

COVID Model Projections

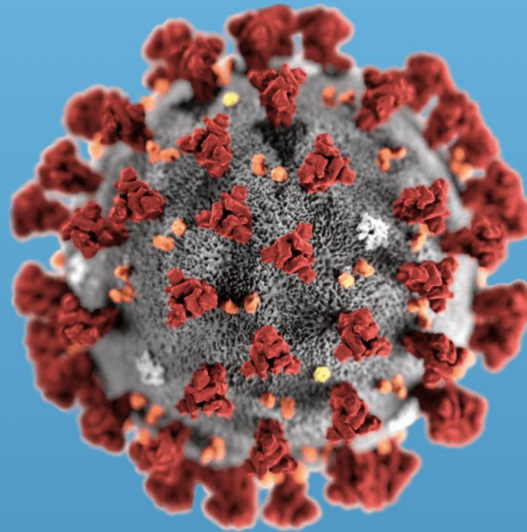
May 14, 2021

[BC COVID-19 Modelling Group](#)

About BC COVID-19 Modelling Group

The BC COVID-19 Modelling Group works on rapid response modelling of the COVID-19 pandemic, with a special focus on British Columbia and Canada.

The interdisciplinary Group was convened by [Caroline Colijn](#) (SFU) and [Dan Coombs](#) (UBC) with support from the [Pacific Institute for the Mathematical Sciences](#).



<https://bccovid-19group.ca>

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*Independent and freely offered advice,
using a diversity of modelling approaches.*

Bending down the VOC curve

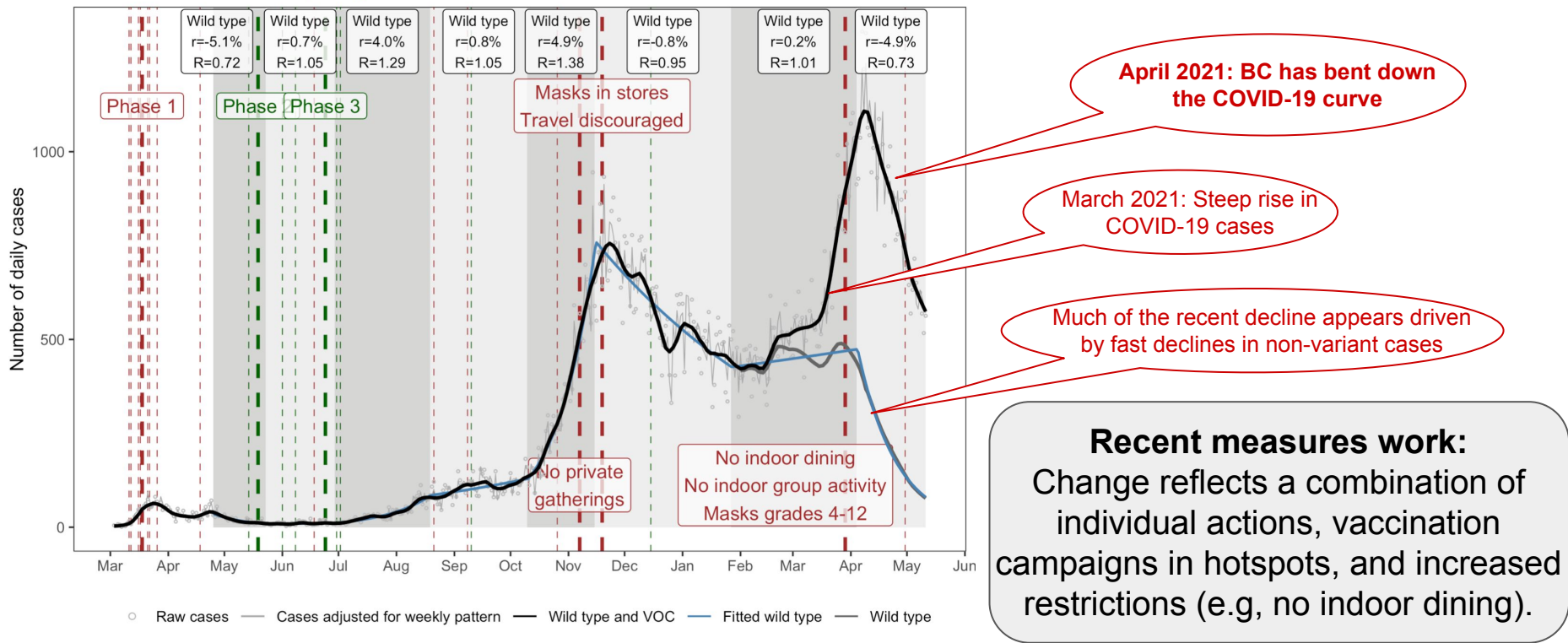
Key messages

- Cases are projected to decline through May
- Hospital and ICU occupancy declining slowly but predicted to remain above 300 and above 100 through May.
- If recent measures are lifted at the end of May (returning to February/March 2021 activities), cases, hospital, and ICU occupancy will grow briefly but then decline by late June as vaccination catches up.
- Recent changes in growth associated with larger impact on VOC than WT.
 - Not due to vaccination
 - Likely due to individual behaviour changes (masks, distancing, restaurant rule)

State of the COVID-19 Pandemic in BC

Covid-19 daily new cases in British Columbia (up to Tue May 11)

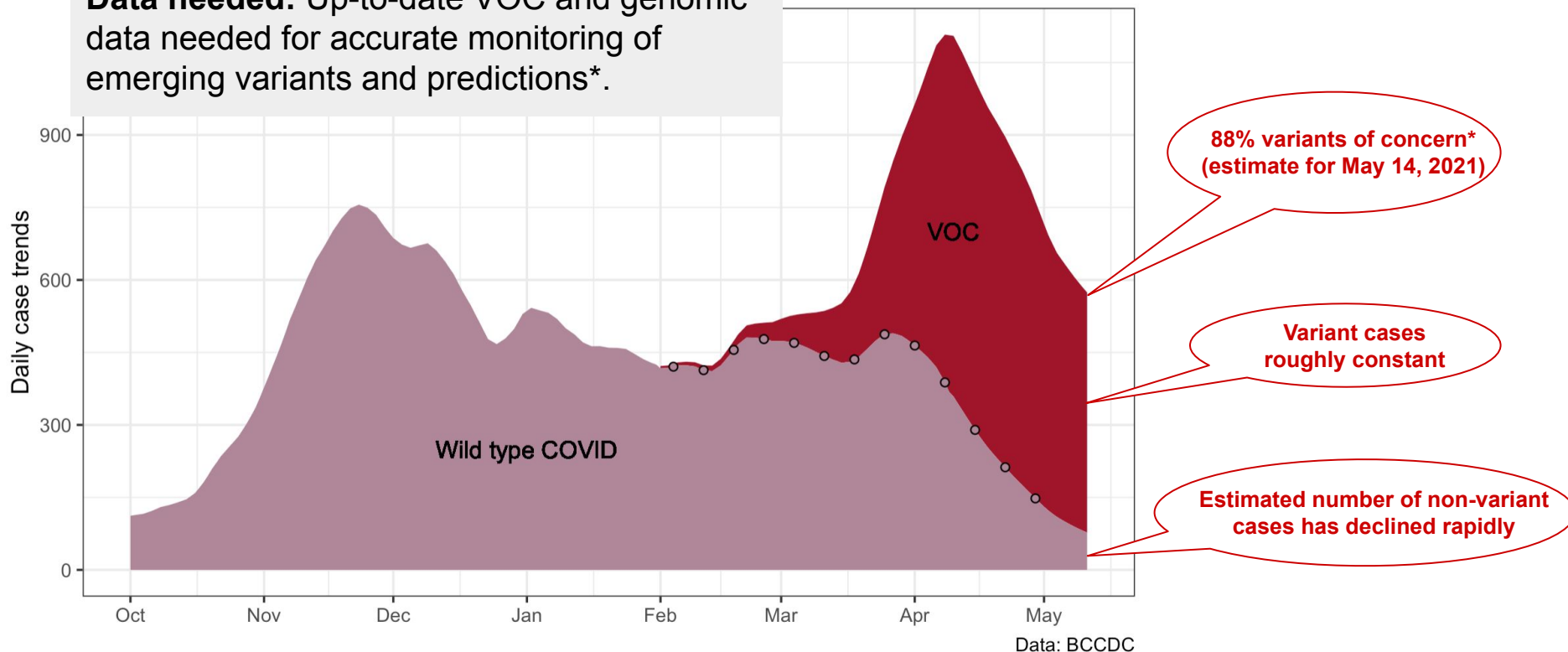
Timeline of **closure** and **reopening** events



Source (J. von Bergmann) Case data from BC COVID-19 Database (<http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data>). Vertical lines give dates of public health measures (major as thick lines, minor as thin lines). Grey dots are raw case counts, grey lines is cases adjusted for weekly pattern, black STL trend line and blue fitted periods of constant exponential growth.

State of the COVID-19 Pandemic in BC

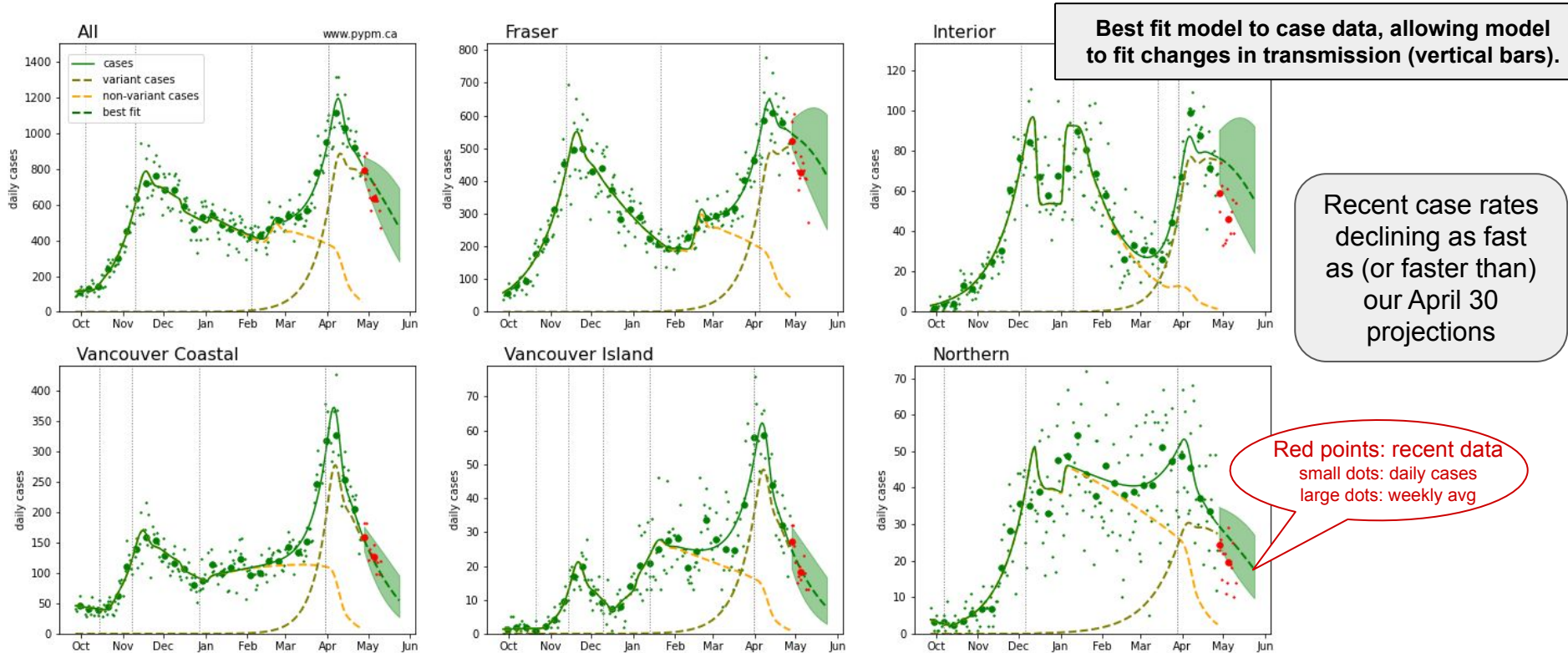
Data needed: Up-to-date VOC and genomic data needed for accurate monitoring of emerging variants and predictions*.



Source (J. von Bergmann). Case data from BC COVID-19 Database (<http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data>) and smoothed using STL trend line that removes day-of-the-week effects. VOC data from BCCDC (April 7, 2021). Variant data: <http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data#variants>

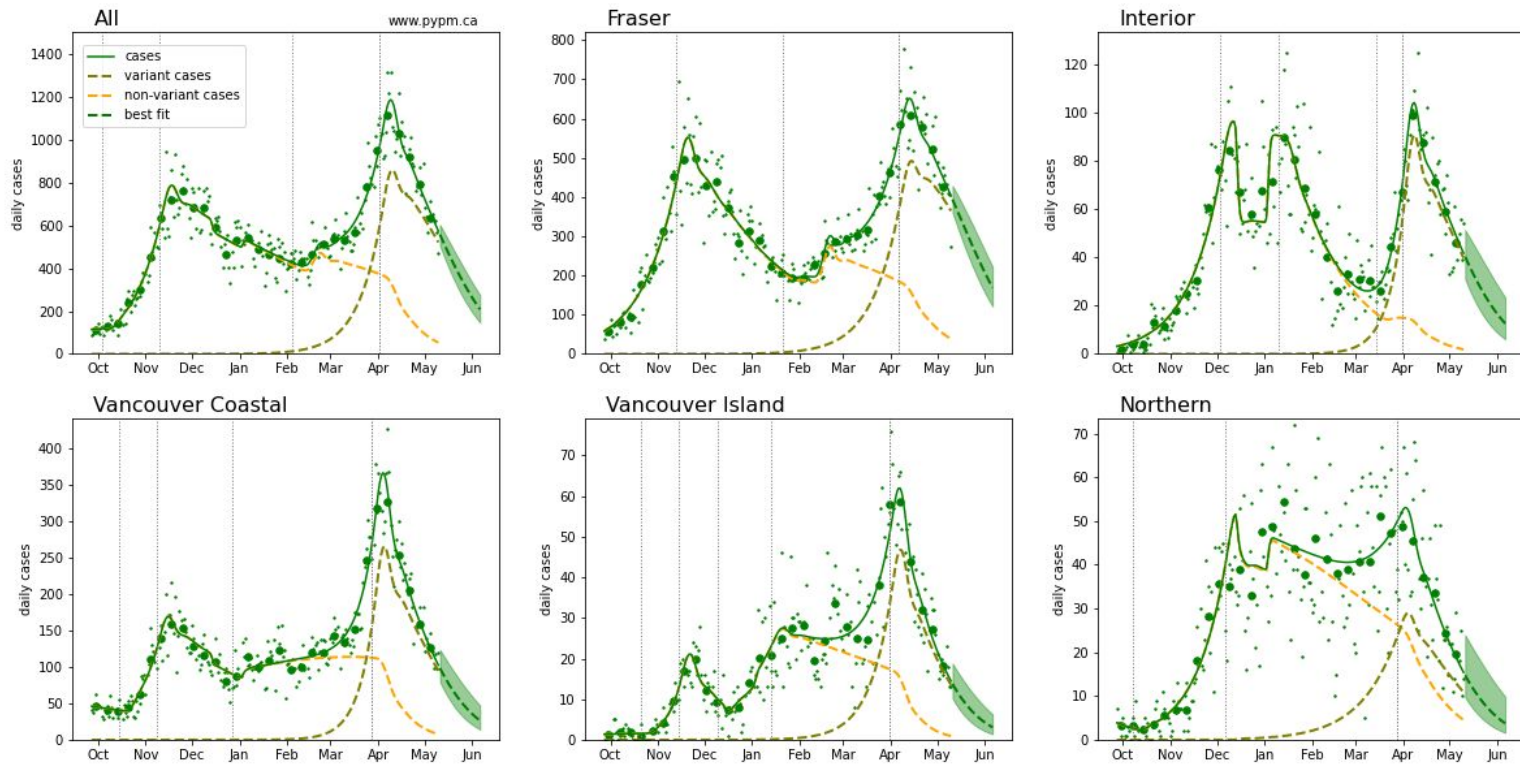
*Accounting for slowdown in variant spread (slide 11).

April 30 model fit to case data by Health Authority



Source (D. Karlen). See www.pypm.ca. Assumes homogeneous mixing (no age structure). Assumes vaccination rate of 1st doses continues at 35,000/day (assumes vaccines given to all ages and in proportion to HA populations). Vaccination model benchmarked with data from Israel: see Appendix and [link](#). Model fits to case data projected into May assuming current public health measures. Shaded bands indicate range of trajectories consistent with case data (68% CL).

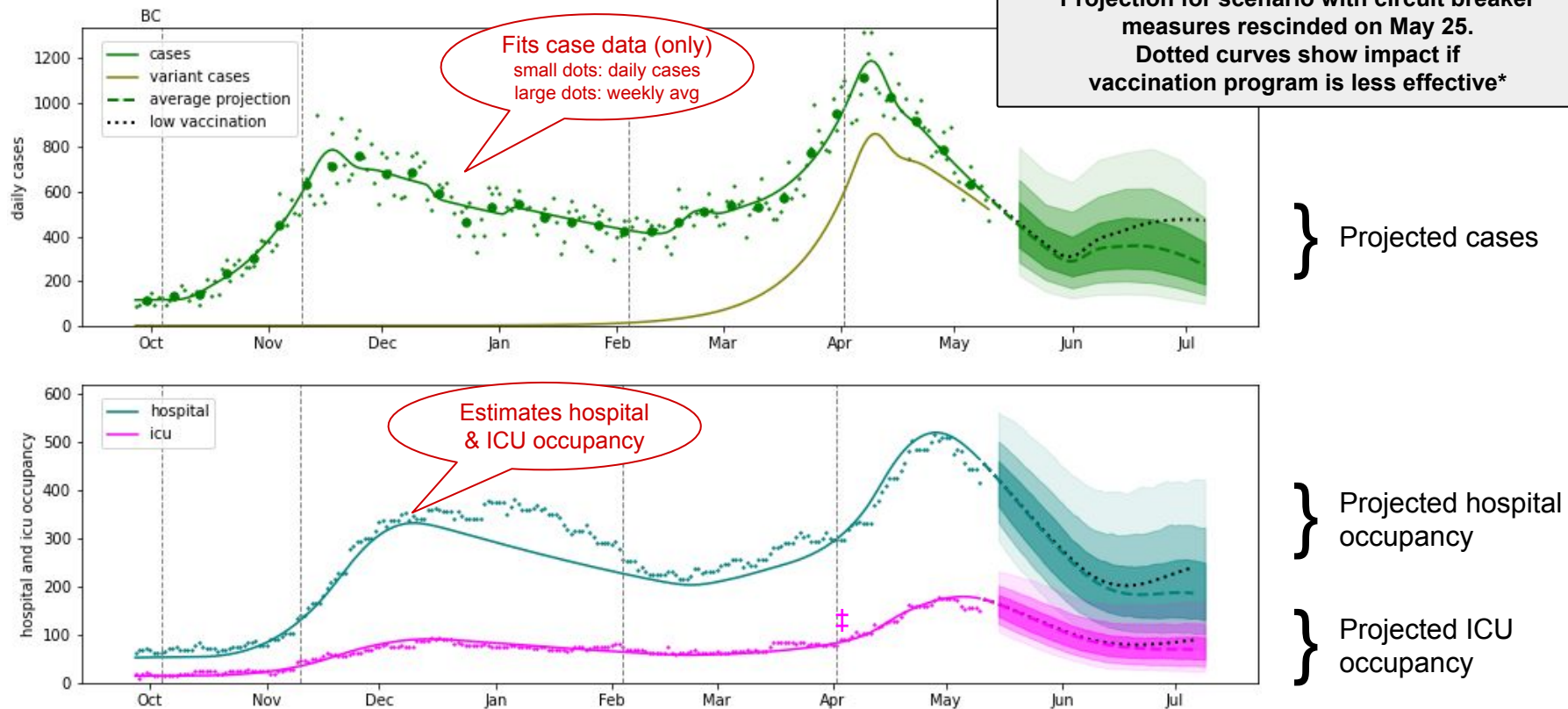
Updated model fit to case data by Health Authority



New projections show continued case declines as vaccines rollout.

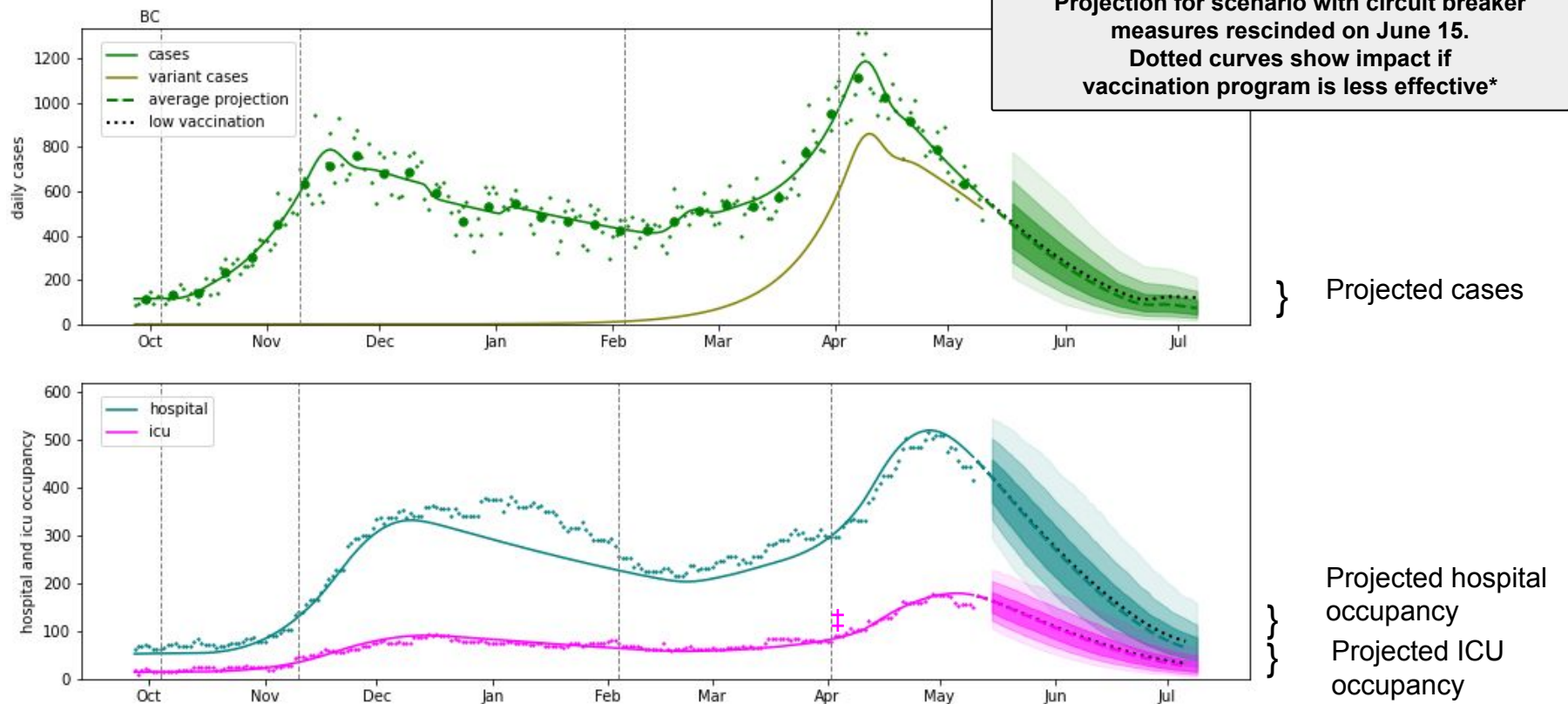
Source (D. Karlen). See www.pymp.ca. These models have no age structure. Assumes vaccination rate of 1st doses grows to 45,000/day on May 17 (given to all ages and in proportion to HA populations until 75% of the population is vaccinated), ultimate 1st dose effectiveness is 90%. Vaccination model benchmarked with data from Israel: see Appendix and [link](#). Assumes current public health measures remain in place. Shaded bands indicate range of trajectories consistent with case data (68% CL).

Model fit with relaxation on May 25



Source (D. Karlen). See www.pympm.ca. Homogeneous mixing (no age structure). *Nominal versus low vaccination rate assumptions: 45,000/day vs 35,000/day up until 75% vs 65% vaccinated, with 90% vs 80% asymptotic effectiveness of first dose (see Appendix for comparison to real-world effectiveness). Projection is for a scenario rescinding the March 30 measures (the “circuit breaker”) on May 25, returning BC to activity levels in early 2021. ‡To match ICU data, the fraction of cases leading to ICU admission is increased by 60% ± 20% in early April. Bands show approximate 50%, 80%, and 95% intervals for nominal vaccination campaign.

Model fit with relaxation on June 15



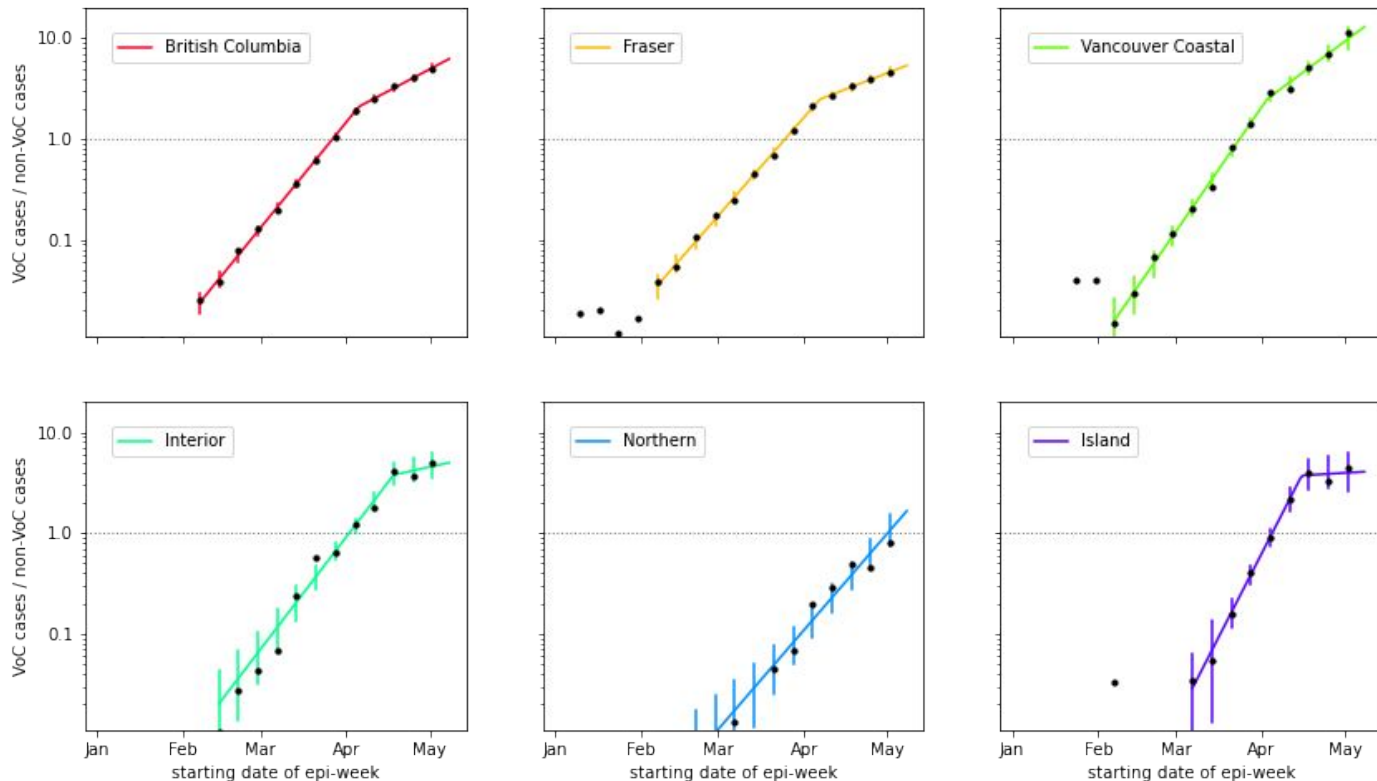
Source (D. Karlen). See www.pyppm.ca. Homogeneous mixing (no age structure). *Nominal versus low vaccination rate assumptions: 45,000/day vs 35,000 up until 75% vs 65% vaccinated, 90% vs 80% asymptomatic effectiveness of first dose (see Appendix for comparison to real-world effectiveness). Projection is for a scenario rescinding the March 30 measures (the “circuit breaker”) on June 15, returning BC to activity levels in early 2021. †To match ICU data, the fraction of cases leading to ICU admission is increased by 60% ± 20% in early April. Bands show approximate 50%, 80%, and 95% intervals for nominal vaccination campaign.

Growth advantage of Variants of Concern (VoC) in BC

VoC initially grew
8%/day faster than
original strains

Became dominant
near April 1
(Northern: May 1)

After “circuit breaker”:
advantage reduced to
4%/day faster than
original strains:
- measures had
greater effect on VoC



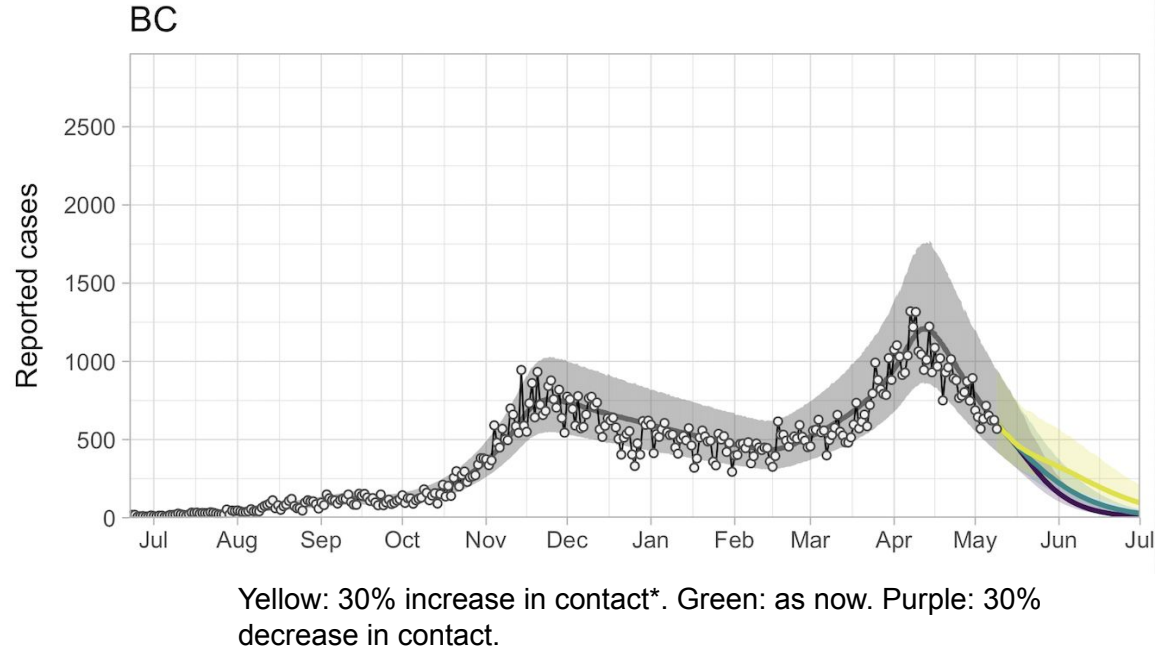
Source (D. Karlen). Fit to weekly VoC and non-VoC case data from [BCCDC](https://www.bccdc.ca). Except for Northern HA, a change to the growth advantage is apparent in early April, and fit estimates the change to occur near April 10. There are insufficient data in Interior, Northern, and Island to accurately estimate the change. For details, see Appendix.

BC incidence projections: contact and slight reopening

Incidence is declining, and vaccinations increasingly contribute to that decline.

Vaccination is incorporated by removing susceptibles at a rate accounting for contact by age, vaccination by age and susceptibility of contacts.

This decline appears robust to a slight increase in contact rates among those distancing (+30% in yellow, -30% in purple).



Source (E. Are, C. Colijn). Daily case numbers projected forward, accounting for VOC data from BCCDC (April 7, 2021). These data provide % of cases that were VOC by week (see slide 5). These data were fit by a logistic function to estimate percent VOC by day (see Appendix of April 14 report). Assuming a 40% increase in transmissibility (consistent with the estimated selection s in the Appendix of April 14 report), the percent VOC is used to create an overall reproduction number R for the virus population. R changes in time as the VOC rises in frequency. The social distancing parameter (among others) is estimated to fit the data using the [‘covidseir’](#) R package (M. Irvine, S. Anderson). * Measured as f , the relative contact rate among those willing and able to distance.

Age and essential worker vaccination model: reopening around May 25 in a singly-vaccinated population

Slight relaxation of measures on May 25 ($R \leq 2.0$, left two panels) avoids a major surge in cases, but too much re-opening ($R \geq 2.3$) causes another spike.

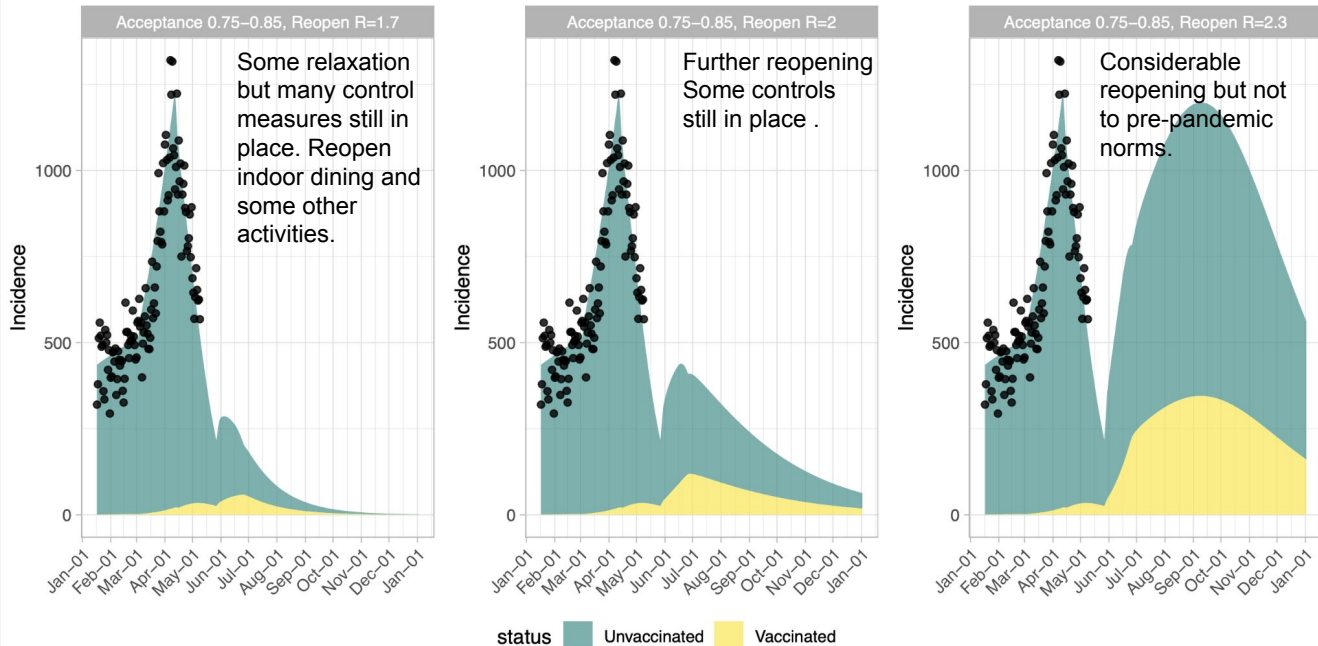
Long-term predictions are illustrations only of what might happen if we reopen too much. Future changes in our behaviour and 2nd doses are not included!

Vaccine Efficacy (single dose):

Against symptoms overall: 0.85

Against infection: 0.7

Against symptoms given infection: 0.5



Source (C. Colijn). Model: [Mulberry et al](#) with age and contact structure allowing for essential workers and with VOC increasing R . Incidence (active case numbers) from BCCDC. Assumes an ascertainment fraction of 0.7. Serological data would improve this estimate. Rollout is approximate. Efficacy references: [Bernal et al](#), [FDA](#) and [Dagan et al](#). Vaccine uptake: 75–85% (PHAC), with youth 12+ included, assuming that all those eligible have a first dose by June 30.

Age and essential worker vaccination model: reopening around June 15 in a singly-vaccinated population

Delaying reopening to mid-June keeps cases down for longer, but reopening too much still leads to a surge.

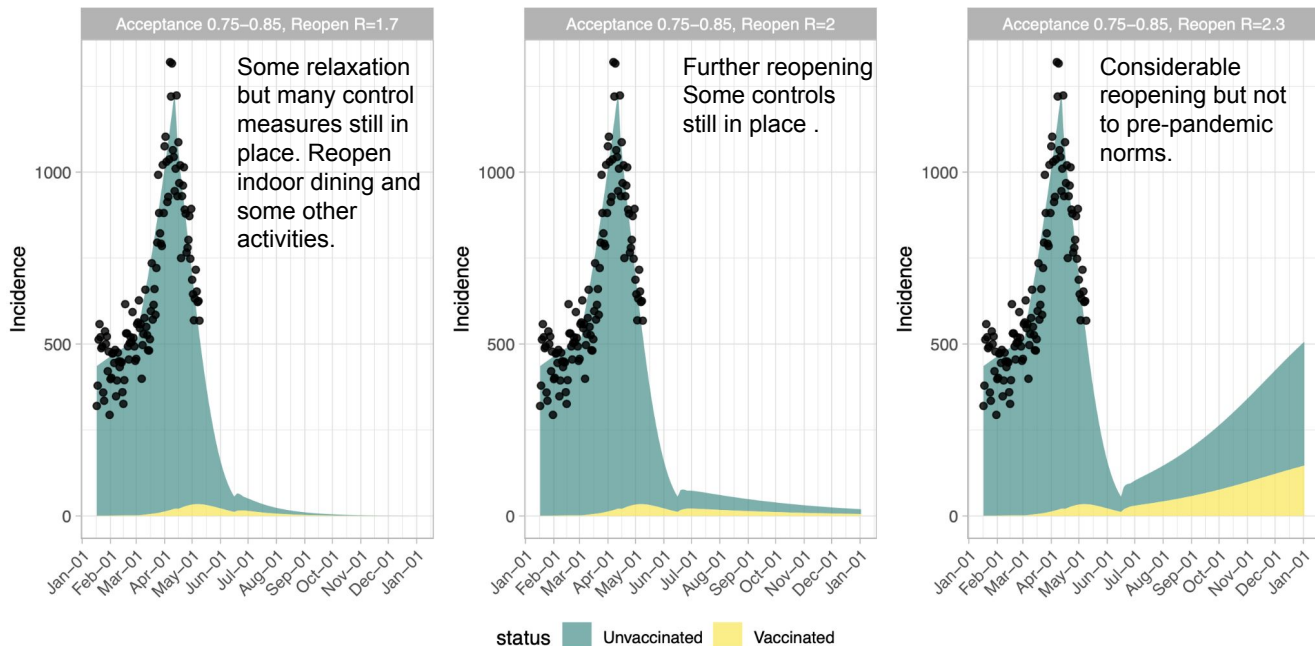
Getting more people effectively vaccinated and continued control measures important over the next few months.

Vaccine Efficacy (single dose):

Against symptoms overall: 0.85

Against infection: 0.7

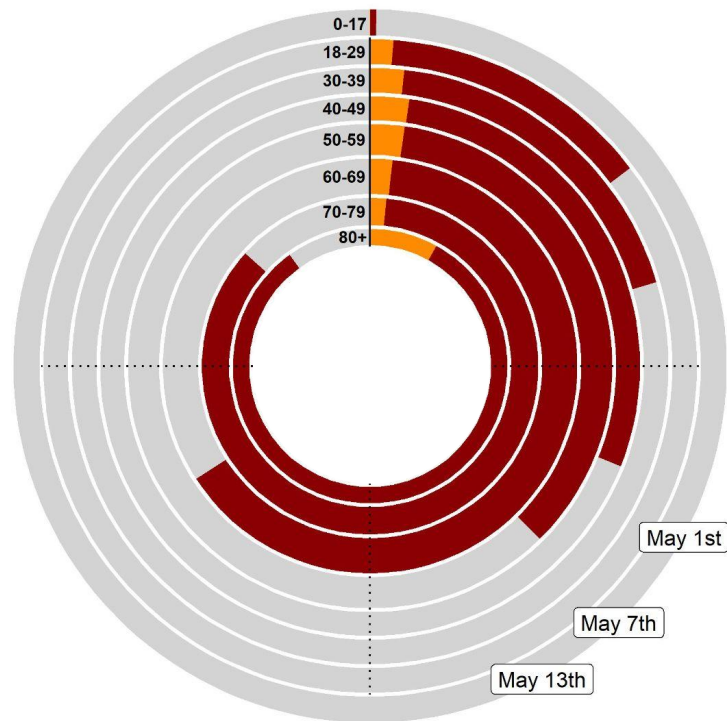
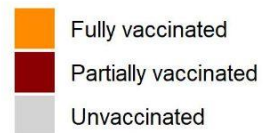
Against symptoms given infection: 0.5



Source (C. Colijn). Model: [Mulberry et al](#) with age and contact structure allowing for essential workers and with VOC increasing R. Incidence (active case numbers) from BCCDC. Assumes an ascertainment fraction of 0.7. Serological data would improve this estimate. Rollout is approximate. Efficacy references: [Bernal et al](#), [FDA](#) and [Dagan et al](#). Vaccine uptake: 75–85% (PHAC), with youth 12+ included, assuming that all those eligible have a first dose by June 30.

Closing the circle: Vaccination status by age

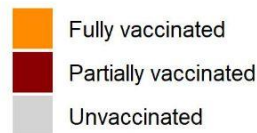
Last BC data update May 1, 2021



Making progress:
Average vaccination levels
by date in BC

Closing the circle: Vaccination status by age

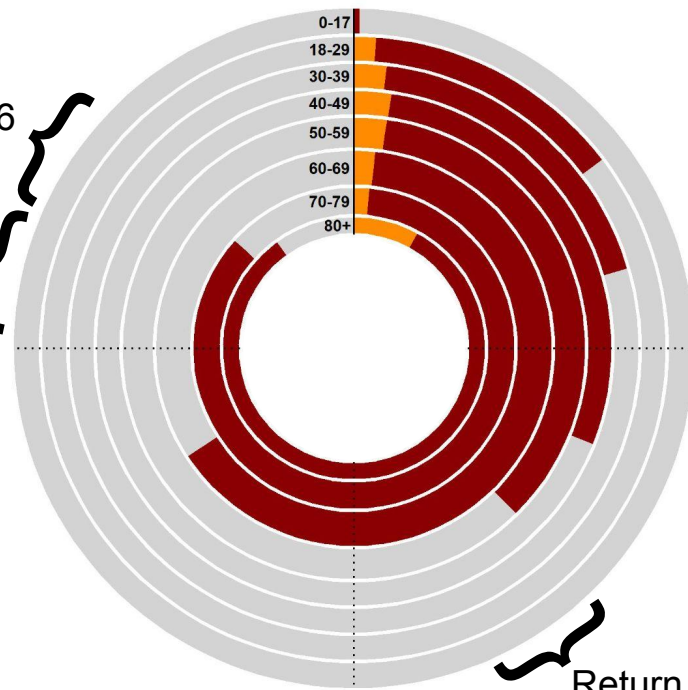
Last BC data update May 1, 2021



Herd immunity if $R_0 \sim 5-6$

Herd immunity if $R_0 \sim 4-5$

R_0 for variants now in BC is estimated to be ~ 2.8 to 5.4^* , without control measures



Herd immunity: the level of immunity in a population at which a disease starts to decline

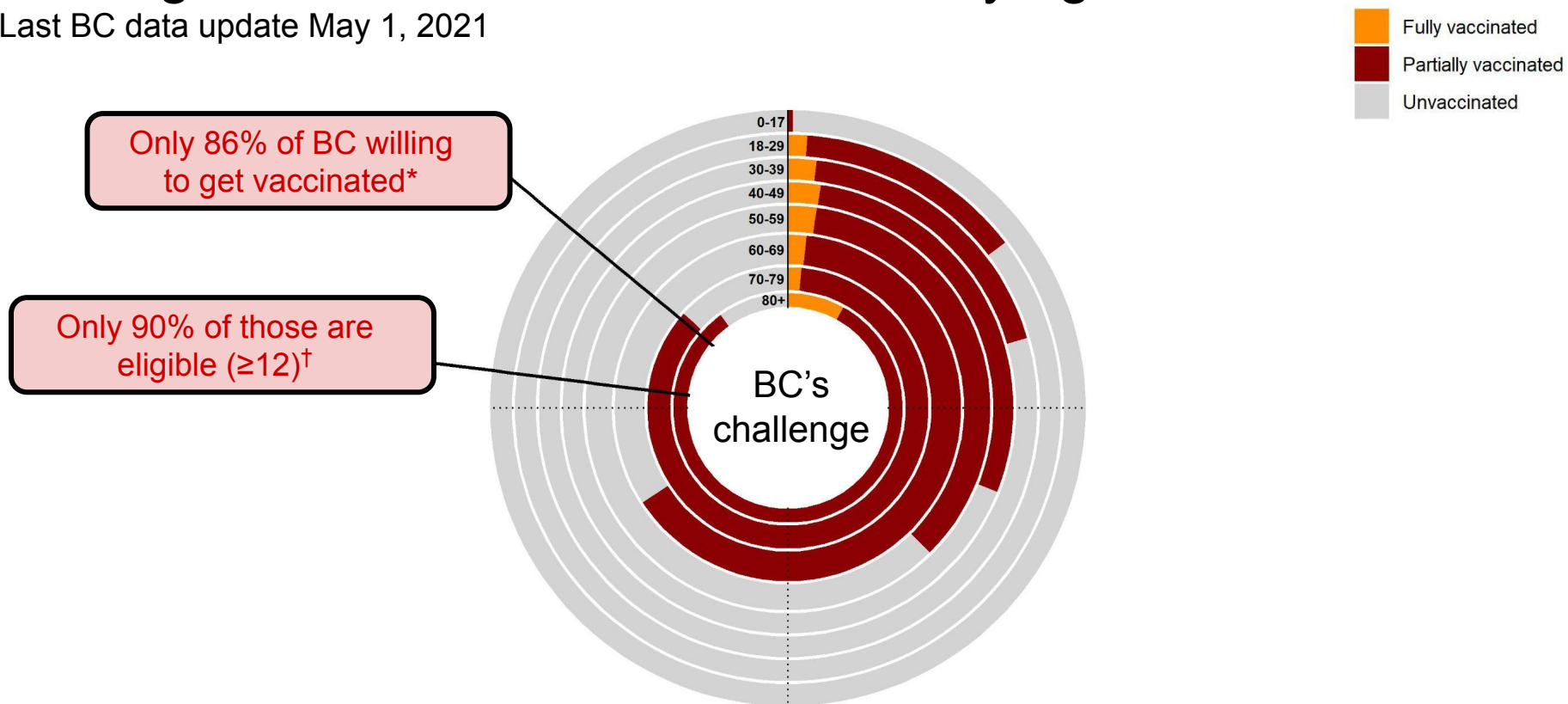
→ $(1-f) R < 1$ where f is level of immunity

Reproductive number (R): number of new cases per case, called R_0 in the absence of any control measures.

Return to Feb/March 2021 activities when $R \sim 1.7$ for variants now in BC[†]

Closing the circle: Vaccination status by age

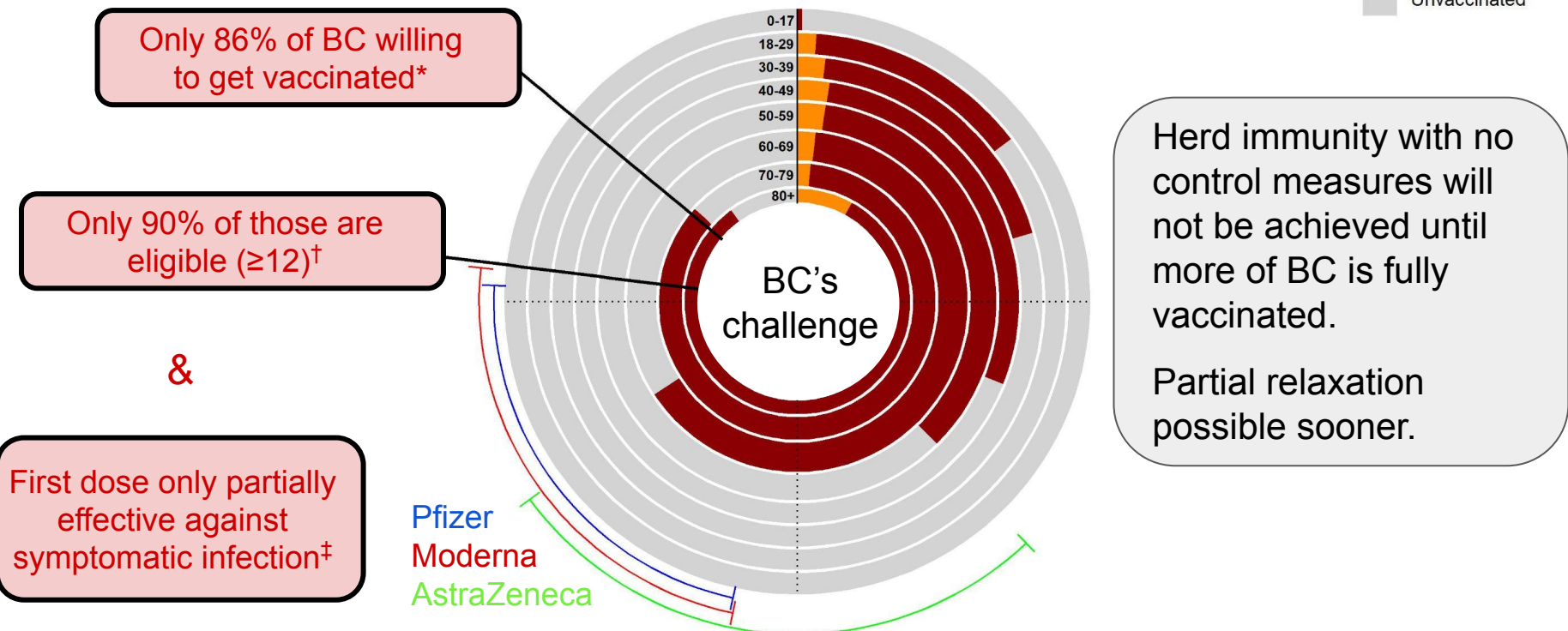
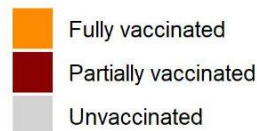
Last BC data update May 1, 2021



Source (B. Wiley). Design by Blake Shaffer. *Angus Reid (April 26, 2021): <https://angusreid.org/vaccine-astrazeneca-johnson/>. [†]BCCDC (April 24, 2021) Epi-week 16 Situation Report. [‡]NACI "Recommendations on the use of COVID-19 vaccines" (May 3, 2021), Efficacy against symptoms >14 days after one dose (>21 days for AstraZeneca) but before two doses; Pfizer: 92.3% [95%CI: 69-98%]; Moderna: 92.1% [95%CI: 68.8-91.1%]; AstraZeneca: 71.3% [95%CI: 49.0-83.8%].

Closing the circle: Vaccination status by age

Last BC data update May 1, 2021

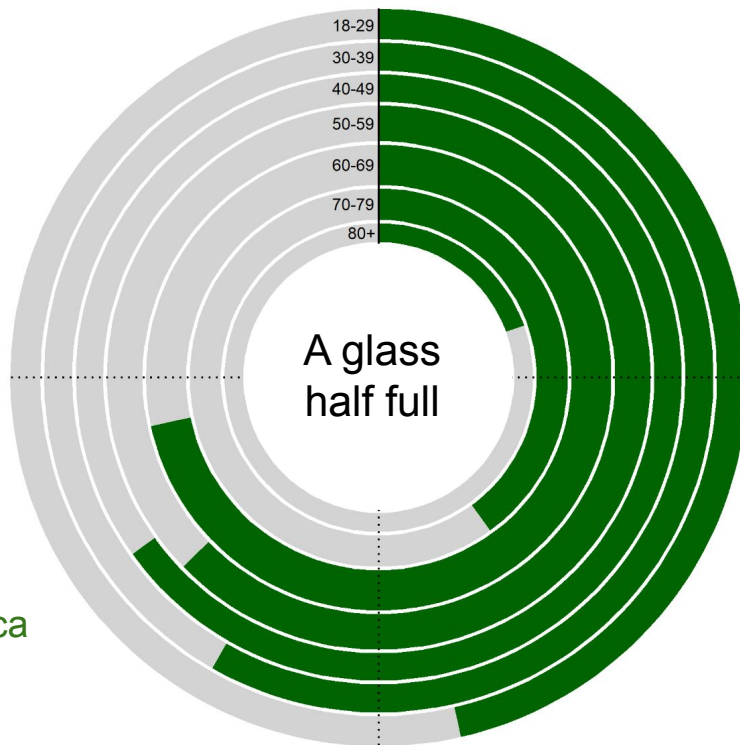


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Fraction registered for vaccination in BC

Last BC data update May 9, 2021

Registered for Vaccination
Unregistered for Vaccination



Many more people need to register for vaccinations to ensure the rollout (and our return to normal) is as fast as possible.

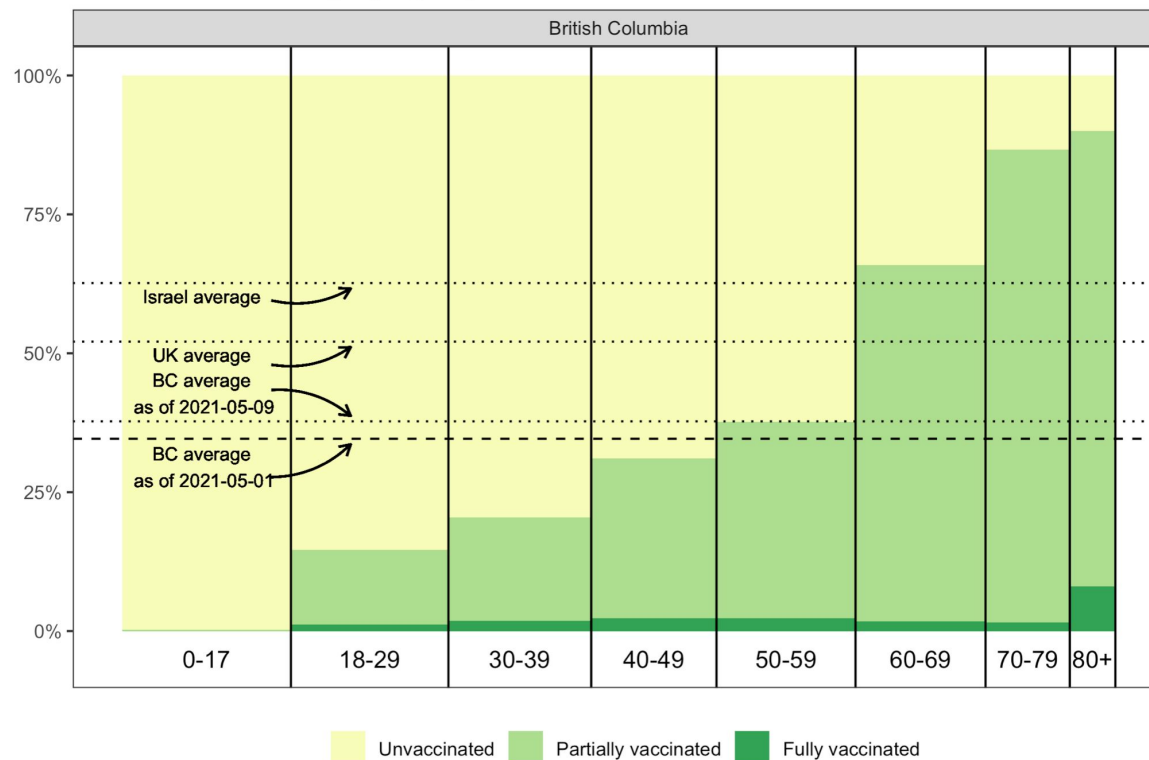


<http://www.getvaccinated.gov.bc.ca>

Source (B. Wiley). Design by Blake Shaffer. https://news.gov.bc.ca/files/5-10-21_vaccine_registration.pdf Many individuals in the older age groups and in targeted communities have been vaccinated without registration, but all adults (18+) are currently being asked to register (<http://www.getvaccinated.gov.bc.ca> or call 1-833-838-2323).

Vaccination status by age group

Last age-based BC data update May 01



Israel: 62.7% vaccinated (at least one dose). Schools fully reopened on Apr 26 with no restrictions; no restrictions on travel; immunity passports being used for indoor dining, gyms and sports; no restrictions on indoor/outdoor socialization in groups of 50 or less

UK: 52.9% vaccinated (at least one dose). Schools fully open with optional rapid testing available and masks for secondary students; travel is discouraged; indoor dining remains closed; outdoor socializing only, in groups of up to 6. Further reopening starting May 17.

Countries with high vaccination levels are seeing enough decline in cases to reopen slowly

PHAC, StatCan table 17-10-0005

Data gap: Where are the genomes?

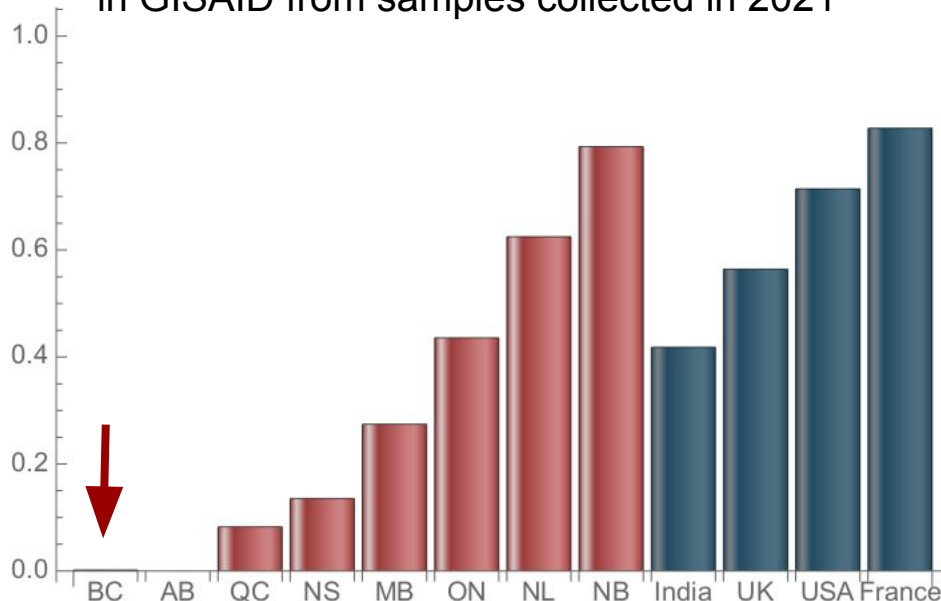


BC is a global leader in genomics, yet BC has not publicly shared the thousands of SARS-CoV-2 genomes sequenced in 2021.

These sequences are needed for global analyses to:

- Identify new variants
- Estimate rates of spread
- Assess efficacy of restrictions
- Detect importations

Fraction of SARS-CoV-2 genomes in GISAID from samples collected in 2021



2021 samples:	BC	AB	QC	NS	MB	ON	NL	NB	India	UK	USA	France
	11	0	530	147	369	6879	170	303	5543	228 780	307 515	26 277
All samples:	5876	1676	6425	1086	1344	15 779	272	382	13 245	405 537	430 393	31 743

Further messages

Case numbers projected to decline through May, with hospital and ICU remaining moderate (>300 and >100, respectively).

Partial re-opening to February/March 2021 levels of activity* on May 25 risks slight rise in cases and hospital demand, lower risk if delayed until mid-June.

Re-opening substantially beyond early 2021 activity levels requires higher vaccination uptake, second doses, and/or additional control measures.

Newly shared community-level data on cases and vaccinations will help guide future modelling and local efforts to vaccinate and tackle rising cases. Thanks!

*E.g., restaurant re-openings, “safe six” indoor gatherings with same group

Data gaps remaining

- Serological survey data has not been released from the most recent surveys. These data are essential for understanding the impact of the disease on different communities and to assess relative infection rates of age groups that are often asymptomatic (youth).
- Severity of each VOC (Hospital/ICU demand and death rates) is needed to better predict near-term impacts of COVID-19 on our communities.
- Crucial genetic data is missing. Only 11 of the thousands of COVID-19 (0.1%) genomes sequenced in BC in 2021 have been uploaded to the global GISAID database. This impedes the global effort to learn about which variants matter and how they impact disease.

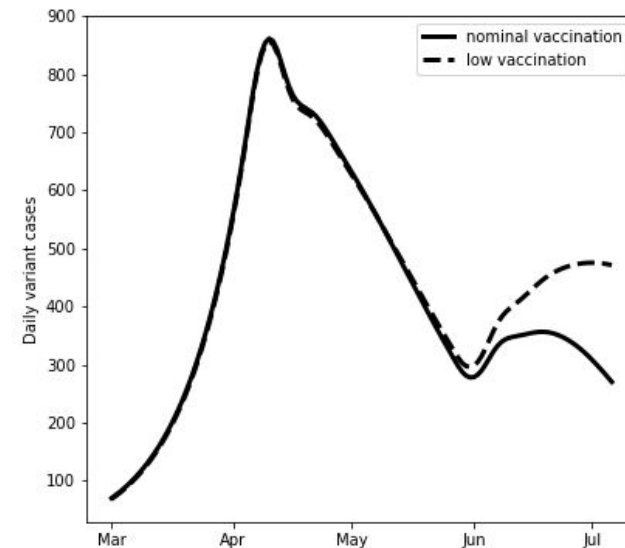
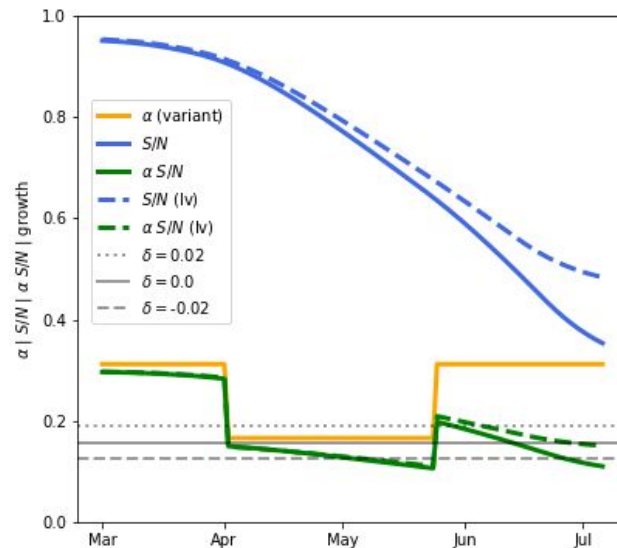
Appendix: Looking under the hood

How changes in transmission rate (yellow) and a decline in the number of susceptible individuals (blue) combine to reduce the growth of COVID-19 (green) in pypm model (slide 4)

The daily growth rate (δ) depends on the product of the transmission rate (α) and the susceptible fraction (S/N).

The product is shown by the green curves and the grey horizontal lines show the growth rate for a few values.

In the nominal vaccination scenario, growth becomes negative in mid-June.



Nominal vaccination scenario: ultimate effectiveness: 90%, 1st dose vaccination rate: 45,000/day until 75% of population vaccinated.

Low vaccination scenario (lv): ultimate effectiveness: 80%, 1st dose vaccination rate: 35,000/day until 65% of population vaccinated.

Appendix: Model assumptions for vaccine efficacy

The pympm model assumes that the efficacy at preventing infection of a single dose rises over time, ultimately reaching 0.9 (solid curve: normative) or 0.8 (dotted: lower efficacy case).

The observed real-world effectiveness of Pfizer [from Israel](#) was comparable, preventing 46% of infections between days 14-20 and 60% between days 21-27 (Dagan et al. 2021 NEJM).

