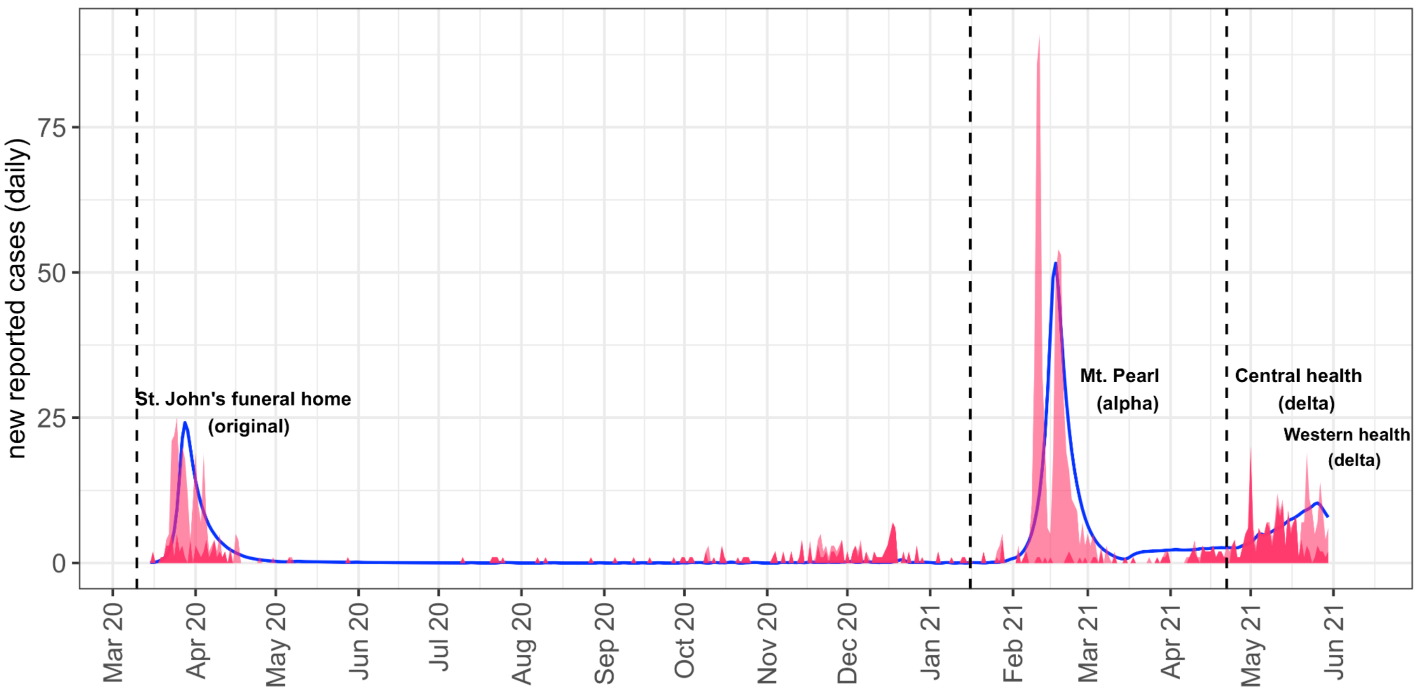
Pandemic preparedness needs modelling preparedness

What the COVID-19 pandemic taught us about the modelling, the philosophy, and the profession

Amy Hurford

COVID-19 cases reported in Newfoundland and Labrador



What the COVID-19 pandemic taught modellers about future pandemic preparedness

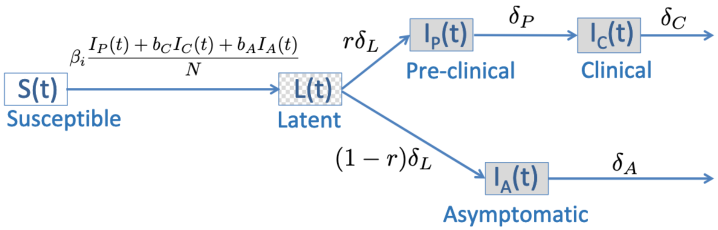
1. Technical issues that need to be considered to do modeling to support all jurisdictions
    - Pitfall1: atto-fox
    - Pitfall 2: island of Transmithica
    - Pitfall 3: over-generalization
    - Fixes

2. Modelling philosophy
    - Mechanistic vs. statistical
    - Agent-based vs. compartmental
    - Space stations vs. fire stations

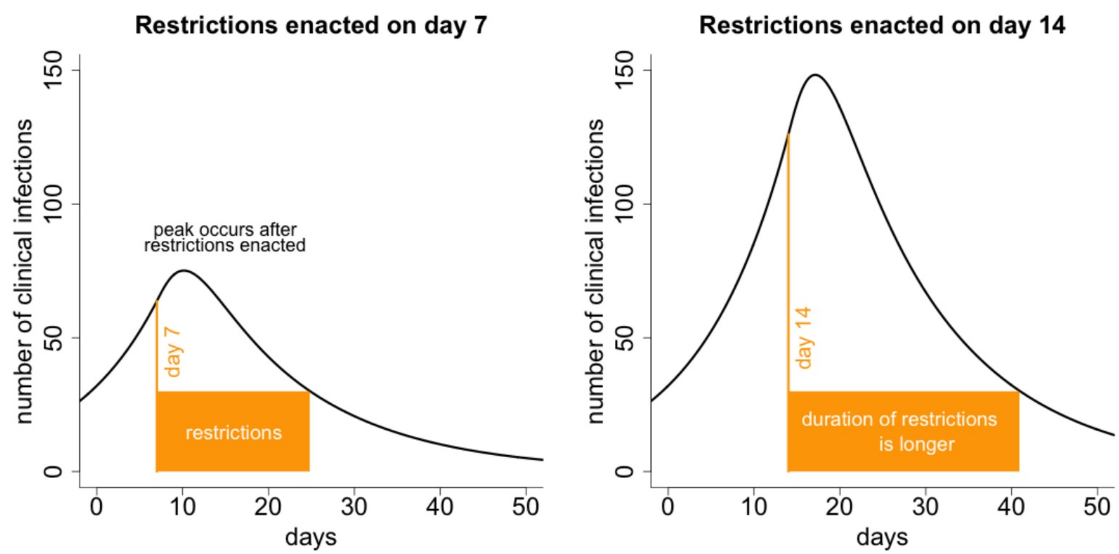
3. The profession: modellers in pandemic decision support

The types of models affected by the pitfalls are not bad approaches (compartmental models, ODEs, and continuous dependent variables)

COVID-19 model



$$\frac{dS(t)}{dt} = -\beta_i S(t) \frac{I_P(t) + b_C I_C(t) + b_A I_A(t)}{N},$$
$$\frac{dL(t)}{dt} = \beta_i S(t) \frac{I_P(t) + b_C I_C(t) + b_A I_A(t)}{N} - \delta_L(t),$$
$$\frac{dI_P(t)}{dt} = r\delta_L L(t) - \delta_P I_P(t),$$
$$\frac{dI_C(t)}{dt} = \delta_P I_P(t) - \delta_C I_C(t),$$
$$\frac{dI_A(t)}{dt} = (1-r)\delta_L L(t) - \delta_A I_A(t),$$

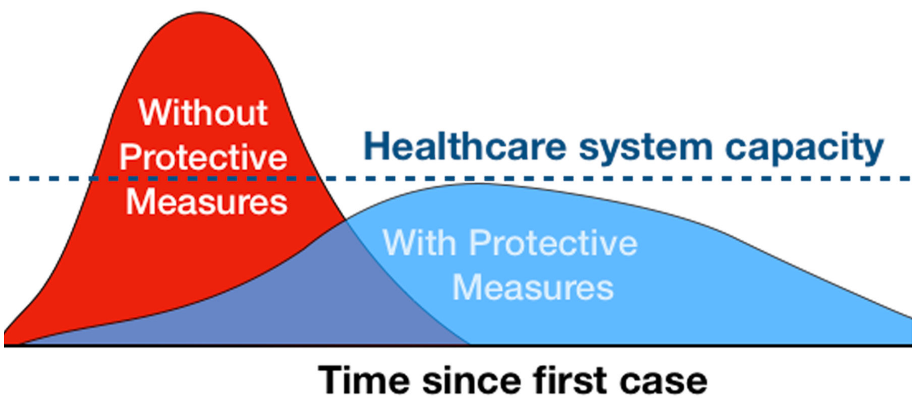


Hurford and Watmough. 2021. Don’t wait, re-escalate: delayed action results in longer duration of COVID-19 measures. MedRxiv

The types of models affected by the pitfalls are not bad approaches (compartmental models, ODEs, and continuous dependent variables)

Simple models are valuable as “stylized facts” for communication to non-modellers

Flatten the curve



Adapted from CDC / The Economist

Omicron (less severe, more transmissible) was forecast to place an extreme burden on the healthcare system

CoVaRR-Net Pillar 6 (Computational Biology and Modelling)[1]

Executive summary: The current epidemiological, experimental, and computational evidence to date points to a clear growth advantage of the Omicron variant of SARS-CoV-2. Canada should therefore be prepared for another large pandemic wave within the next month. Even if Omicron disease severity remains the same, or even less severe than previous variants (due to viral changes and/or increased immunity), the exponential growth that is forecast will result in a large number of cases in a very short period of time, placing an extreme burden on the medical care system.

The types of models affected by the pitfalls are not bad approaches (compartmental models, ODEs, and continuous dependent variables)

Feasibility of fitting and sensitivity analysis is a strength of fast models, i.e. ODEs with continuous dependent variables

Consider a model:

- 20 parameters (no means unusual in ecology/epidemiology)
- 10 values of each parameter
- 1 second per model run

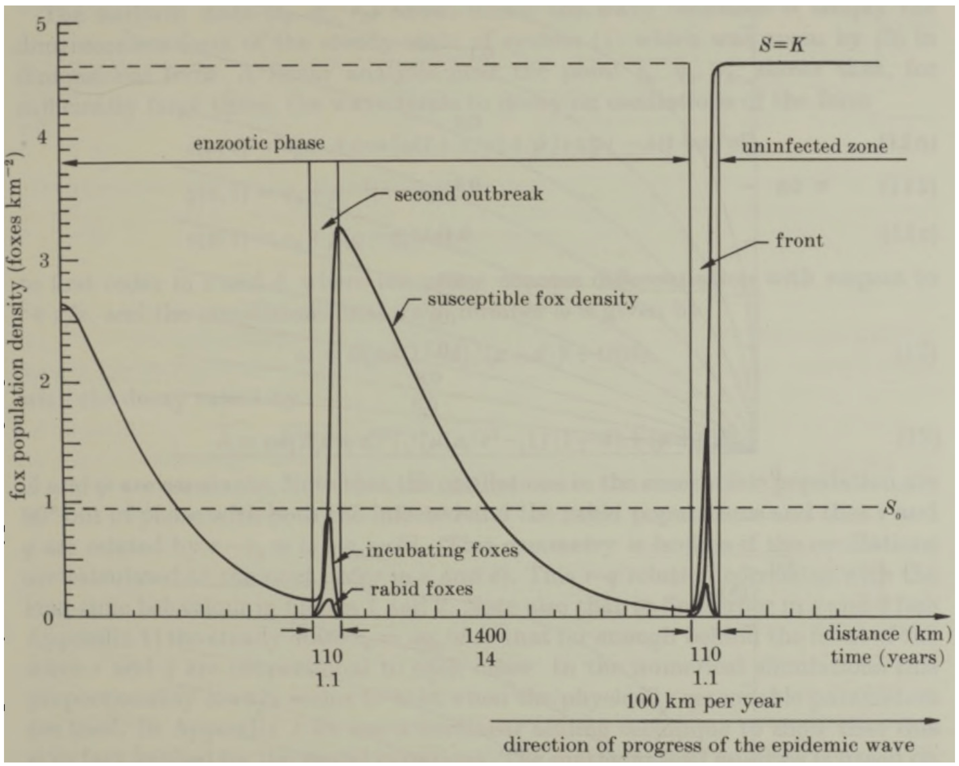
Number of required runs: 10^{20} = 100,000,000,000,000,000,000

Start time: immediately after Big Bang

Current status: 0.4% complete

Argument is from Dietz (2017) Ecological forecasting, p140

Murray et al. 1986: rabies would re-appear in south England 6 years later



Murray et al. 1986. On the spatial spread of rabies among foxes

- Main conclusions of Murray et al. 1986 are based on a technical error: the atto-fox (Mollison 1991)
- Aside from the error, Murray et al. 1986 is quite inspiring

Continuous dependent variables cause the atto-fox problem

- “As to the second wave, close inspection shows that the explanation lies not so much in the determinism of the model as in its modeling of the population as continuous rather than discrete and its associated inability to let population variables reach the value zero”

- “.. The density of infected [foxes] … declines to a minimum of around one atto-fox (10^{-18} of a fox) per square kilometer. The model then allows this atto-fox to start the second wave as soon as the susceptible population has regrown sufficiently.

Mollison, 1991. Dependence of epidemic and population velocities on basic parameters

Pitfall 1: atto-fox

- Concerns models where population variables never reach zero, enabling rebounds from very small values (i.e., 10^{-18})

- Affects modelling concerning:
  - Public health measures that are released
  - Elimination strategies, and travel measures
  - Transmission dynamics involving clusters of cases

- Solutions
  - End the outbreak when a small value is reached (Hansen and Day 2011)
  - Modelling outbreak duration and time between outbreaks (Martignoni et al. 2024)
  - Importation-community spread switch model

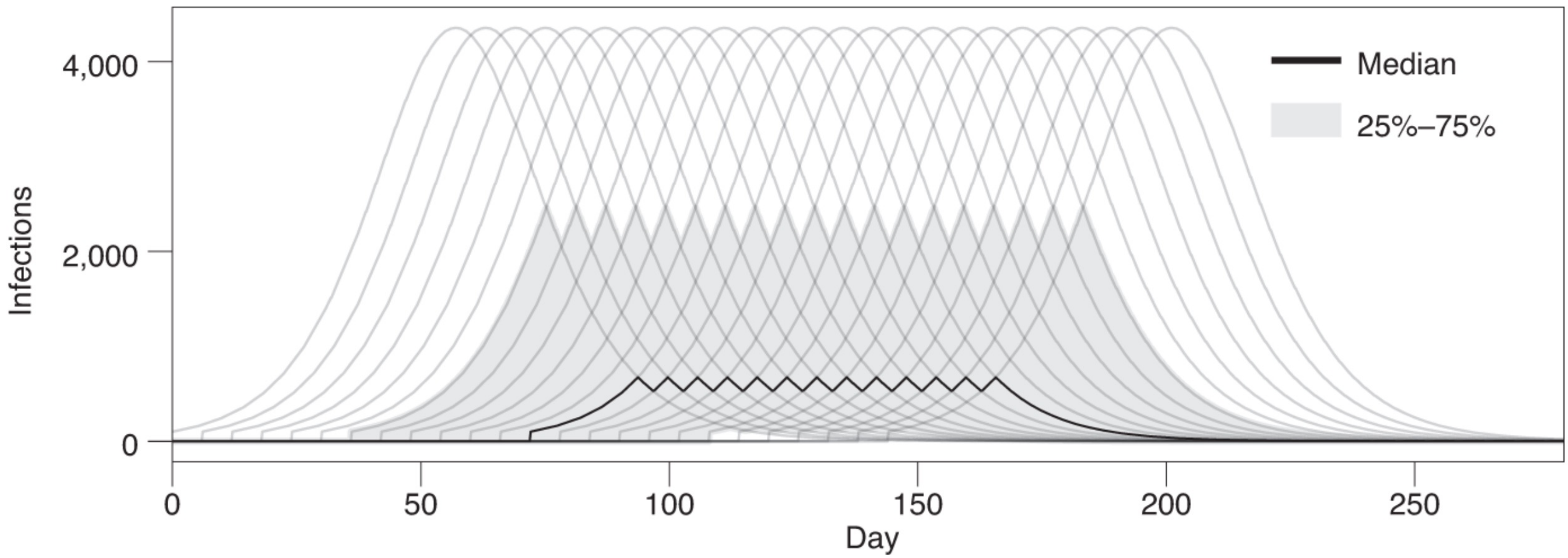
Hansen and Day. 2011. Optimal control of epidemics with limited resources

Pitfall 2: island of Transmithica

On the island of Transmithaca, one million people lived in complete isolation from the rest of the world. A virus had ravaged the outside world, and, in the process, all viral parameters had become known with perfect precision. As Transmithaca slowly opened up for outside visitors, the inhabitants knew everything about the virus – except when it would arrive. The leaders of Transmithaca asked their epidemiologists to estimate how the disease would impact society. The epidemiologists simulated a number of scenarios, all with perfect choices of parameters, but different starting dates for the epidemic. Their simulations produced an ensemble of epidemic curves and, thinking that the individual simulated epidemic trajectories might clutter the picture, they presented the fixed-time summary statistics shown in grey and black in Fig. 1. Thus, the islanders prepared for an outbreak that might infect between 2,000 and 3,000 individuals at peak impact. As we can inspect, however, from the ensemble of time-displaced curves, the actual peak impact in every single case is more than 4,000 cases.

Juul et al. 2021 Fixed-time descriptive statistics underestimate extremes of epidemic curve ensembles

Pitfall 2: island of Transmithica



Simulations of the outbreak on the island Transmithaca (created using a deterministic compartmental model). Grey curves show individual simulations. Median and confidence intervals calculated using fixed-time statistics are defined in the legend. Simulations are identical except for the date on which the outbreak starts. The fixed-time descriptive statistics do not capture peak numbers of infections.

Juul et al. 2021. Fixed-time descriptive statistics underestimate extremes of epidemic curve ensembles

Pitfall 2: island of Transmithica

- Concerns uncertain start dates, problem affects deterministic, stochastic, and agent-based models

- Affects modelling:
  - for regions that have no community outbreaks;
  - linking importation models to community spread models;
  - Ensemble forecasts of hospitalizations during the COVID-19 pandemic in the Netherlands (Juul et al. 2021)

- Solutions (see Juul et al. 2021 for details):

  (1) curve-based summary statistics
  (2) summarizing estimated likelihoods of specific scenarios of interest

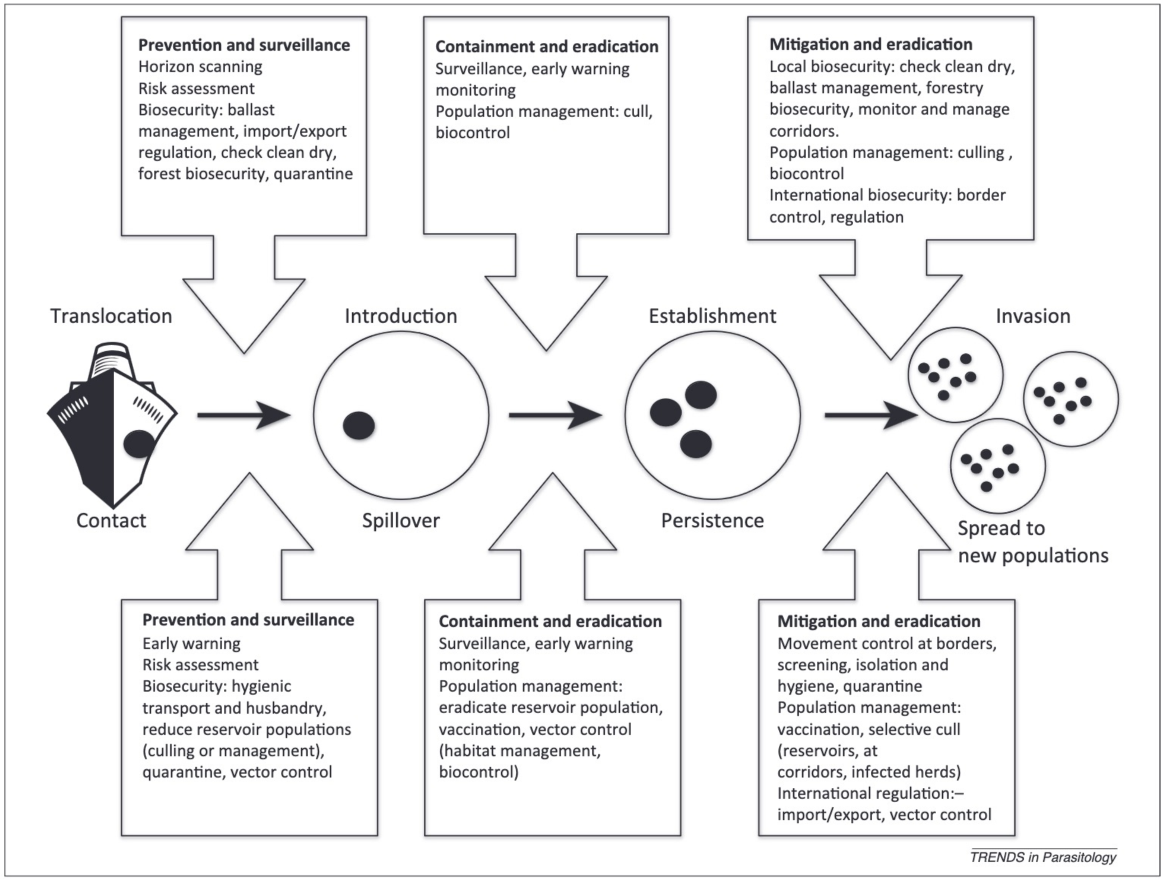
Pitfall 3: Over-generalization from regions with community spread

- No cases: with no confirmed cases
- Sporadic cases: with one or more cases, imported or locally detected
- Clusters of cases: experiencing cases, clustered in time, geographic location and/or by common exposures
- Community transmission: experiencing larger outbreaks of local transmission defined through an assessment of factors including, but not limited to: large numbers of cases not linkable to transmission chains; large numbers of cases from sentinel lab surveillance; and/or multiple unrelated clusters in several areas of the country/territory/area
- Pending: transmission classification has not been reported to WHO

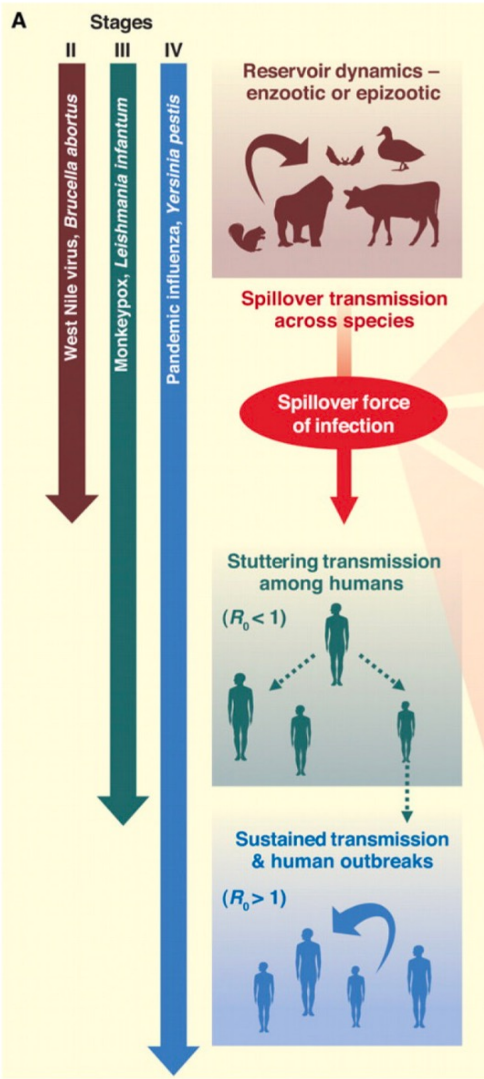
Reporting Country/ Territory/Area	Total confirmed cases	Total confirmed new cases	Total deaths	Total new deaths	Transmission classification[i]	Days since last reported case
Hungary	4 114	7	576	3	Community transmission	0
Kyrgyzstan	3 954	228	43	1	Clusters of cases	0
Bosnia and Herzegovina	3 675	88	172	1	Community transmission	0
Greece	3 310	8	190	0	Clusters of cases	0
Croatia	2 388	22	107	0	Sporadic cases	0

WHO coronavirus (COVID-19) situational report 157 – June 25 2020

Chronological stages of risk



Dunn and Hatcher. 2015. Parasites and biological invasions: parallels, interactions and control



Insights from zoonotic spillover

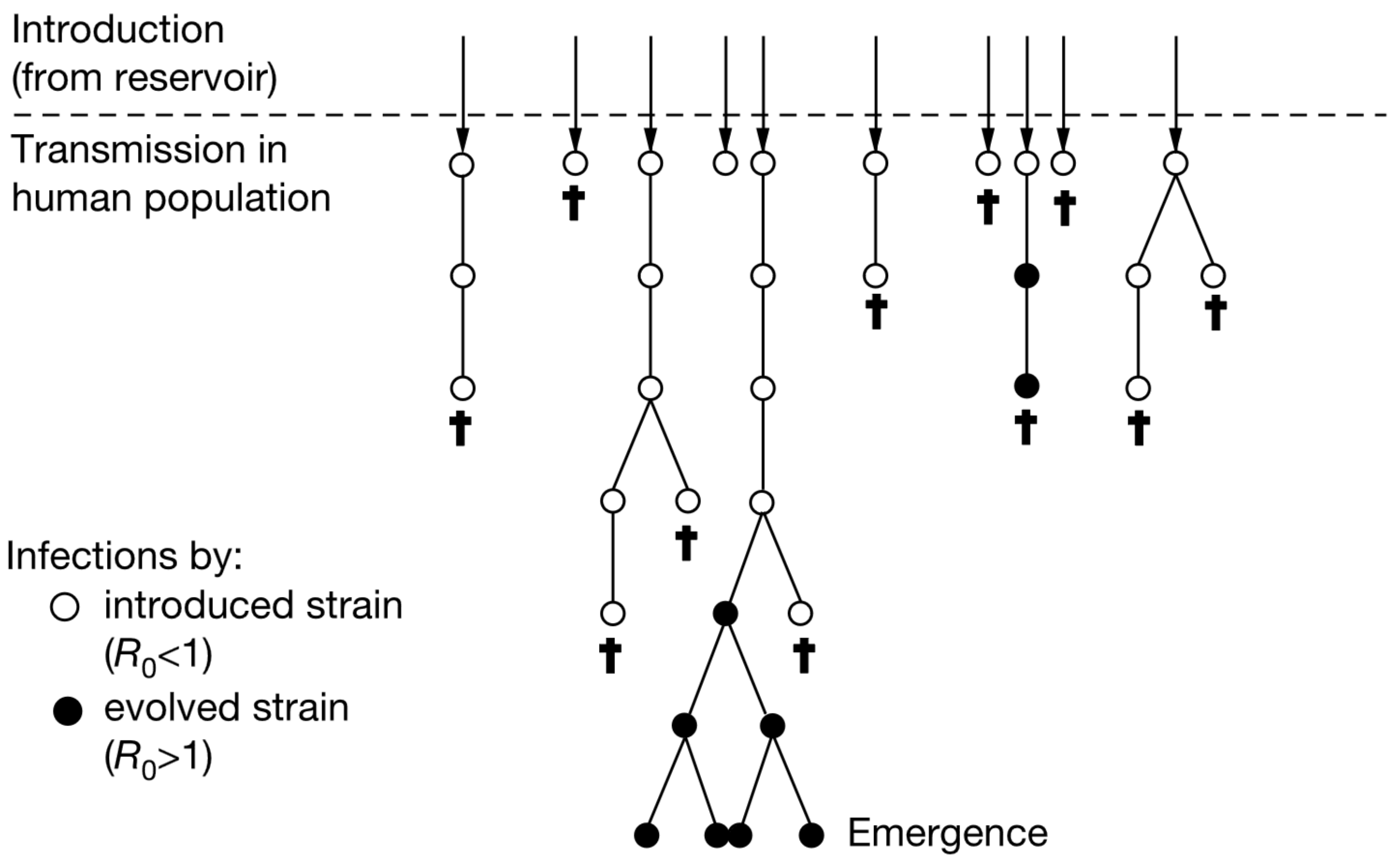
For the COVID-19 pandemic, reframe this terminology as human-human spillovers from other regions:

Stage III: Stuttering transmission $R_t < 1$
Stage IV: Sustained transmission $R_t > 1$

The reservoir is another region rather than an animal

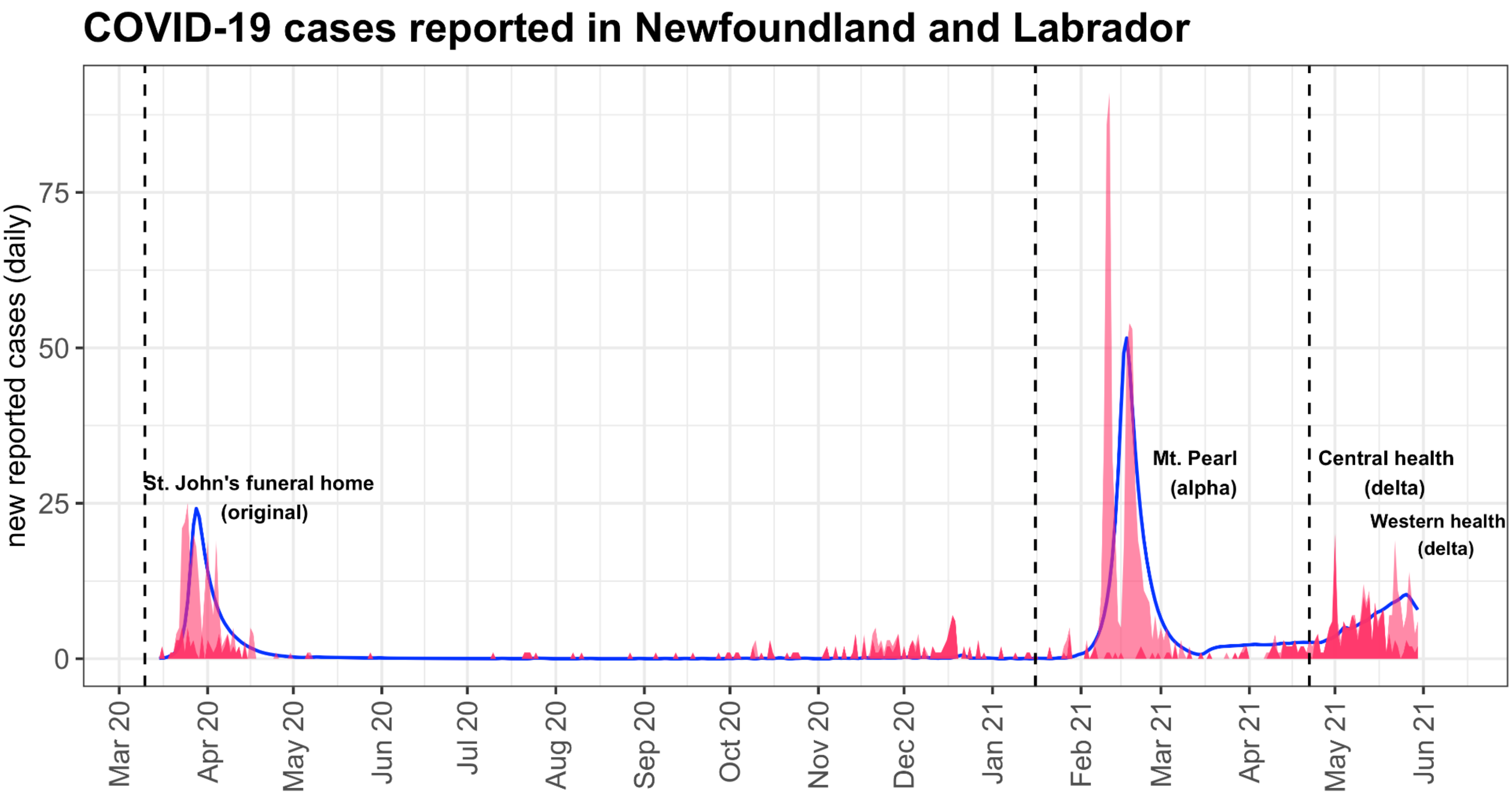
Lloyd-Smith et al. 2009. Epidemic dynamics at the human-animal interface.

Stage III: Stuttering transmission



Antia et al. 2003. The role of evolution in the emergence of infectious disease

Stage III: Stuttering transmission (re-framed)



Pitfall 3: Over-generalization from regions with community spread

Concerns using community spreads models (i.e., SIR) and resulting recommendations in regions where community spread is not occurring

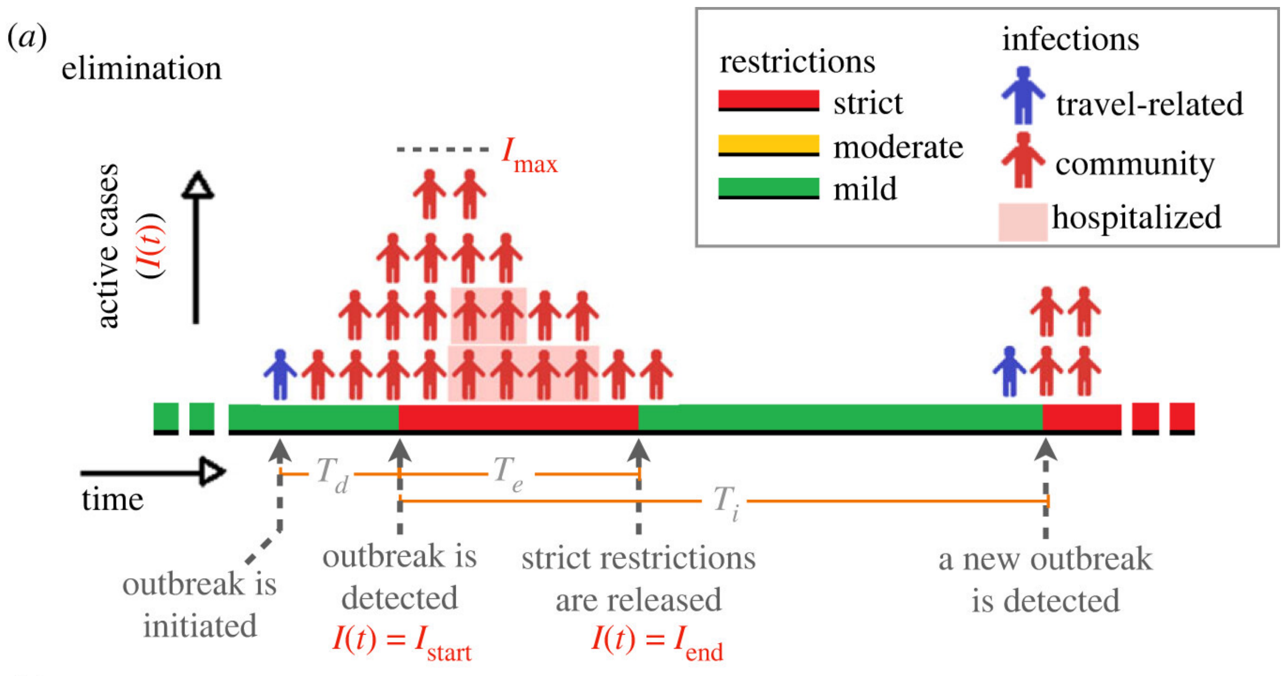
Affects:

- Regions without community spread
- Underserved and under-resourced jurisdictions

Solutions:

- Multijurisdictional representation
- Do the modelling correctly
- Serving and resourcing all jursidictions
- Canadian small jurisdictions modelling group (CanSJ)

Fixes: Modelling outbreak duration and time between outbreaks

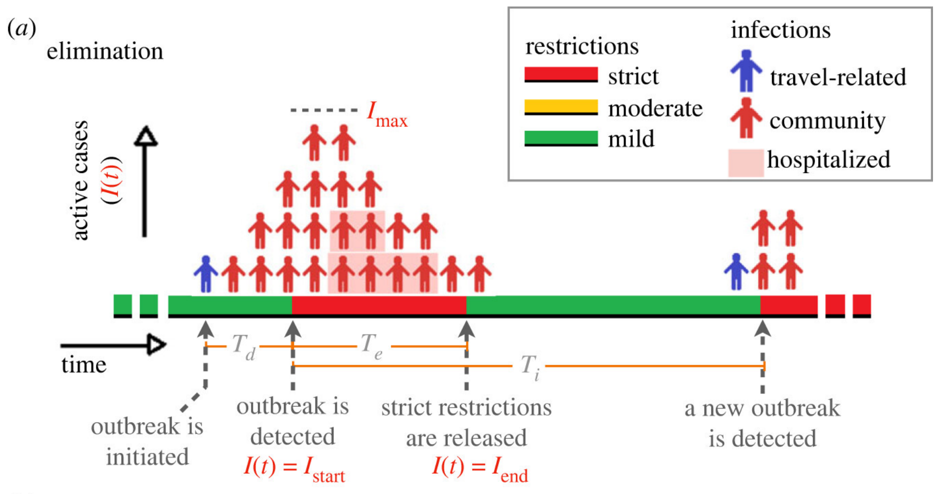


Dr. Maria Martignoni

Could be modelled as a branching process or an agent-based model, but atto-fox problem is “not so much about the determinism”.

Martignoni et al. 2024. Is SARS-CoV-2 elimination or mitigation best? Regional and disease characteristics determine the best strategy

Fixes: Modelling outbreak duration and time between outbreaks



Percentage of days with mild restrictions, $T_e < T_i$

$$\frac{T_i - T_e}{T_i} \times 100$$

$$T_e = \frac{\ln(I_{\text{start}}/I_{\text{end}})}{\gamma(1 - R_c)}$$

Martignoni et al. 2024. Is SARS-CoV-2 elimination or mitigation best? Regional and disease characteristics determine the best strategy

Model fitting: importation-community spread switch model

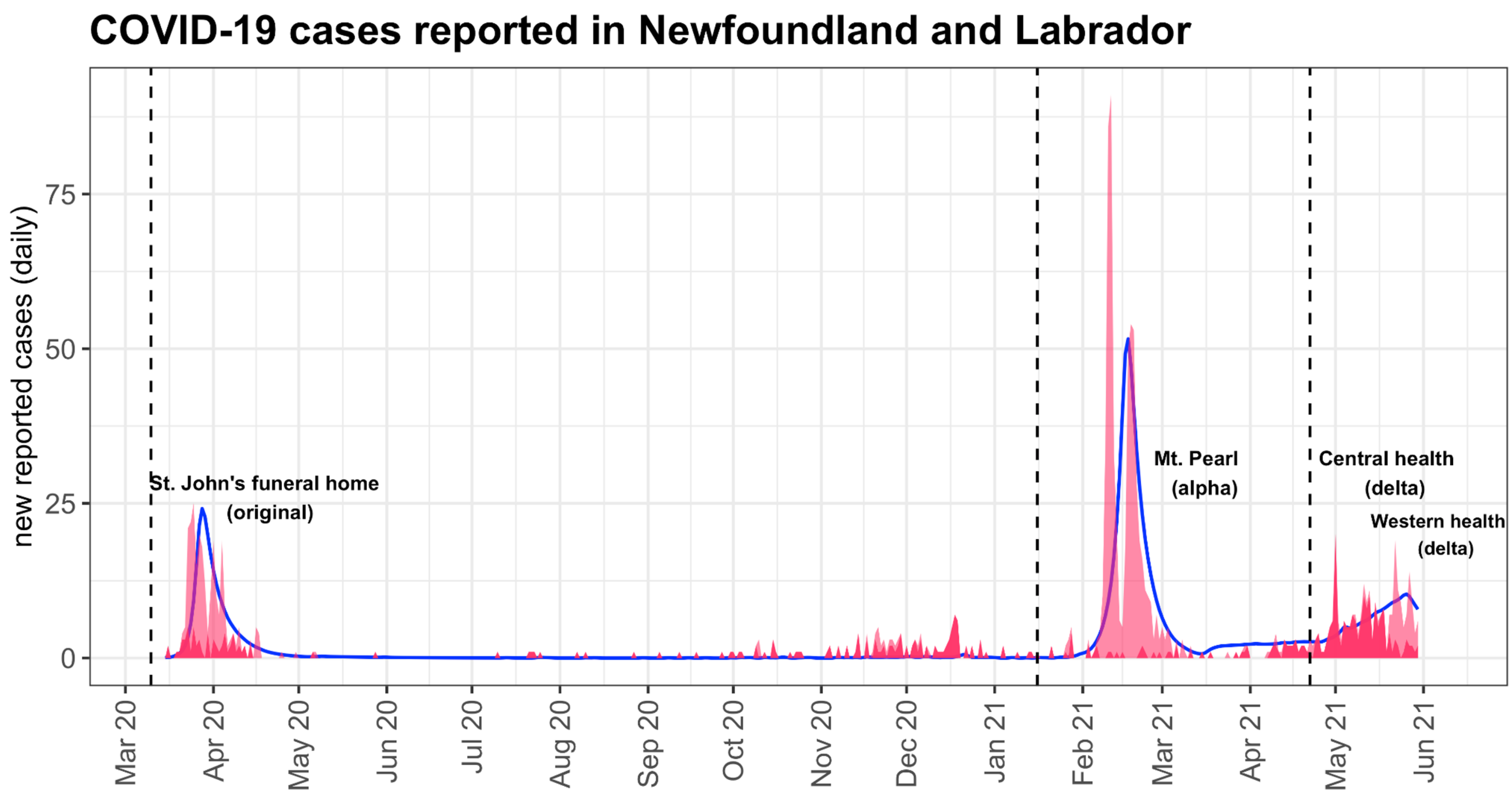


Figure by Zahra Mohammadi, in collaboration with Steve Walker using macpan2 (unpublished)

Model fitting: importation-community spread switch model

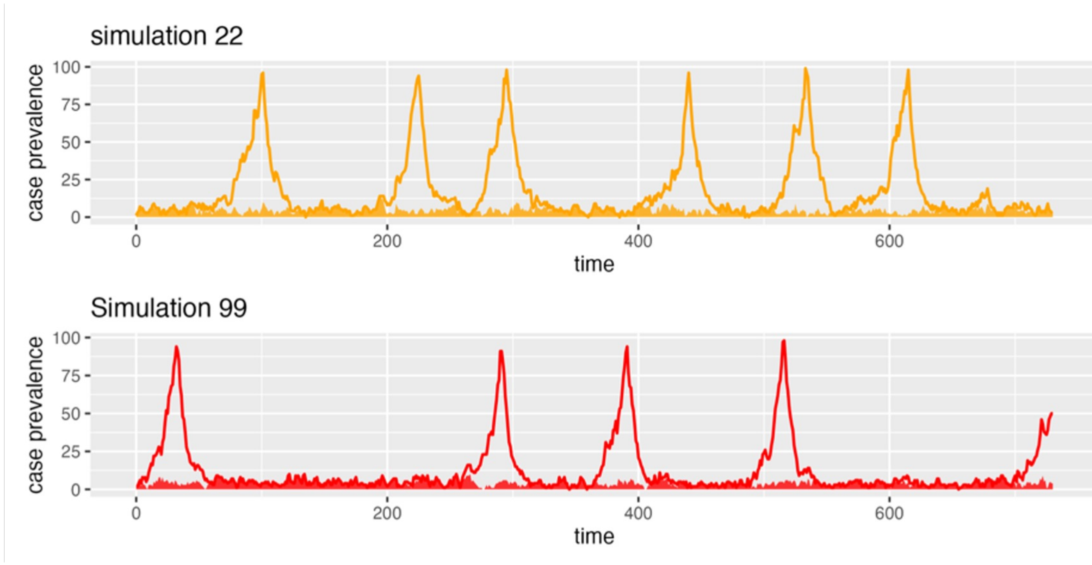
- Data: incidence of travel-related cases (dark shading) and community cases (light shading)
- Include a model variable that is travelers in isolation
- 10 days before a reported community outbreak, briefly allow the rate that an isolating traveler infects a susceptible community members to be positive (vertical dashed line)
    - All other times this rate is 0
- When infection incidence is less than a small threshold, set to 0.

Features of the importation-community spread switch model

Overcomes:

- Pitfall 1 (atto-fox) by setting low incidence to 0
- Pitfall 2 (island of Transmithica) by fixing the community outbreak start dates (vertical dashed lines). Start date is not treated as uncertain.

Scenario modelling, i.e. following from the switch model



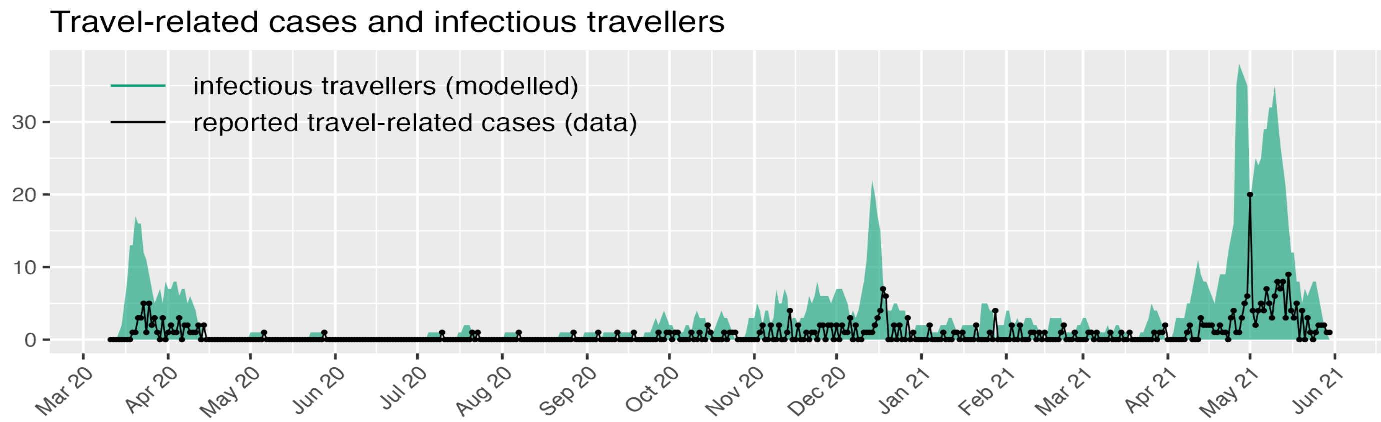
- Community outbreak dates determined by travel-related cases (details next slide)

- $R_t > 1$ except from when community cases ≥ 100 until elimination

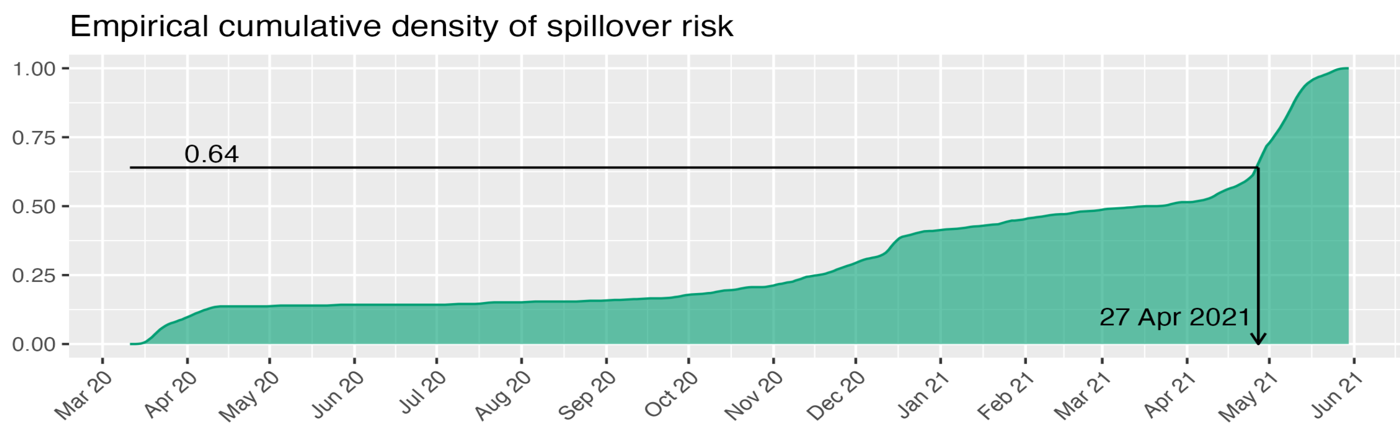
Multiple realizations
<u>DO:</u> ● Av. number of community outbreaks ● Av. size of community outbreak ● Av. days without community cases <u>DO NOT:</u> ● Av. prevalence at a given time ● Consider the date meaningful

Determining when the outbreaks start for the scenario modelling

Use travel-related case data and a model to estimate infectious travelers (prevalence)



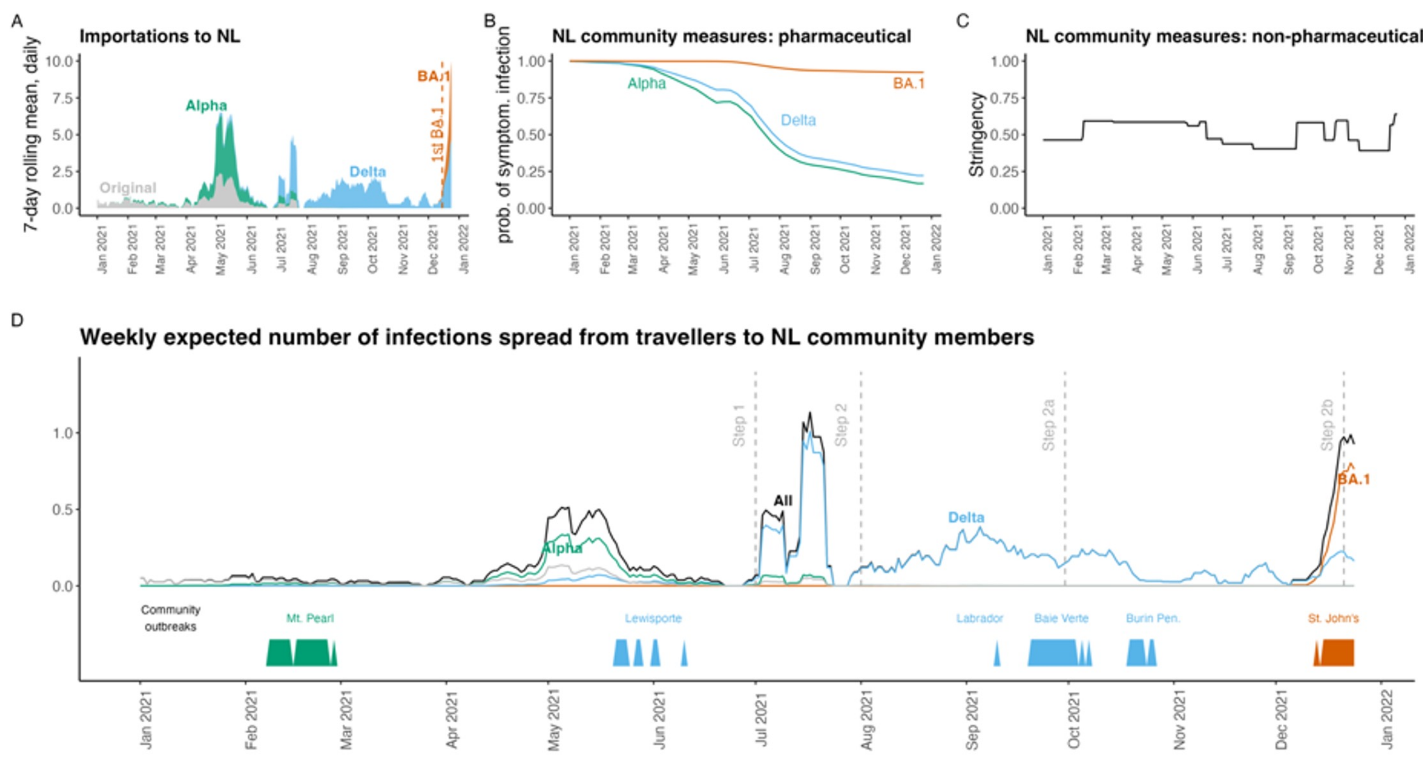
Use the inverse cumulative method to sample the start dates for community outbreaks from the empirical density of infectious travelers (prevalence)



Determining when the outbreaks start for the scenario modelling

Extend this idea by using the same method for a more detailed spillover model

i.e., make D into a cumulative density and use inverse method



Hurford et al. 2023. Pandemic modelling for regions implementing an elimination strategy

Summary: what we learned about the modelling

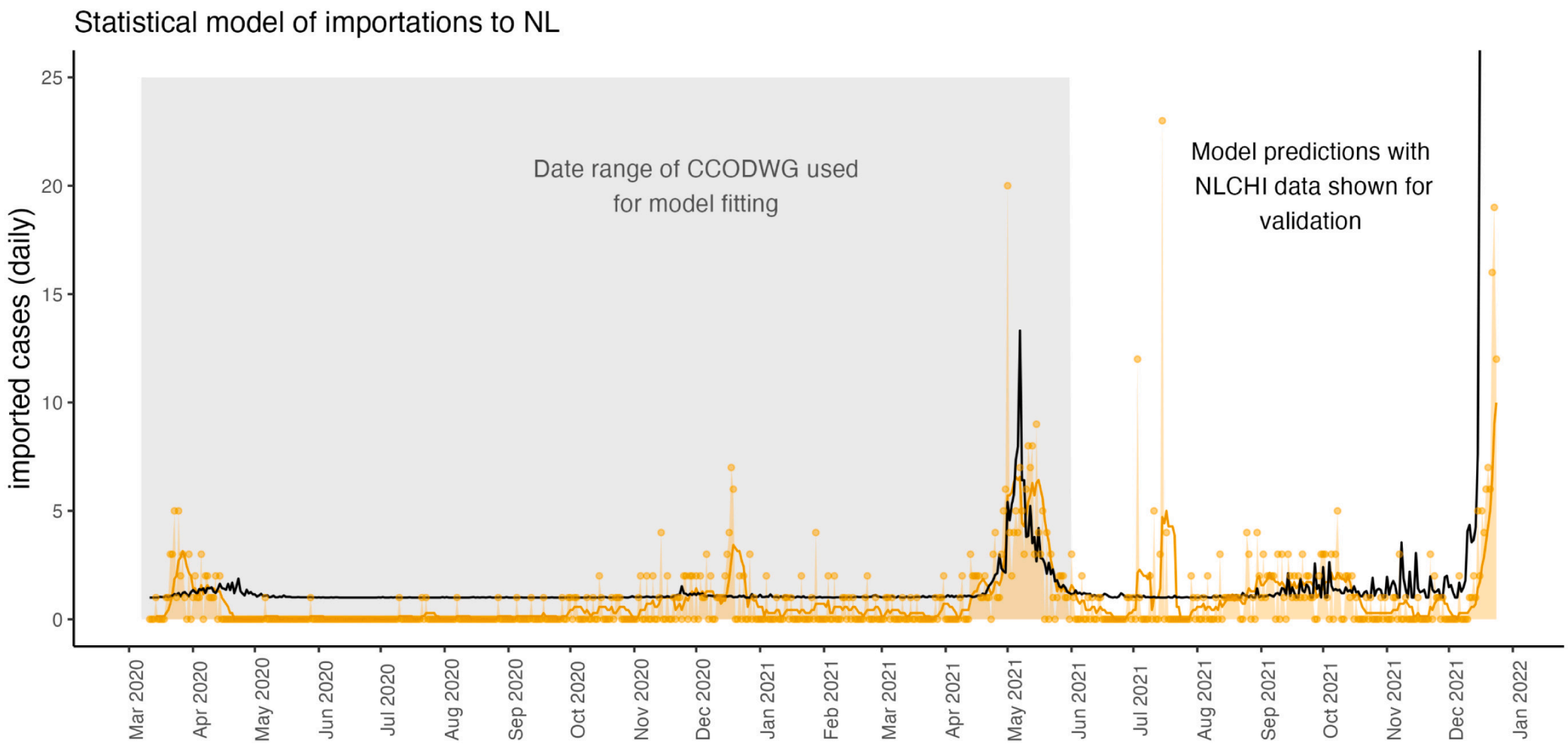
- Model outbreak duration and time between outbreaks (Martignoni et al. 2024)
- Fit and simulate using the ideas of the importation-community spread switch model (unpublished)
- We need general modelling frameworks, with the flexibility to model:
  - Both clusters of cases and community transmission
  - Where the complete range of public health responses are potentially optimal

The philosophy

Decisions about the types of models to use

- Mechanistic models vs. statistical models
- Agent-based models vs. compartmental models
- Region-specific models: space stations vs. fire stations

Travel-related cases reported in NL



Hurford et al. 2023. Pandemic modelling for regions implementing an elimination strategy

Mechanistic model for travel-related cases reported in NL

r: Regular travelers

rw: rotational workers

$$R_{\mathrm{CA}}(t) = \sum_i R_i^{r,e}(t) + R_i^{r,s}(t) + R_i^{rw}(t)$$

CA: Canadian origin

i: province

e: exposure notification

s: symptoms

$$R_{\mathrm{INT}}(t) = R_{\mathrm{INT}}^{r,e}(t) + R_{\mathrm{INT}}^{r,s}(t)$$

INT: International origin

Table D5 COVID-19 testing requirements for travellers arriving in Newfoundland and Labrador due to border measures implemented by the Government of Canada or Special Measures Orders issued by Newfoundland and Labrador.

Dates	Test policy
2020-09-09	Asymptomatic rotational workers are exempt from the requirement to self-isolate for 14 days if they receive a negative test result for a test completed between five and seven days after their return
2020-11-25	Rotational workers required to wait until day seven of their 14-day self-isolation period to arrange COVID-19 testing
2021-01-07	Requirement for mandatory negative COVID-19 test result for air passengers entering Canada (Federal measure)
2021-03-12	Domestic rotational workers can cease self-isolation if testing negative (tested upon return, day 7 and on day 11,12 or 13)
2021-03-27	Updated rotational worker requirements: must isolate away from families for 14 days, cannot avail test on day 7 or modified self-isolation
2021-04-19	Essential workers entering the province required to self-isolate until they receive their 1st negative test result
2021-05-15	COVID-19 testing order for individuals arriving in NL (testing requirements during their 14-day self-isolation)

Table D6 Exposure notification from Public Health Advisories in NL during the COVID-19 pandemic where passengers on arriving flights were asked to arrange COVID-19 testing (Government of Newfoundland Labrador, 2023).

Date	Exposure notification to passengers	Origin	Destination
2020-09-27	WestJet Flights 306 arrived on Monday, September 21	Winnipeg, MB	St. John's, NL
	WestJet Flights 328 arrived on Monday, September 21	Toronto, ON	St. John's, NL
2020-10-05	Air Canada Flight AC604 arrived on Wednesday, September 30	Toronto, ON	Halifax, NS
	Air Canada Flight AC8876 arrived on Wednesday, September 30	Halifax, NS	Deer Lake, NL
2020-10-23	Air Canada Flight 7484 arrived on Monday, October 12	Toronto, ON	Deer Lake, NL
2020-11-04	Air Canada Flight 7484 arrived on Friday, October 30	Toronto, ON	Deer Lake, NL
2020-11-23	Air Canada Flight 8880 arrived on Thursday, November 19	Halifax, NS	Deer Lake, NL
2020-11-24	People who returned to NL from Nova Scotia in the last two weeks, and who visited bars in Halifax and surrounding metro communities	NS	NL
2020-12-04	WestJet Flight 3428 arrived on Thursday, November 26	Halifax, NS	St. John's, NL
2020-12-20	Several flight advisories this weekend:		
	Air Canada Flight 8862 arrived on Monday, December 7	Halifax, NS	Gander, NL
	Air Canada Flight 690 arrived on Friday, December 11	Toronto, ON	St. John's, NL
	Air Canada Flight 8862 arrived on Friday, December 11	Halifax, NS	Gander, NL
	Air Canada Flight 8862 arrived on Tuesday, December 15	Halifax, NS	Gander, NL
	Air Canada Flight 690 arrived on Tuesday, December 15	Toronto, ON	St. John's, NL
	Air Canada Flight 690 arrived on Thursday, December 17	Toronto, ON	St. John's, NL
2020-12-29	Air Canada Flight 8880 arrived on Tuesday, December 22	Halifax, NS	Deer Lake, NL
2021-01-20	Who traveled on the MV Blue Puttees to and from North Sydney, Nova Scotia, and Port Aux Basques between Tuesday, December 29 and Saturday, January 16	Sydney, NS	Port Aux Basques, NL
2021-02-15	Air Canada Flight 7484 arrived on Thursday, February 11,	Toronto, ON	Deer Lake, NL
2021-03-04	Air Canada Flight 8996 arrived on Thursday, February 25	Halifax, NS	St. John's, NL
2021-04-19	Air Canada Flight 8008 arrived on Monday, April 13	Toronto, ON	Deer Lake, NL
2021-05-02	Air Canada Flight 8016 arrived on Friday, April 30	Montreal, QC	St. John's, NL
2021-05-06	Air Canada Flight 7540 arrived on Tuesday, May 4	Toronto, ON	Deer Lake, NL
2021-05-11	Air Canada Flight 7542 arrived on Monday, May 10	Toronto, ON	Deer Lake, NL

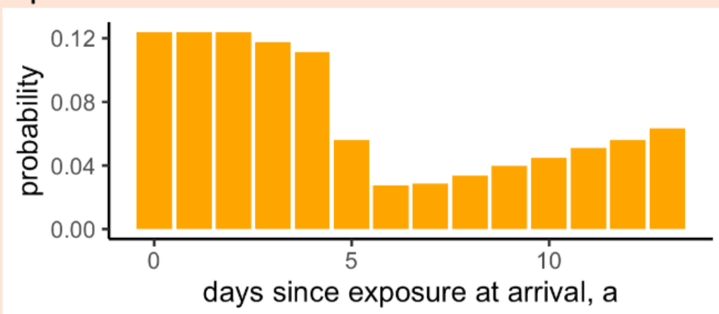
Mechanistic model parameters – none are fitted

Symbol	Definition	Value	Reference
t	Days relative to a reference date	≥ 0 days	
t_e	Days after arrival when an exposure notifications was issued	3 days	Assumed. Ranged between 2 and 7 days
t_r	Days between requesting a post-arrival test and the test occurring (for travellers without scheduled tests)	3 days	Assumed
t_{rep}	Days between testing and reporting in NL	1 day	Assumed
t_1, t_2, t_3	Days after arrival for the first, second, and third mandatory post-arrival test (if applicable)		see Table D5 in the Supplementary Information for details
a	Days since exposure of an infected person	0 to 13 days	after 13 days probability of infection spread is negligible Ferretti et al. (2020)
$\bar{a}$	Average number of days after arrival when symptoms first occur	1 day	See Eq. (C13). The exact value is 1.49 days
$\lambda(a)$	Probability of first developing symptoms given exposure a days ago	Eq. (C10)	Lauer et al (2020)
$\gamma(a)$	Probability of a true positive given exposure a days ago	Eq. (D15)	Hellewell et al (2021)
ψ	Fraction of travelers who travel despite having symptoms	0.75	Smith et al (2020)
ρ	Fraction of infections that are symptomatic	0.69	Godin et al (2021)
σ	Probability that symptomatic regular travellers get tested in NL	0.8	Assumed
ϕ	Proportion of all travelers that were infected on a flight, and were tested after exposure notifications were issued	0.01	Assumed

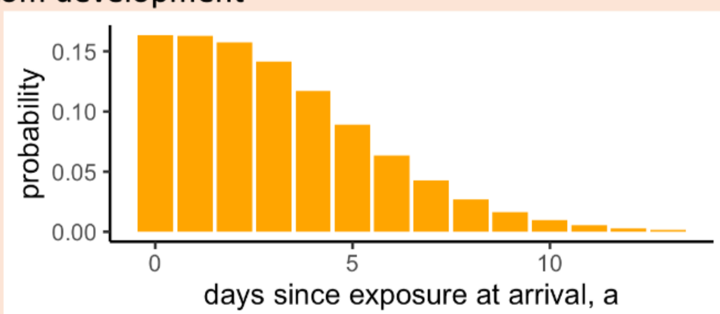
The number of **inbound infected travelers** arriving on day t is $\sum v_i(t)\, f_i(t)$. This includes travelers of Canadian origin (regular travelers and rotational workers) and international origin.

Days since exposure for arriving infected travelers is affected by:

a) pre-departure tests

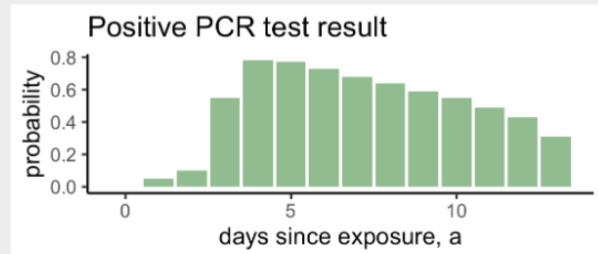


b) symptom development



c) infection on the flight. For travelers that are infected on a flight, the days since exposure at arrival is a=0.

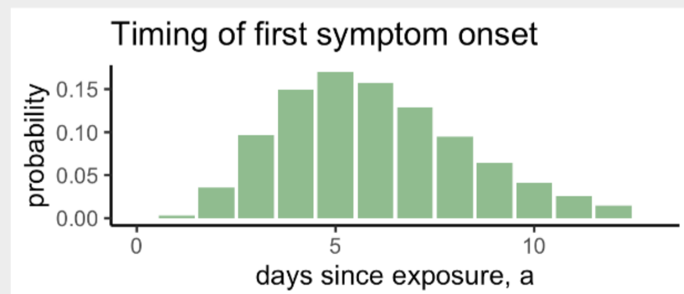
After arrival in NL, infected travelers are **reported as a travel-related case** on day t, after a positive test result, and a reporting delay. Days since exposure at testing affects the probability of a positive test result:



The timing of the test is:

a) after a test is requested, after an exposure notification is issued for a flight;

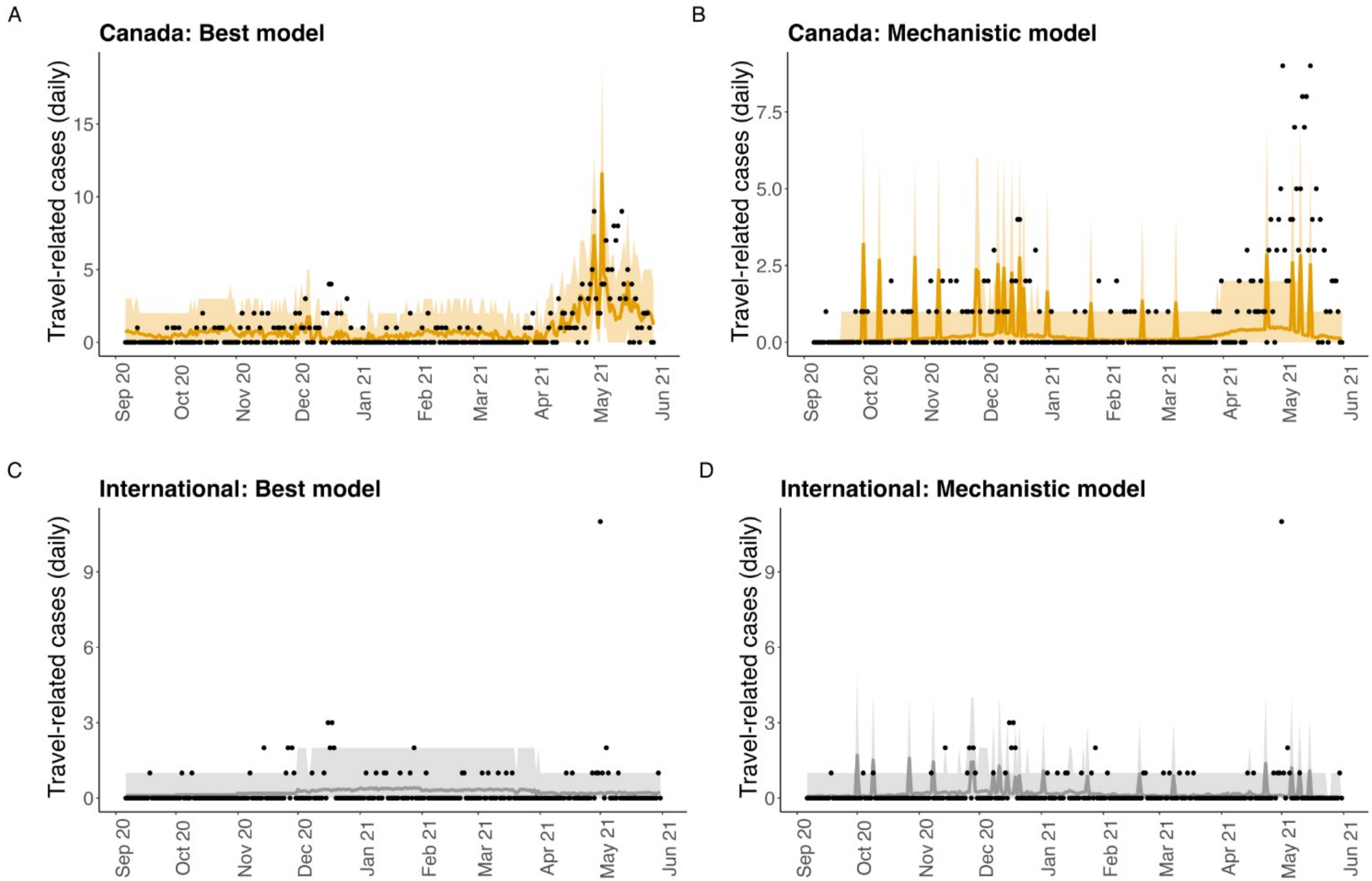
b) after a test is requested, after symptoms develop; or



c) a pre-determined number of days after arrival for rotational workers.

Table 4 Model selection for predicted daily travel-related cases reported in NL from Canadian and international origins. Models where variables are stratified for Canadian provinces and the territories are denoted with 'Provinces' in parenthesis. Models were variables are aggregated for the Canadian provinces and the territories are denoted with 'Canada' in parenthesis.

	Canada	K	AICc	ΔAICc	log Lik	Lik Ratio
1	Travel volume × prevalence proportion (Provinces)	10	638.6	0.00	-308.9	532.0
2	Prevalence prevalence (Provinces)	10	654.2	15.6	-316.7	516.4
3	Travel volume (Provinces)	10	683.2	44.5	-331.2	487.5
4	Travel volume × Prevalence proportion (Canada)	1	830.3	191.6	-414.1	319.3
5	Travel volume (Canada)	1	831.1	192.4	-414.5	320.8
6	Prevalence proportion (Canada)	2	832.6	193.9	-415.3	319.3
	Mechanistic model	0	989.4	350.8	-494.7	
	International					
1	Travel volume	1	359.6	0.00	-178.8	653.1
2	Travel volume × Infection prevalence	1	411.3	51.7	-204.7	601.4
3	Prevalence proportion	1	427.6	68.0	-212.8	585.1
	Mechanistic model	0	383.4	23.8	-191.7	



A
Canada: Best model
B
Canada: Mechanistic model
C
International: Best model
D
International: Mechanistic model
Travel-related cases (daily)
0
5
10
15
0.0
2.5
5.0
7.5
0
3
6
9
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21
Mar 21
Apr 21
May 21
Jun 21

Agent-based models vs. compartmental models

Evaluation of COVID-19 vaccination strategies with a delayed second dose

Seyed M. Moghadas[1]*, Thomas N. Vilches[2], Kevin Zhang[3], Shokoofeh Nourbakhsh[1], Pratha Sah[4], Meagan C. Fitzpatrick[4,5], Alison P. Galvani[4]

1 Agent-Based Modelling Laboratory, York University, Toronto, Ontario, Canada, **2** Institute of Mathematics,

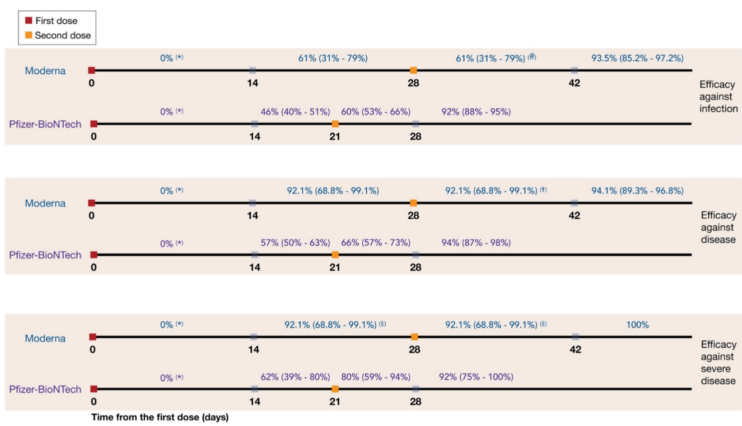
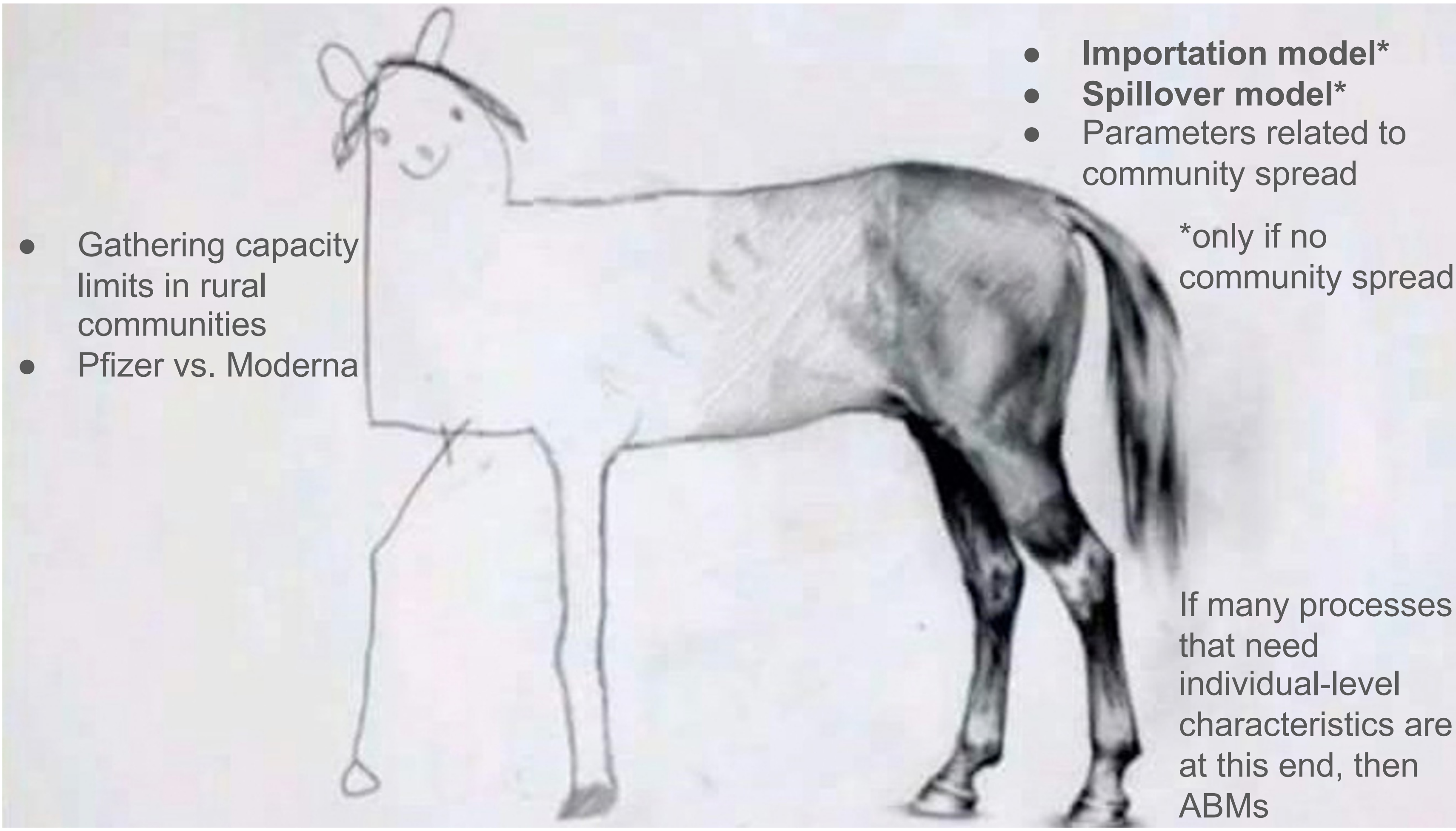


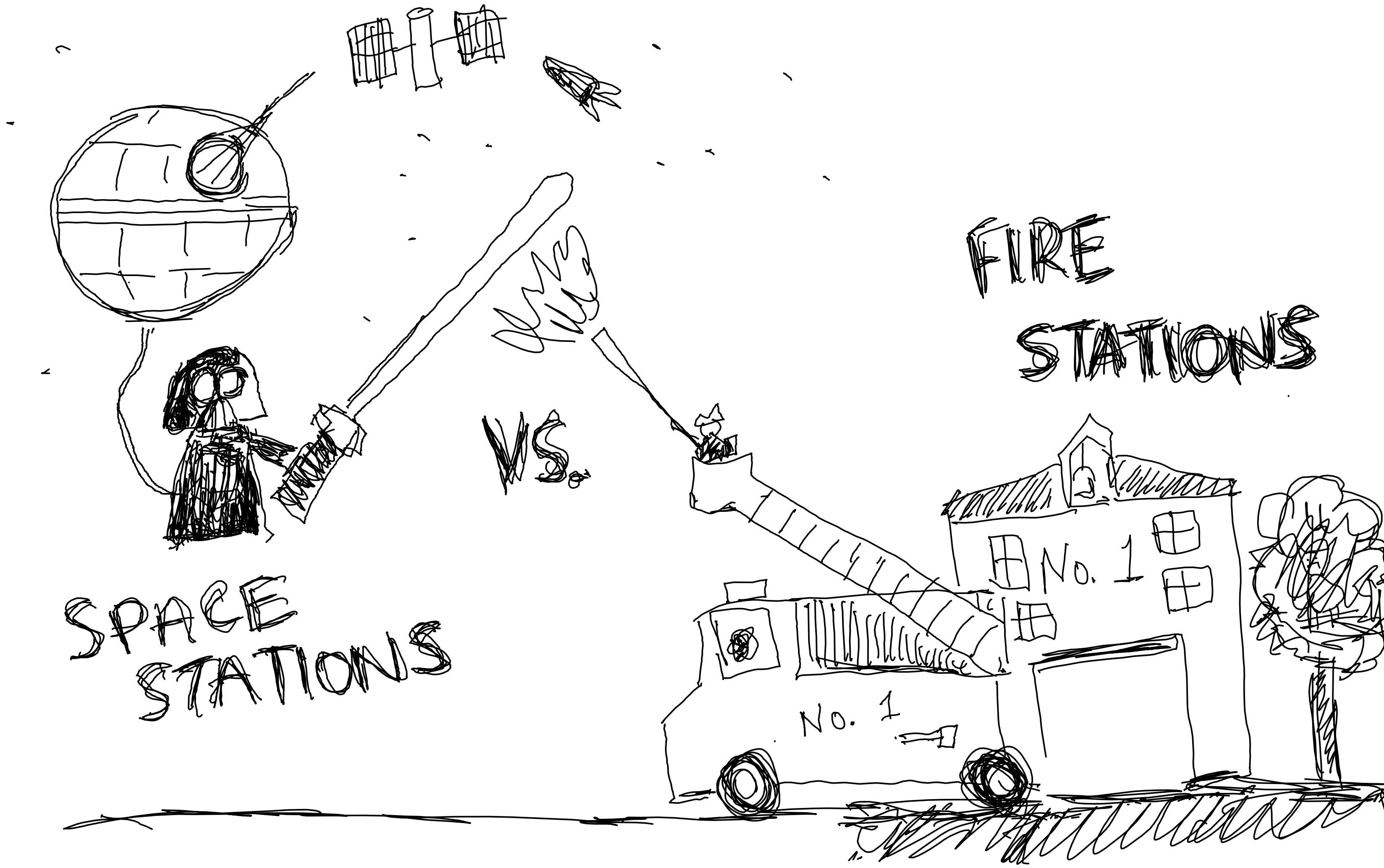
Fig 1. Efficacy of Moderna and Pfizer-BioNTech vaccines against all infection, symptomatic disease, and severe disease, derived from published studies and US FDA briefing documents [3,4,6,22–24]. (*) During the first 14 days following the first dose of vaccines, there was no statistically significant difference between the protection in the vaccinated and unvaccinated cohorts. (#) Conservatively assumed to be the same as efficacy against infection during the preceding 14 days (prior to the second dose). (†) Conservatively assumed to be the same as efficacy against severe disease during the preceding 14 days (prior to the second dose). (§) Assumed to be the same as efficacy against symptomatic COVID-19. COVID-19, Coronavirus Disease 2019; FDA, Food and Drug Administration.

Agent-based models vs. compartmental models

	Fast results	Realistic assumptions	Few cases	Insight	Reference
Agent-based model	No	Yes	Yes	A little	Adams 2020
Stochastic model	Depends	Depends	Yes	Moderate	Bertozzi et al. 2020
Compartmental model	Yes	No	No	Yes	Arino et al. 2006; Adams 2020; Saltelli et al.; Bertozzi et al. 2020
	Short-term predictions		**Scenarios**		
Statistical model	Yes		No		Holmdahl and Buckee 2020
Mechanistic model	Yes		Yes		Funk and King 2020
Ensemble model	Yes		Yes		Adam 2020; Shea et al 2020

ABM vs. compartmental - conflation with model complexity




FIRE
STATIONS
VS.
SPACE
STATIONS
No. 1
No. 1

Reasons for fire stations

- Most of us experienced the COVID-19 public health emergency in primarily one place. Anecdotally, you need some local expertise or critical errors are likely (no slides on this – just recounting my observation)

- Regional characteristics determine the best public health response

- Small jurisdictions are under-resourced and their needs can be overlooked, or falsely assumed, in bigger conversations

Regional considerations determine the best public health response

2021 Updated WHO recommendations

Risk-assessment approach to the implementation of risk mitigation measures for international travel

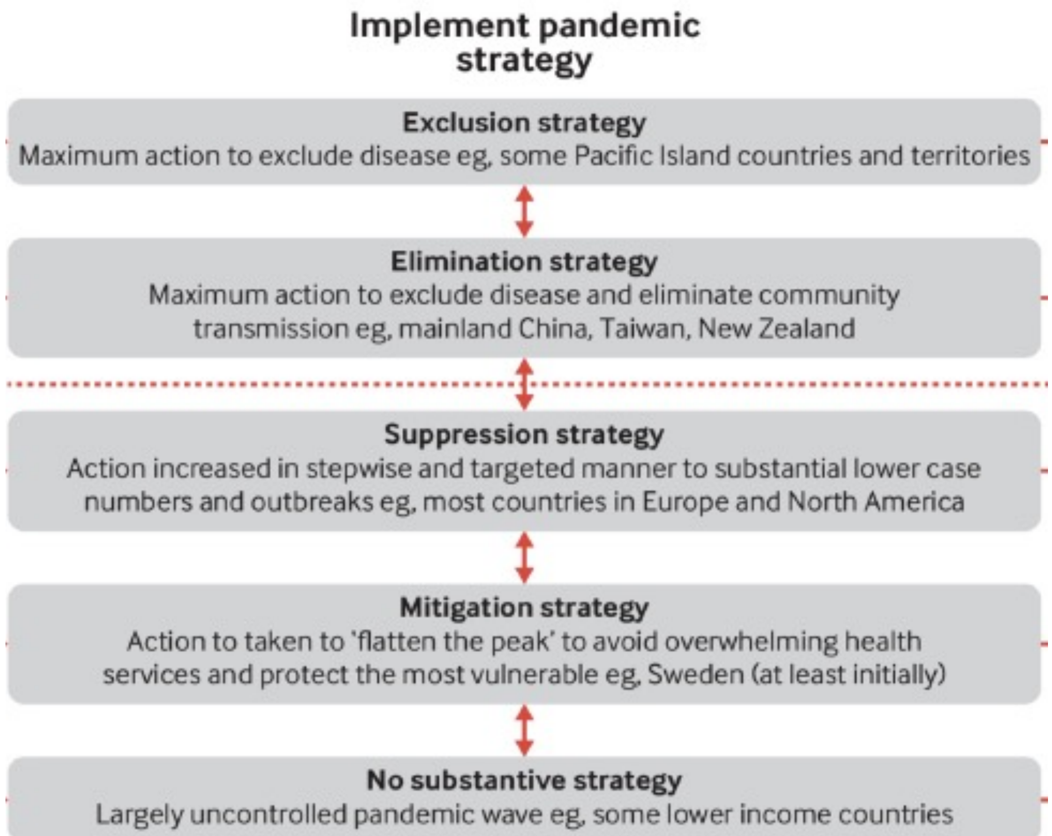
National authorities should conduct thorough, systematic and regular risk assessments as new information emerges to inform the introduction, adjustment and discontinuation of risk mitigation measures in the context of international travel.

For international inbound travel, the following factors should be considered:

- the local epidemiology (8) in departure and destination countries
- the volume of travellers between countries and existing bilateral and multilateral agreements between countries to facilitate free movement
- public health and health services performance and capacity (7) to detect and care for cases and their contacts in the destination country, including among vulnerable travellers, such as refugees, migrants and temporary or seasonal workers whose livelihoods largely depend on cross-border activities
- public health and social measures implemented to control the spread of COVID-19 in departure and destination countries and available evidence on adherence and effectiveness of such measures in reducing transmission
- contextual factors, including economic impact, human rights and feasibility of applying measures.

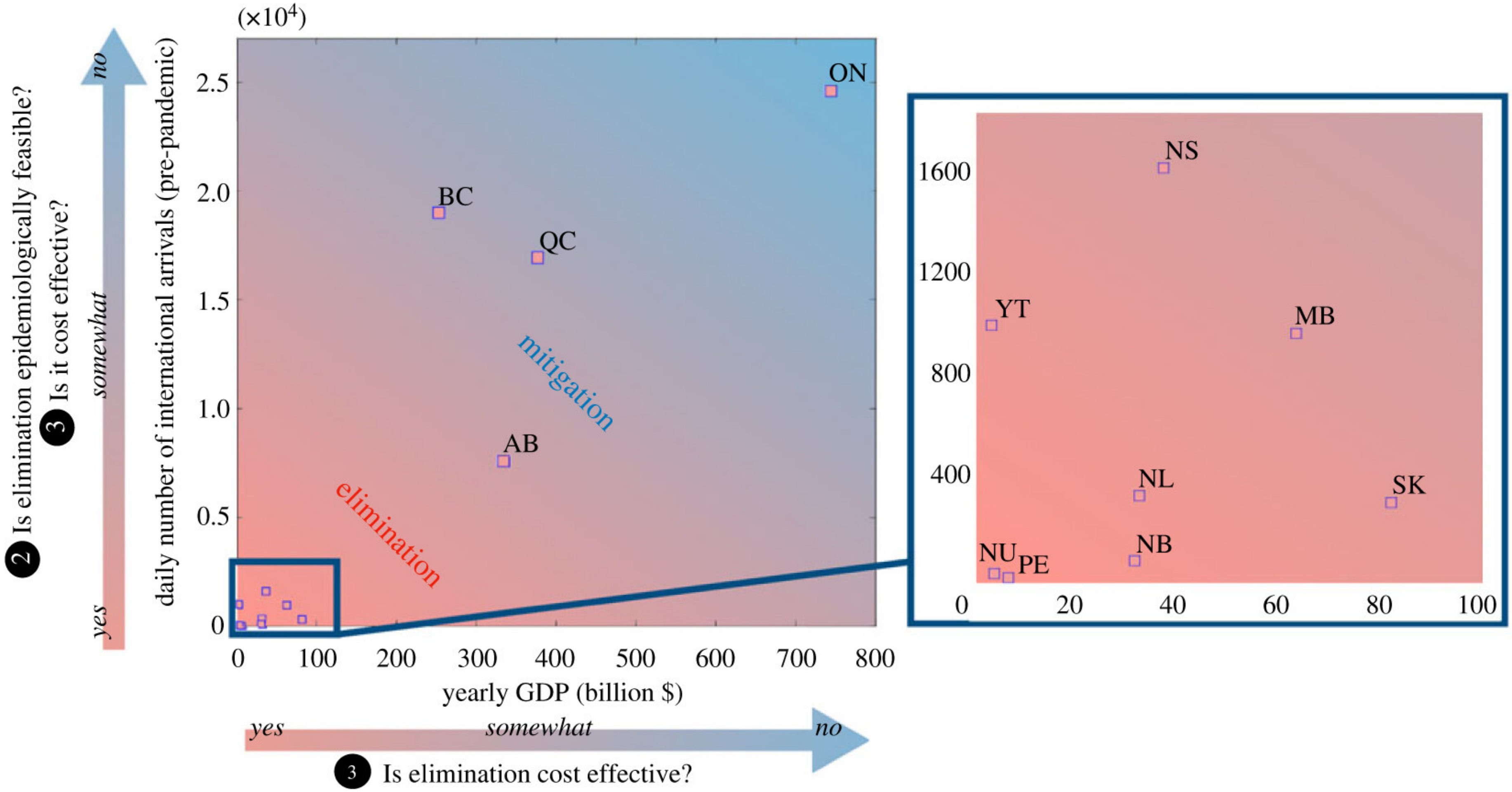
Technical considerations for implementing a risk-based approach to international travel in the context of COVID-19 2 July 2021

Public health strategies



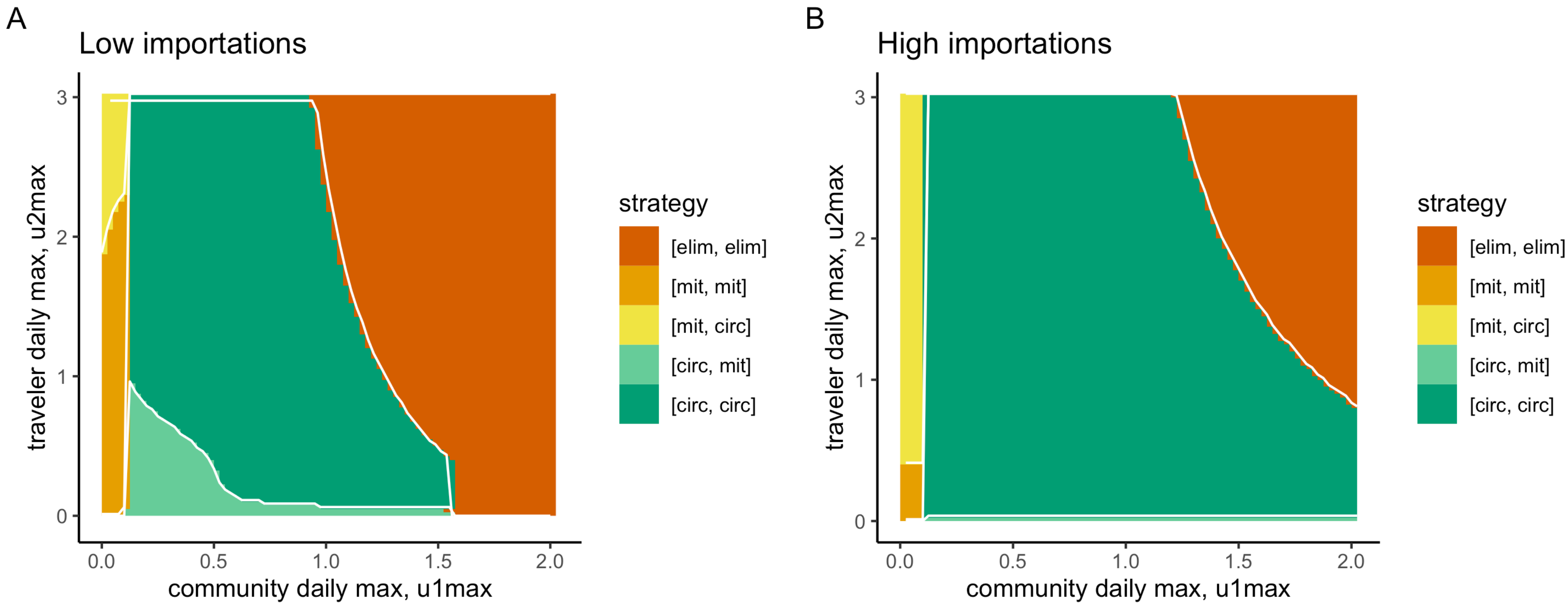
A mitigation strategy can be continuous or circuit breaker

Baker et al. 2020. Elimination could be the optimal response strategy for covid-19 and other emerging pandemic diseases



Martignoni et al. 2024. Is SARS-CoV-2 elimination or mitigation best? Regional and disease characteristics determine the best strategy

Optimal controls rephrased in the terminology of public health strategies



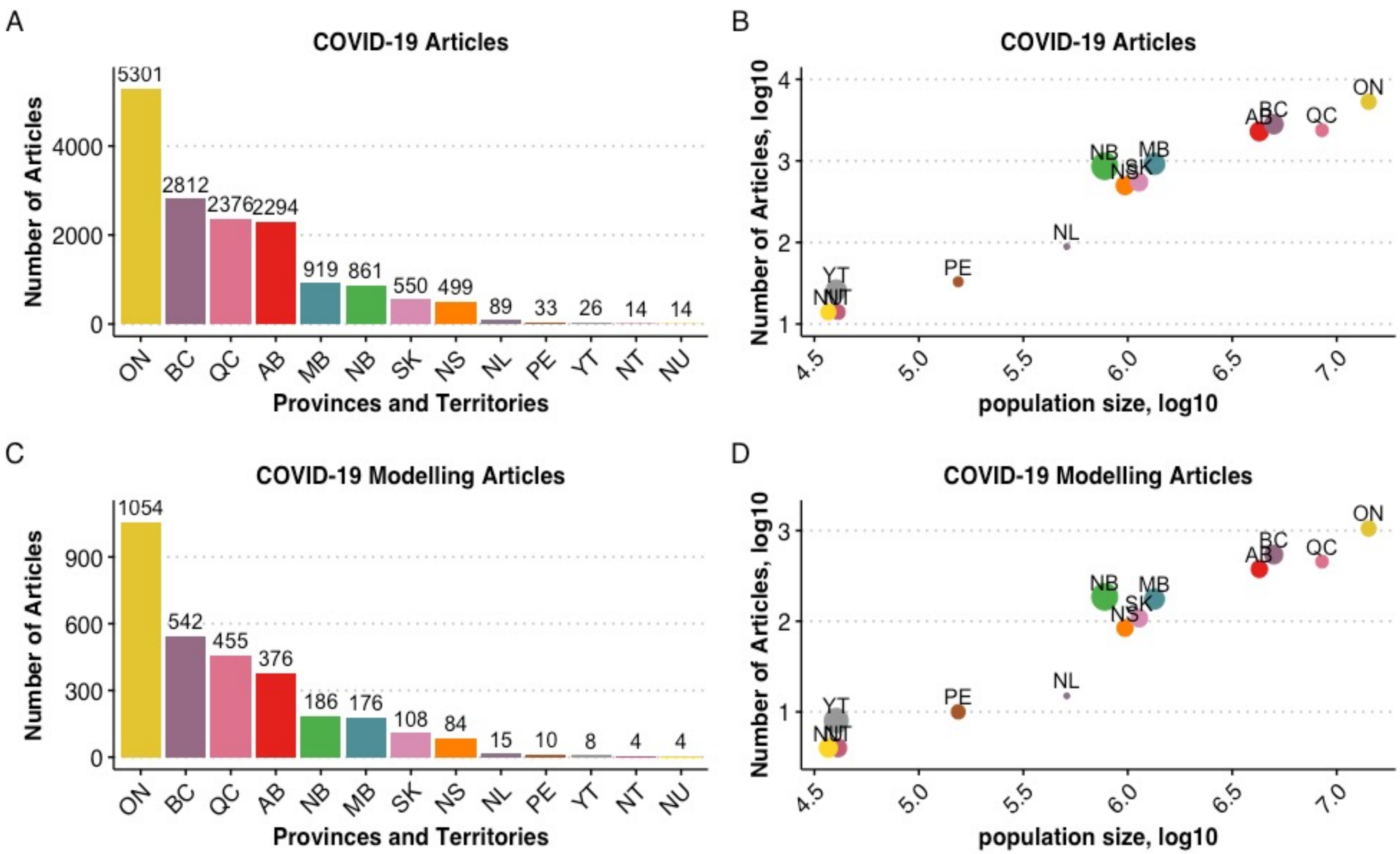
G. Adu-Boahen. Optimal Control Strategies in Epidemic Models: Analysis of Community and Traveler Isolation Strategies Under Resource Constraints. MSc thesis (incomplete)

Small jurisdictions are under-resourced

“the need for additional public health physicians is most acute in rural areas, the Atlantic provinces, the territories and areas served by Health Canada’s First Nations and Inuit Health Branch".

--- 2003 report by the National Advisory Committee on *SARS and Public Health*

Small jurisdictions are under-resourced



Small jurisdictions are not heard

Heroism and tragedy of 1918 Spanish flu remembered in N.L.

It's estimated 1/3 of Labrador's Inuit population died during the worldwide influenza pandemic

Mark Quinn · CBC News · Posted: Sep 30, 2018 5:30 AM EDT | Last Updated: September 30, 2018

American Samoa was one of the few places to report no mortalities from the 1918 influenza pandemic

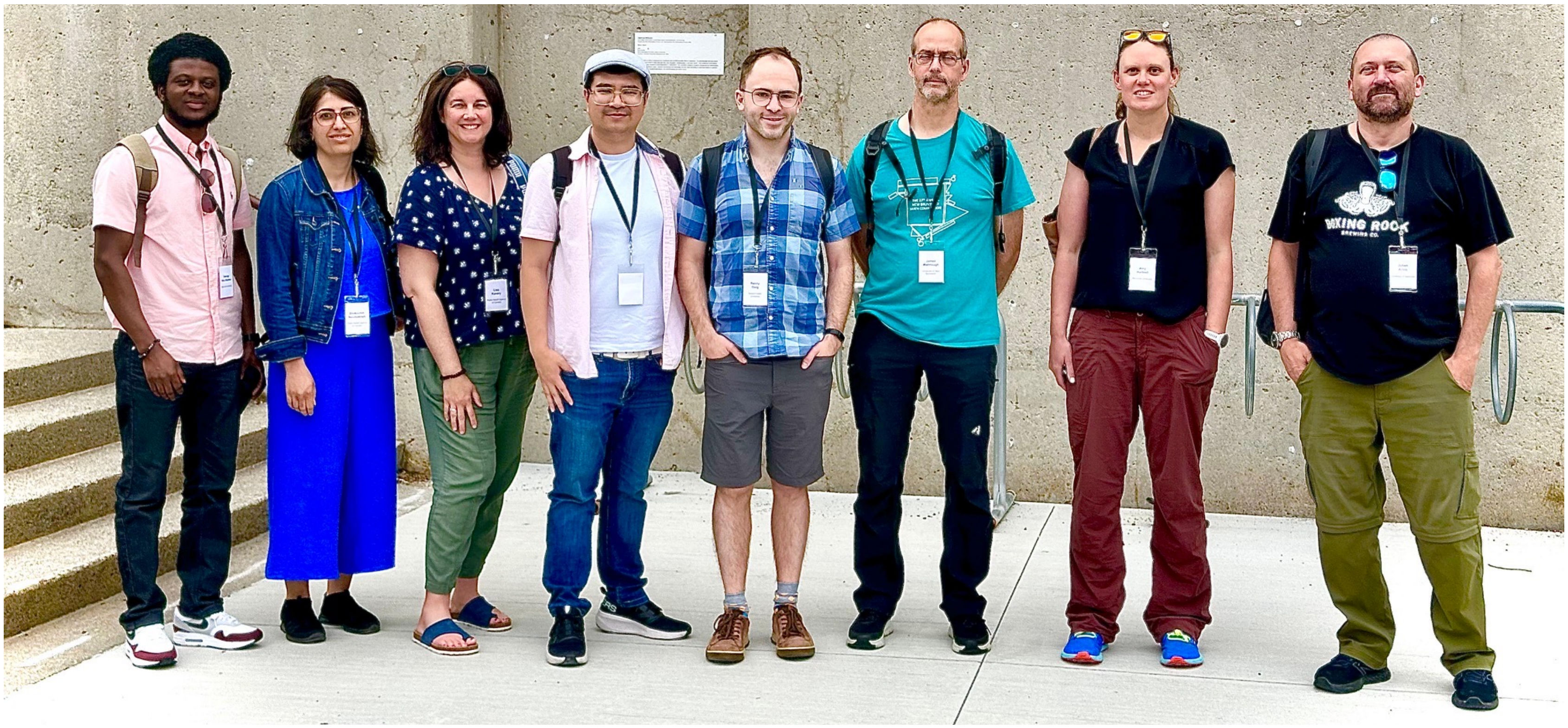
Maritime quarantine, including several day wait period before disembarking maintained until at least 1920

Outbreak in 1926 resulted in clinical infections in 25% of the population;

1/1000 residents died, ~200 lower than overall mortality in nearby Western Samoa

Shanks and Bundage. 2012. Pacific islands which escaped the 1918–1919 influenza pandemic and their subsequent mortality experiences

Small jurisdictions are not heard



Canadian Small Jurisdictions Working Group (CanSJ)

Reasons for space stations

- Under-resourced jurisdictions need access to the best experts too!

Changing contact patterns in Newfoundland and Labrador, Canada in response to public health measures during the COVID-19 pandemic

Renny Doig[1*], Amy Hurford[2,3*], Liangliang Wang[1], Caroline Colijn[4]

[1]Department of Statistics and Actuarial Science, Simon Fraser University, 8888 University Drive, Burnaby, BC, Canada

Summary: what we learned about modelling philosophy

- Mechanistic modelling is under-valued
- Both simple compartmental models and ABMs are needed
- Region-specific modelling is needed. Can be achieved by
  - Building modelling capacity in regional public health (fire stations);
  - Regional experts in an adjacent field with support from modeling experts (space station collaboration)
  - Multijurisdictional representation

The profession (NSERC-based infectious disease modeller)

Reflecting on the emergency response, the actual modelling may have mattered less than the relationships

- Groups of colleagues (CANMOD, OMNI-REUNIS, MfPH, PHAC External Experts Group)
- Interdisciplinary groups (NL Predictive Analytics team, Ontario Science Table & Modelling Consensus Table)
- Referrals from colleagues to establish new relationships
- Decision-makers (CMOHs)
- Public (media and knowledge translation experts such as NCCID)

Pandemic preparedness means also establishing the relationships, and organizing your group of colleagues

The profession (NSERC-based infectious disease modeller)

We need to:

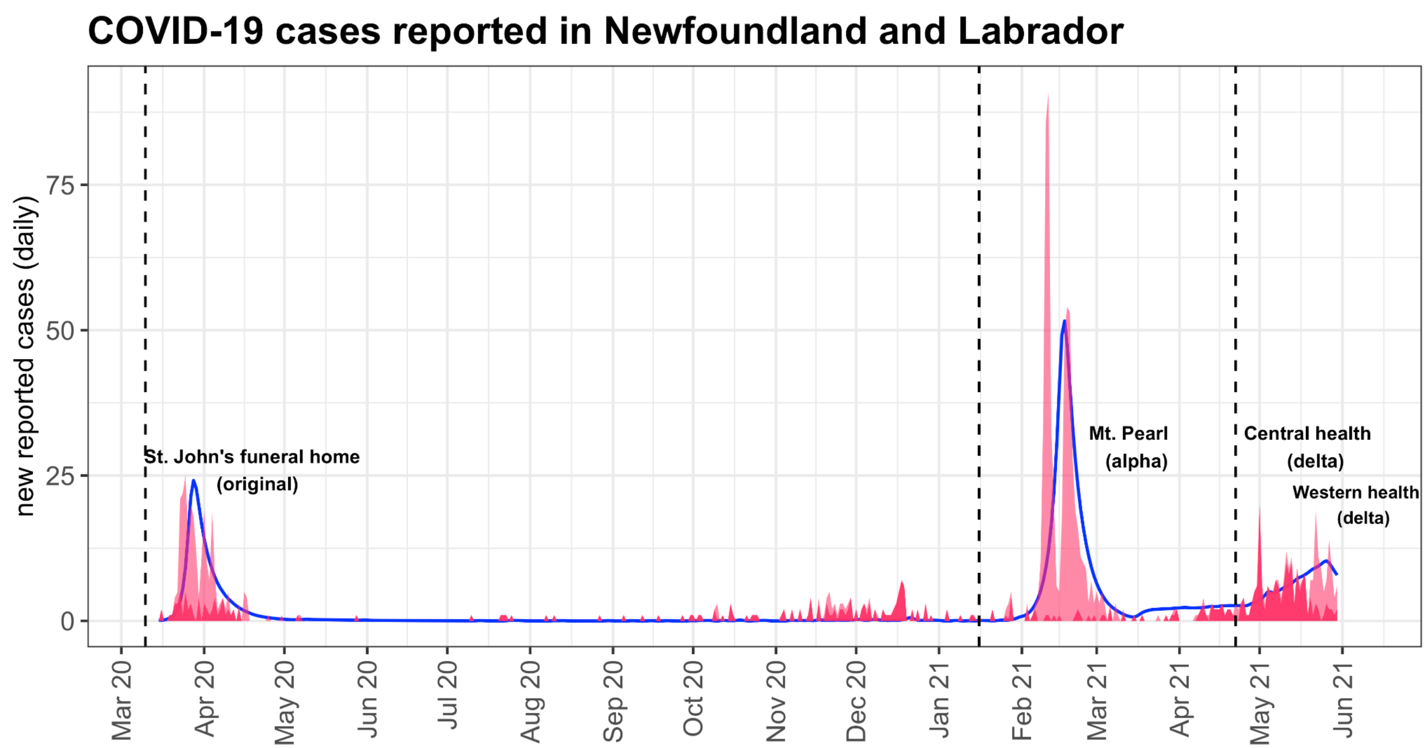
- Advocate for mathematical modelling as critical to pandemic preparedness and the emergency response
- Build relationships, particularly with medical disciplines
- Participate in cross-disciplinary activities
- Do training and knowledge translation on how to do good modelling
- Keep in mind:
  - developing new models (NSERC)
  - health applications of existing math models (CIHR)
- Be resilient

NSERC. Addendum to the guidelines for the eligibility of applications related to health

Pandemic preparedness needs modelling preparedness

What the COVID-19 pandemic taught us about the modelling, the philosophy, and the profession

Amy Hurford



MEMORIAL UNIVERSITY

Newfoundland & Labrador Centre for Health Information
CANMOD
MATHEMATICS FOR PUBLIC HEALTH
AARMS Atlantic Association for Research in the Mathematical Sciences
OMNI | RÉUNIS
Public Health Agency of Canada
NSERC CRSNG

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McMaster U Steve Walker

NLHS – Digital Health Kendra Lester; Alicia Blackmore

U Manitoba Julien Arino

U New Brunswick James Watmough

Simon Fraser U Caroline Colijn; Renny Doig; Liangliang Wang

NLHS Suzette Spurrell; Andrea Morrissey

CanSJ

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MMI

Maud Menten Institute

Mathematics for the Life Sciences

PIMS