decreased as a percentage throughout the month. The estimated national percentage of this group collectively was 69% in week 48, 64% in week 49, 53% in week 50 and 39% in week 51 (variants shown in shades of green, Figures 4 and 5, Table 1).

The percentage of JN.1 (a descendant lineage of BA.2.86) increased from weeks 48 to week 51. The estimated national percentage was this variant was 17% in week 48, 26% in week 49, 34% in week 50 and 49% in week 51 (shown in purple in Figures 4 and 5, Table 1).

The percentage of BA.2.86 increased slightly across the month, from 6% in week 48 to 10% in week 51.

XBC and other recombinant lineages decreased as a percentage of the national total over December, being at low levels by the end of the month.

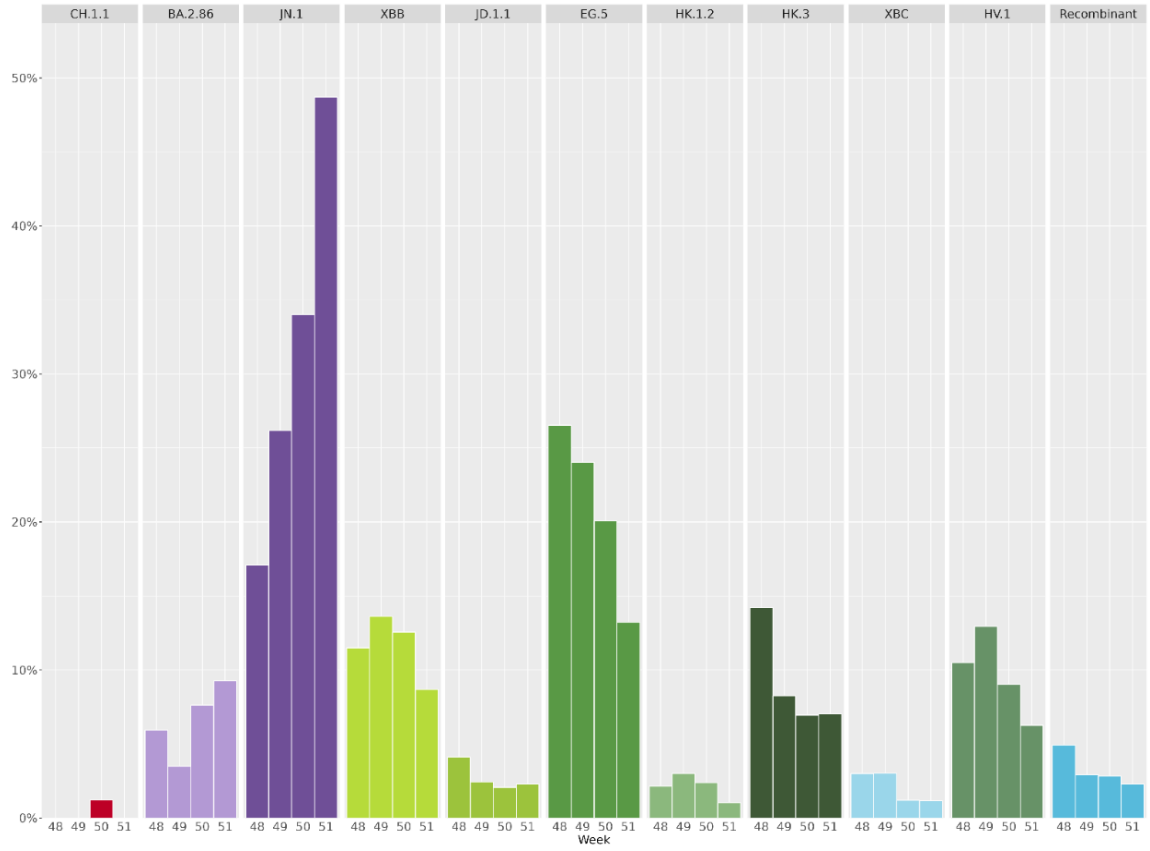

Figure 4. National percentage of each variant for week 48 (ending 03 December 2023) to week 51 (ending 24 December 2023).

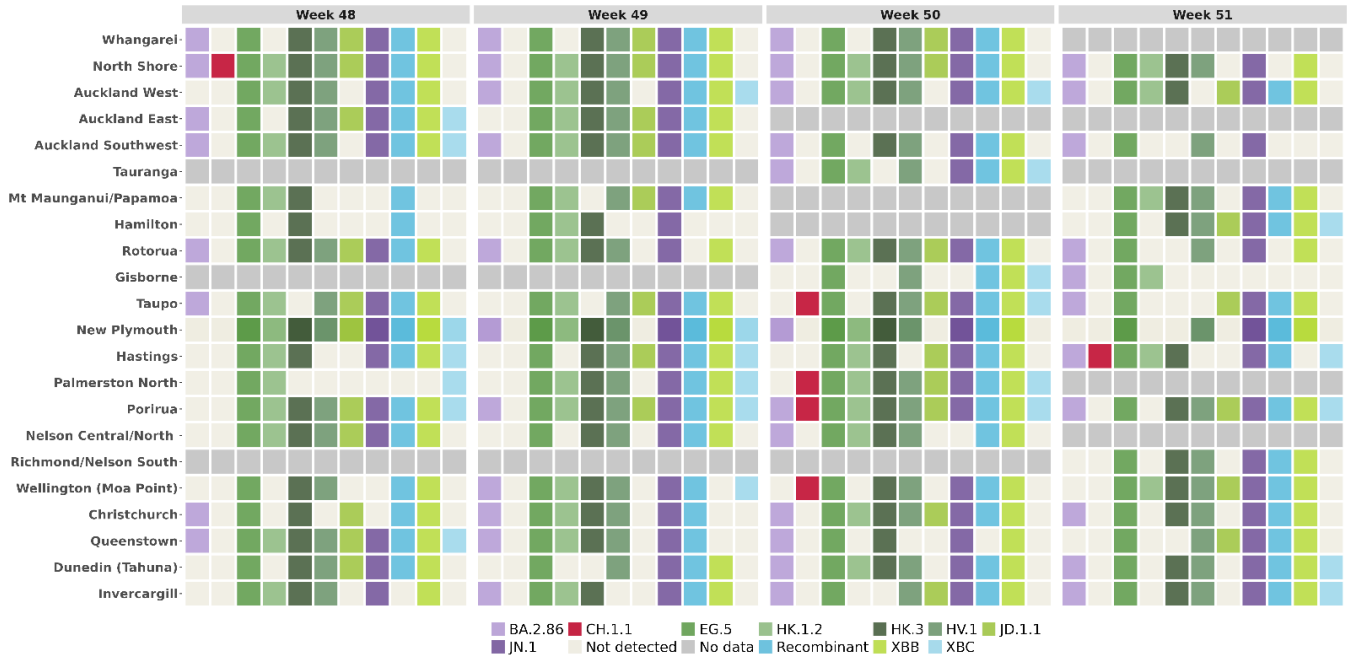

Table 1. Data from ~20 wastewater sentinel sites sampled from week 48 (ending 3 December 2023) to week 51 (ending 24 December 2023). Coloured box denotes that the variant was detected at that site that week, cream box denotes that the variant was not detected, and grey box denotes site was not sampled that week.

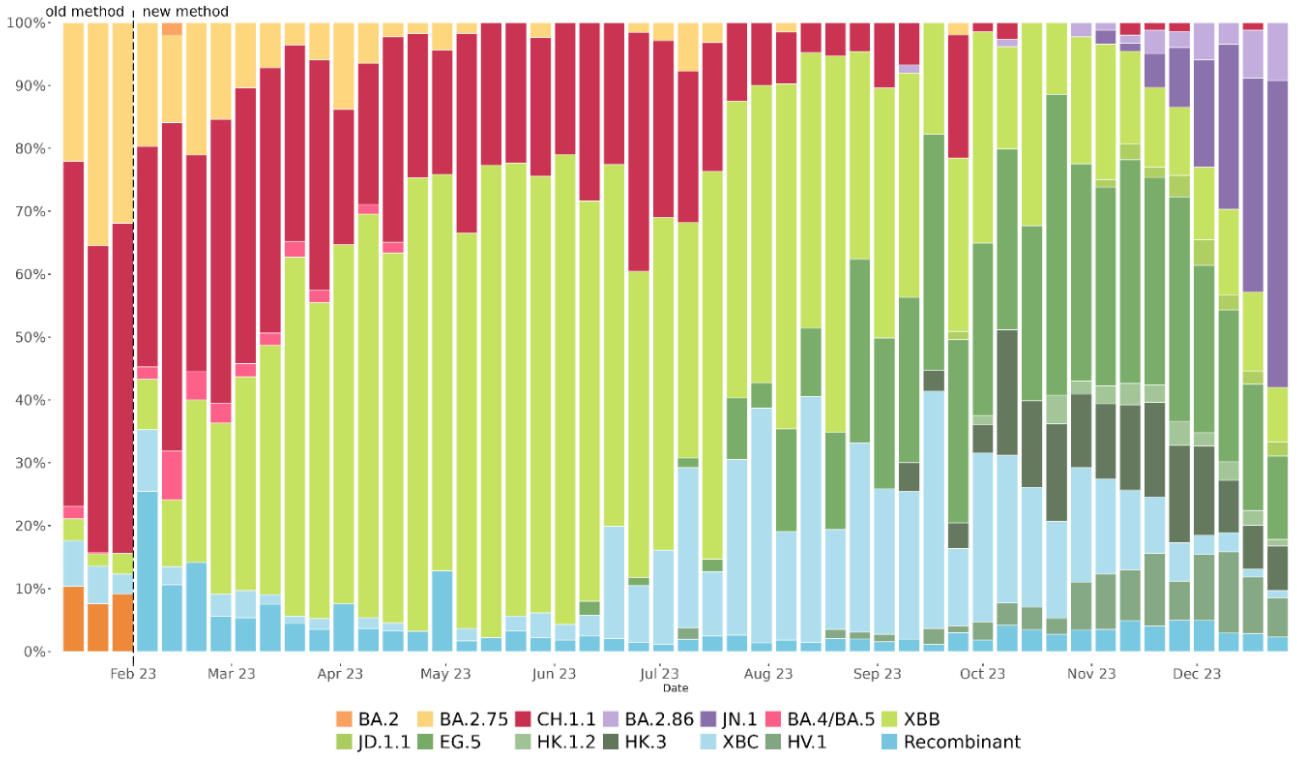

Figure 5. Estimated variant percentage over time at a national scale (average). Data are collected from ~20 sentinel sites each week.

Instantaneous Reproduction Number

Daily wastewater and case data up to 31 December 2023 was used for the modelling. The uncertainty in these measures is denoted with 95% credible intervals (shown in green in Figure 6).

The estimate of the instantaneous reproduction number for 31 December 2023 (in week 52) was 0.94 (95% credible interval 0.67 – 1.31, Figure 6).

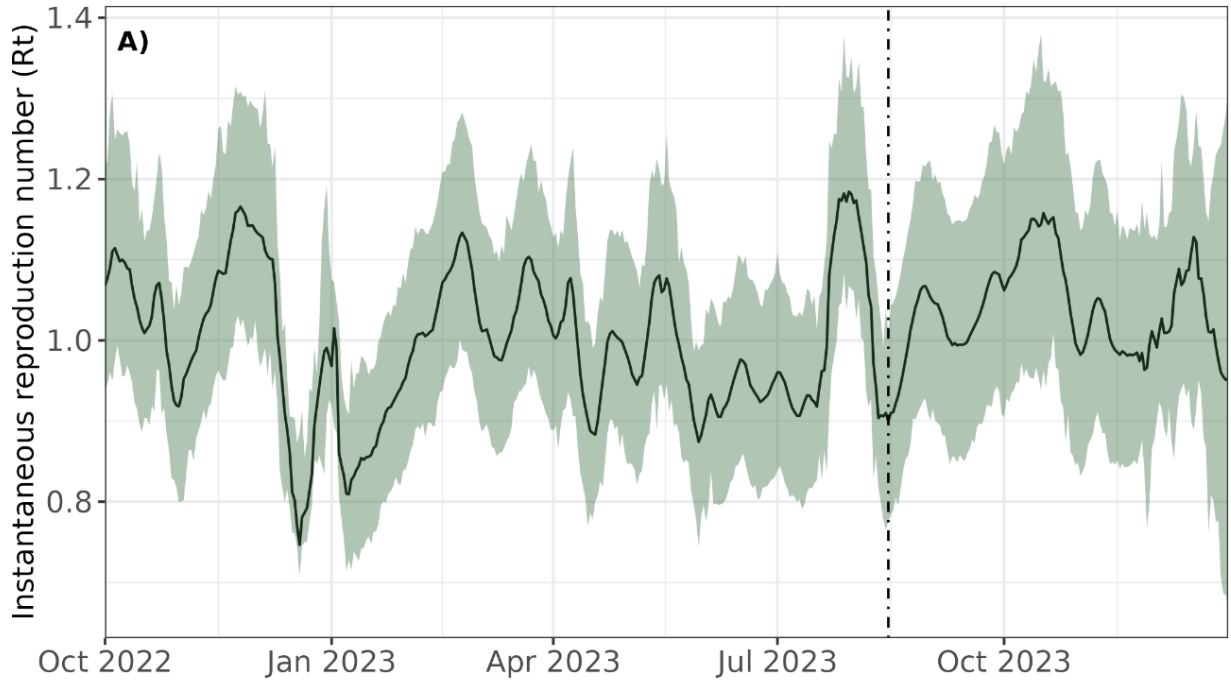

Figure 6. Estimates of instantaneous reproduction number. Black vertical lines represent when COVID-19 restrictions were lifted on 15 August 2023. Black solid lines represent central estimates. Shaded regions show 95% credible intervals on the value of the hidden states.

Trends in Ministry of Health Regions

Regional analysis of the wastewater data is shown in Figure 7. Regional estimates could not be calculated for week 52 (ending 31 December 2023) due to a limited sampling schedule being operated over the holiday break.

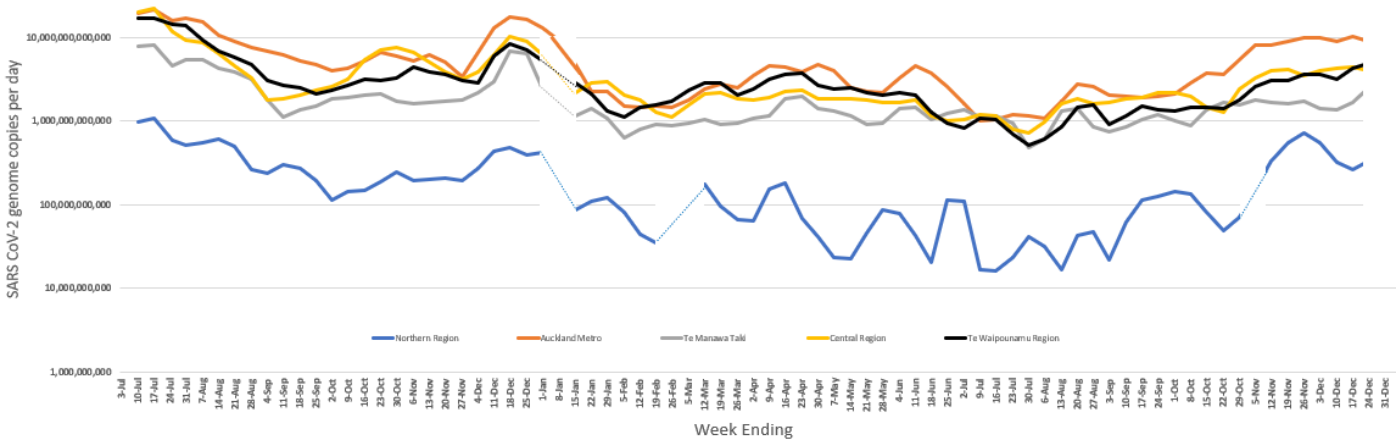

Figure 7. Two week rolling average of total SARS-CoV-2 genome copies detected per day in the five Ministry of Health regions. Dashed lines are inferred levels during periods when samples were either not collected (Christmas period) or insufficient numbers collected (due to weather impacts) for the region.

Acknowledgements

This work represents the combined efforts of many individuals and organisations.

We thank the teams across the country who are collecting the wastewater that underpins this work.

The wastewater analysis has been undertaken at ESR by a team including laboratory staff, data scientists, bioinformaticians, and other staff. Ongoing support for this work from the Ministry of Health and ESR management is appreciated.

Notes

Sites and frequency of sample collection: The catchment population sites selected for the surveillance range from approximately 400 to over 1,000,000 individuals. The sites cover all regions of the country. Most major towns and all cities, as well as many smaller communities, are included. In early 2023, the wastewater catchment areas cover over 75% of the population connected to wastewater treatment plants. The sites from which samples have been collected have varied over the last 12 months. New sites may be added over time, and/or sampling may reduce in frequency or cease for other sites. The selection and frequency of sampling vary depending on the local population, access to wastewater collection points, staff availability to collect samples and risk factors. When included, samples are collected at least weekly, with twice weekly sampling being common.

Sampling method: The preferred option is to automatically collect a 24 hour 'composite' sample. This is where a pump automatically collects a small volume of wastewater every 15 minutes over 24 hours using a composite sampler. These samplers are available in some wastewater treatment plants. When composite samplers are not available, 'grab' samples are collected. These range from a sample being taken at a single point in time, to 3 samples taken over 30 minutes, to samples collected over a day. Grab samples represent only the composition of the source at that time of collection and may not be as representative as a 24-hour composite sampler. More variation may be expected with grab samples.

Laboratory analysis of wastewater samples: Samples are sent from each wastewater treatment plant to ESR. Processing of each sample commences within an hour or two of receipt. Processing involves the concentration of virus from 250 mL sample to approx. 1 mL using centrifugation and polyethylene glycol. Viral RNA is then extracted from a small volume of 0.2 mL concentrate to give a final volume of 0.05 mL The presence of SARS-CoV-2 RNA is determined using RT-qPCR. SARS-CoV-2 is considered detected when any of the RT-qPCR replicates are positive.

RT-qPCR: Reverse transcription (RT) to convert RNA to complementary DNA (cDNA), followed by quantitative PCR (qPCR). RT-qPCR is used for detection and quantification of viral RNA.

Method sensitivity: The protocol used to concentrate SARS-CoV-2 from wastewater allows for the sensitive detection of SARS-CoV-2 by RT-qPCR. ESR has shown that when 10 individuals are actively shedding SARS-CoV-2 RNA in a catchment of 100,000 individuals, there was a high likelihood of detecting viral RNA in wastewater (https://doi.org/10.1016/j.watres.2021.118032). Shedding by one individual may be detected in wastewater, but it does depend on many factors including the amount and duration of shedding. Very low levels in wastewater may be not able to be quantified (i.e., less than the limit of quantification- see below).

SARS-CoV-2 RNA detected (positive result): A positive detection in the wastewater indicates that at least one person has been shedding SARS-CoV-2 into the wastewater at some point during the time period that the sample was being collected. In some cases, detections could also be due to the shedding of low levels of SARS-CoV-2 RNA by a recently recovered case. The detection of SARS-CoV-2 RNA does not indicate that infectious virus is present.

SARS-CoV-2 RNA not detected (negative result): A negative result can occur because there are no active 'shedding' cases in the catchment or because the SARS-CoV-2 RNA concentration is too low to be detected, most likely because there are a very low number of cases in the wastewater catchment. Therefore, negative finding does not necessarily guarantee the absence of COVID-19 in the community.

Viral loads and normalisation: When detected, the SARS-CoV-2 RNA concentration is calculated as genome copies per L of wastewater. This is then converted to a viral load of genome copies/day/person. This conversion considers the flow rate of wastewater entering the treatment plant (the influent) and the population in the catchment. The flow rate is the total volume (m3 per day) recorded at the inlet of the wastewater treatment plant over 24 hours. This is a population-normalised viral load. Currently, the flow rate is the average annual flow rate, but will be replaced with daily flow rate when available (note that rainfall may significantly increase the flow rate at the inlet, diluting the sample, and may result in lower concentrations and a false negative result).

Limit of quantification: The lowest concentration of the target that can be reliably quantified is referred to as the limit of quantification. For those samples where SARS-CoV-2 is detected but cannot be quantified, a value of 5 genome copies/mL wastewater is used. While a standard method is being used, virus recovery can vary from sample to sample, and this may affect the quantitation.

Wastewater Data Modelling: ***Instantaneous reproduction number (R_t)****:* The instantaneous reproduction number (R_t) represents the average number of secondary cases that will arise per primary infectious case. The effective reproduction (R_{eff}) number can be measured as either the instantaneous reproduction number (R_t), which measures transmission at a specific point in time; or the case reproductive number, which measures transmission for a specific cohort of individuals. The models described measure the instantaneous reproduction number (R_t). In general terms, an R_t above 1 would typically indicate an increasing number of infections in the population. The instantaneous reproduction number is calculated using a semi-mechanistic model that is fitted to (i) case numbers and (ii) wastewater quantitation, and incorporates information about shedding rates, infection generation times, and case ascertainment. Instantaneous reproduction number is estimated take into account any delays in self-reporting of cases. It should be noted that there is uncertainty in this measure, which is denoted with the 95% credible intervals.

Data subject to change: Data generated for the New Zealand Wastewater COVID-19 Surveillance Programme should be considered provisional and may be subject to change.

Data not shown: Results from certain samples may not be shown, as the result was either deemed invalid, or the sample could not be tested (e.g., leaked in transit, not labelled).

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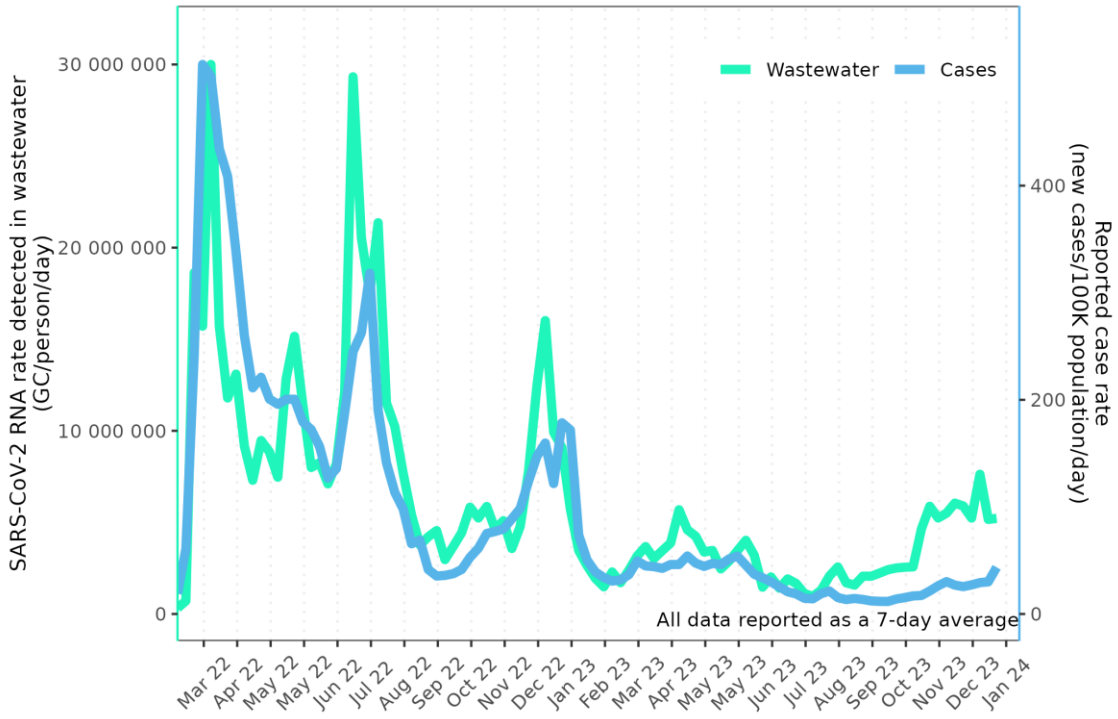
Appendix A. National Results

Time series plotted on linear scale



Appendix B. Site Results Weekly Summary

Table 2: Weekly Summary of Wastewater Sampling Results for SARS-CoV-2

Key: Detected **Detected (not quantified)** **Not detected** **Not tested**

Region	Site	Population	Sample Type	2023 8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Northland	Dargaville	5,000	Grab																																													
	Mangawhai	1,100	Grab																																													
	Maungaturoto	1,300	Grab																																												
	Whangarei	65,000	Autosampler																																												
Auckland	Army Bay	42,000	Autosampler																																												
	Auckland East	680,000	Autosampler																																												
	Auckland Southwest	120,000	Autosampler																																												
	Auckland West	315,000	Autosampler																																												
	Beachlands	6,760	Grab																																												
	North Shore	240,000	Autosampler																																											
	Pukekohe	20,900	Autosampler																																												
	Snells/Algies	4,000	Autosampler																																												
	Warkworth	3,500	Autosampler																																												
Waikato	Cambridge	20,100	Autosampler																																												
	Hamilton	169,000	Autosampler																																												
	Taupo	23,000	Auto/grab																																												
	Te Awamutu	13,100	Autosampler																																												
	Whitianga	6,600	Autosampler																																												
Bay of Plenty	Katikati	5,500	Autosampler																																													
	Kawerau	7,000	Autosampler																																													
	Mt Maunganui/Papamoa	65,000	Autosampler																																													
	Rotorua	59,000	Autosampler																																													
	Tauranga	50,000	Autosampler																																													
	Whakatāne	21,020	Autosampler																																												
Gisborne	Gisborne	37,000	Autosampler																																													
Hawke's Bay	Hastings	80,000	Autosampler																																													
	Napier	55,000	Autosampler																																													
	Waipukurau	4,610	Autosampler																																												
Taranaki	Eltham	2,007	Autosampler																																												

Region	Site	Population	Sample Type
	Hawera	12,000	Autosampler
	New Plymouth	88,000	Autosampler
Manawatu-Whanganui	Dannevirke	5,697	Grab
	Levin	21,200	Autosampler
	Palmerston North	90,000	Autosampler
	Whanganui	44,500	Autosampler
Wellington	Carterton	5,800	Grab
	Hutt Valley	133,000	Autosampler
	Masterton	20,700	Auto/grab
	Otaki	3,500	Autosampler
	Paraparaumu	49,000	Autosampler
	Porirua	85,000	Autosampler
	Wellington (Moa Point)	168,000	Autosampler
Tasman	Motueka	8,300	Autosampler
Nelson	Nelson Central/North	26,000	Autosampler
	Richmond/Nelson South	60,000	Autosampler
Marlborough	Blenheim	31,000	Autosampler
West Coast	Greymouth	10,000	Grab
	Westport	5,000	Grab
Canterbury	Ashburton	18,000	Autosampler
	Christchurch	368,000	Autosampler
	Rolleston & Eastern Selwyn	35,000	Autosampler
	Timaru	28,000	Autosampler
	Woodend	7,600	Grab
Otago	Alexandra	6,200	Autosampler
	Cromwell	7,100	Autosampler
	Dunedin (Green Island)	22,900	Autosampler
	Dunedin (Mosgiel)	14,600	Autosampler
	Dunedin (Tahuna)	84,000	Autosampler
	Queenstown	40,000	Autosampler
	Wanaka	14,500	Grab
Southland	Bluff	2,000	Autosampler
	Gore	8,000	Autosampler
	Invercargill	50,000	Autosampler