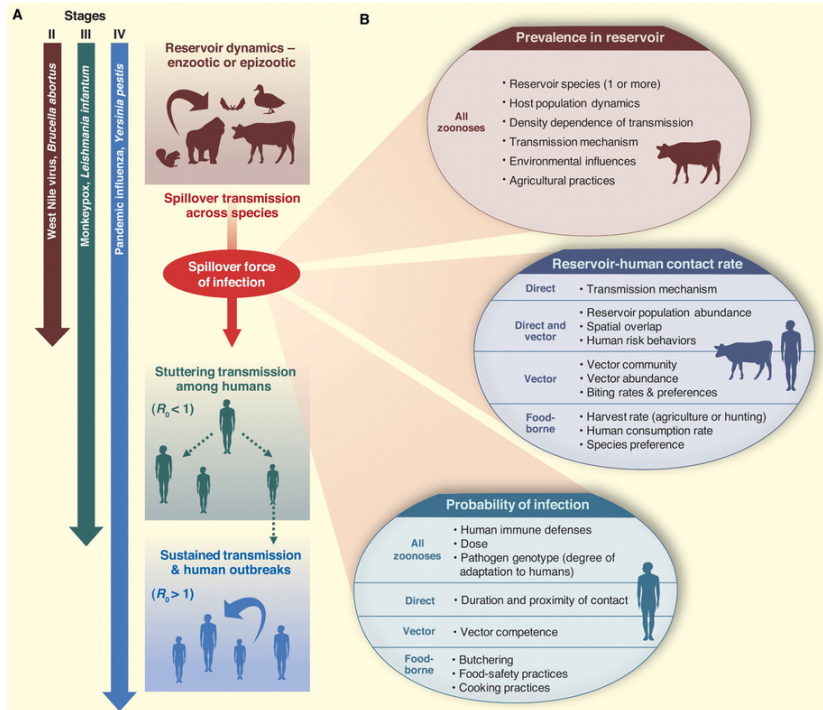


emerging infectious disease

3 April 2023

emerging and re-emerging disease



basically, anything we're worried about

- new mutations
- change in environment
- resistant strains
- species jumps (encounter and compatibility: changes via recombination, mutation)

Do we need to understand *everything*?

- reservoir ecology
- pathogen biology
- human-reservoir interactions

How do we understand? How do we predict?

Batrachochytrium dendrobatidis

Reminders

- fungal pathogen

- most other chytrids are saprophytes, plant pathogens
- *B. salamandrivorans*: salamander pathogen (more restricted)
- first discovered in poison dart frogs
- caused die-offs in E Australia, Central America, Colorado, California ...
- association with high altitude?
- occurred in pristine areas (probably not anthropogenic?)
- pathogenesis via screwed-up osmoregulation

Very confusing ...

- some species decline in the absence of Bd
- some species stable in the presence of Bd (Bd may have been there all along?)
- susceptibility:
 - ability to bask
 - antimicrobial peptides

tipping point hypothesis: in populations all the time, but something happened to increase virulence/reduce tolerance or resistance

- climate change/El Niño ?
- ultraviolet radiation?
- cooler temperatures? (basking etc.)
- pesticides?
- combination (species \times temperature \times U/V \times pesticide \times ...)
- Pounds et al. (2006): “chytrid-thermal-optimum hypothesis”
- Rohr et al. (2008): “numerous other variables, including regional banana and beer production, were better predictors of these extinctions”
- Rohr & Raffel (2010)

novel pathogen hypothesis: mutation/speciation + dispersal

- “Out of Africa” hypothesis
- earlier/broader detection in historical specimens: CA/bullfrog, Brazil ...
- genomics (challenging!)
- Asian sampling

monkeypox

climate change

- warming
 - ‘good’ or ‘bad’ for pathogens?
 - vector biology
 - * extended range
 - * higher activity?
- changes in seasonality, hydrological cycles
- local landscape change
 - hydrology
 - land cover (Lyme disease)
 - forest cover
- changes in reservoir communities

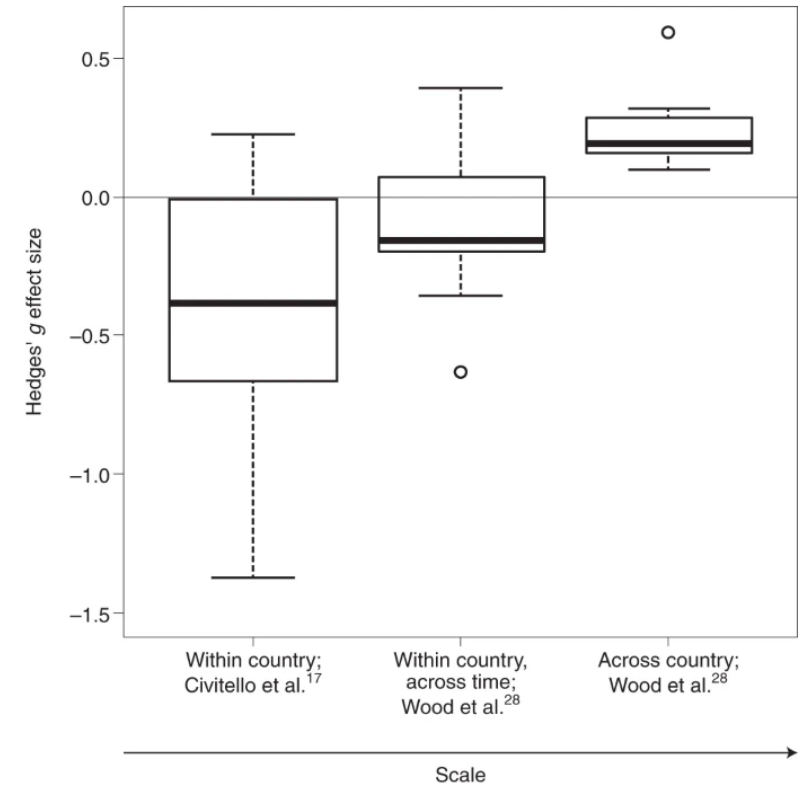
dilution effect (Keesing & Ostfeld, 2021)

- does increased biodiversity decrease disease?
- variation in reservoir competence
- high-quality hosts decrease with increasing biodiversity
 - encounter reduction; host regulation; vector preferences

Kain & Bolker (2019)

Rohr et al. (2020)

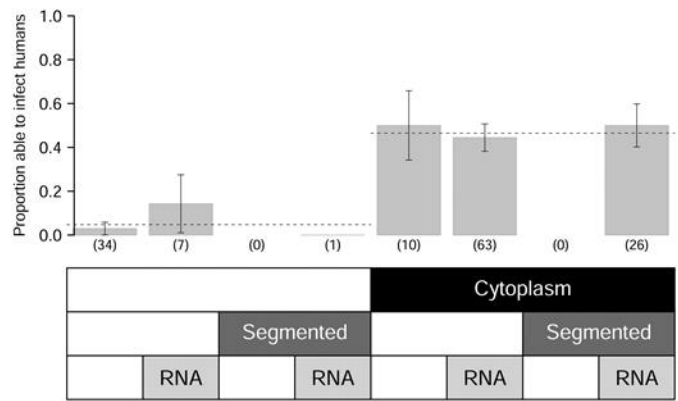
Fig. 4: Hedges' *g* effect sizes.



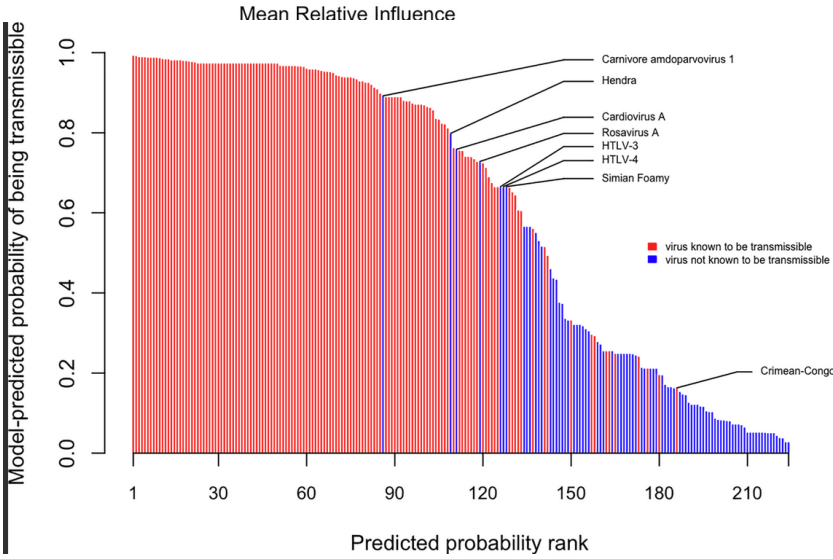
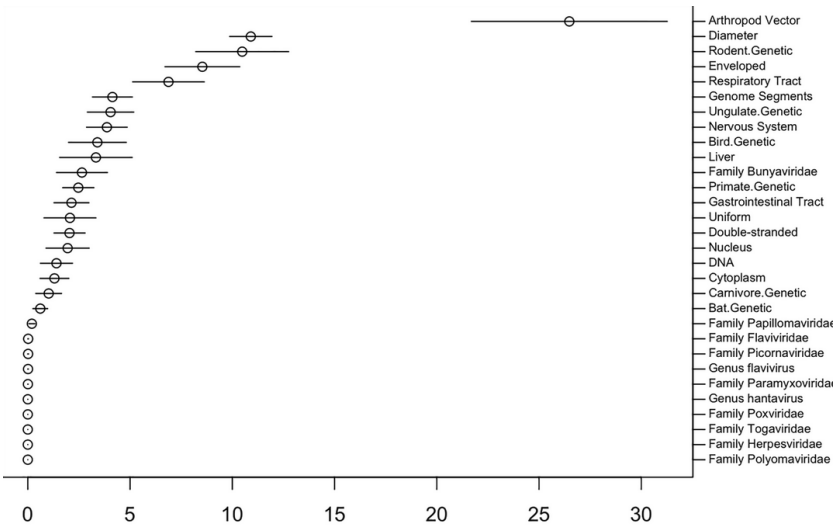
prediction

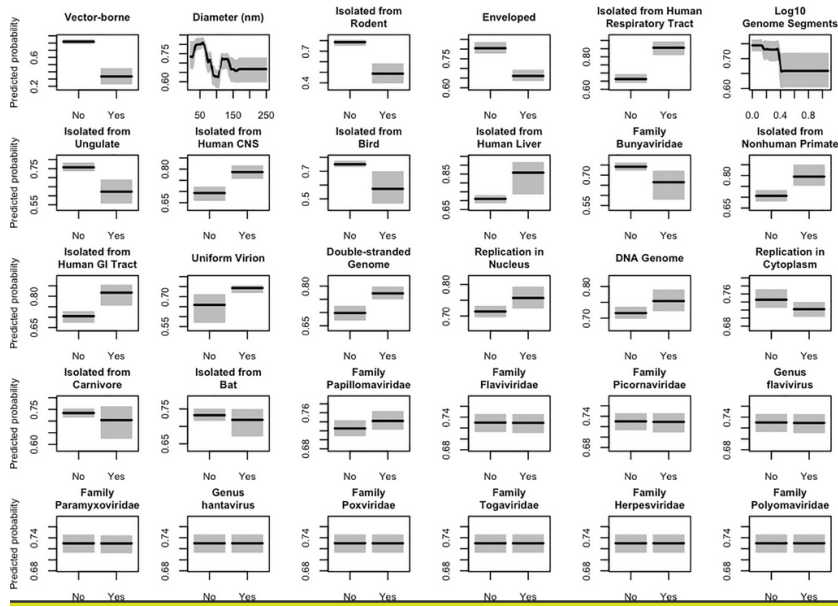
Pulliam & Dushoff (2009)

Figure 1.

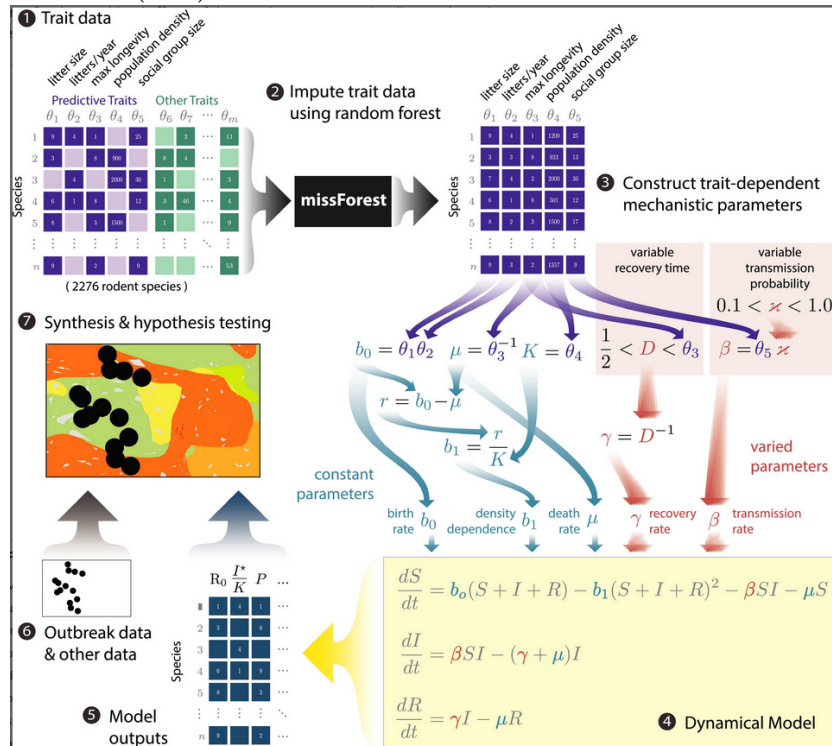


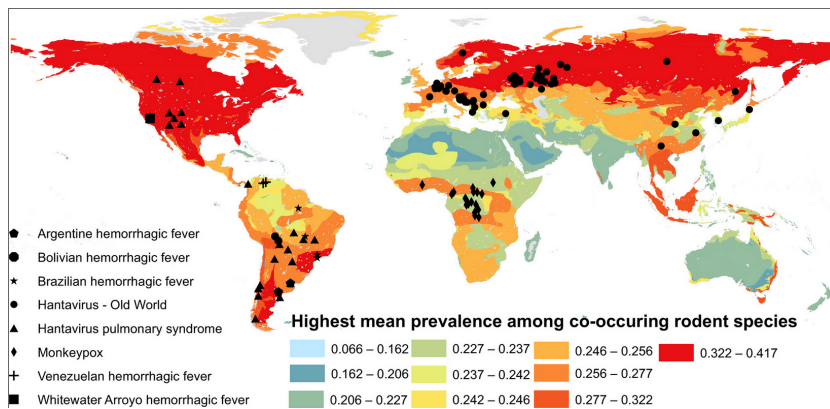
Walker et al. (2018)





Han et al. (2020)





Carlson et al. (2021)

Evans et al. (2023)

MacDonald & Mordecai (2019)

References

- Carlson, C. J., Bevins, S. N., & Schmid, B. V. (2021). Plague risk in the western United States over seven decades of environmental change. *bioRxiv*, 2021.02.26.433096. <https://doi.org/10.1101/2021.02.26.433096>
- Evans, T. S., Tan, C. W., Aung, O., Phyu, S., Lin, H., Coffey, L. L., Toe, A. T., Aung, P., Aung, T. H., Aung, N. T., Weiss, C. M., Thant, K. Z., Htun, Z. T., Murray, S., Wang, L.-F., Johnson, C. K., & Thu, H. M. (2023). Exposure to diverse sarbecoviruses indicates frequent zoonotic spillover in human communities interacting with wildlife. *International Journal of Infectious Diseases*, o(o). <https://doi.org/10.1016/j.ijid.2023.02.015>
- Han, B. A., O'Regan, S. M., Paul Schmidt, J., & Drake, J. M. (2020). Integrating data mining and transmission theory in the ecology of infectious diseases. *Ecology Letters*, 23(8), 1178–1188. <https://doi.org/10.1111/ele.13520>
- Kain, M. P., & Bolker, B. M. (2019). Predicting West Nile virus transmission in North American bird communities using phylogenetic mixed effects models and eBird citizen science data. *Parasites & Vectors*, 12(1), 395. <https://doi.org/10.1186/s13071-019-3656-8>
- Keesing, F., & Ostfeld, R. S. (2021). Dilution effects in disease ecology. *Ecology Letters*, 24(11), 2490–2505. <https://doi.org/10.1111/ele.13875>
- MacDonald, A. J., & Mordecai, E. A. (2019). Amazon deforestation drives malaria transmission, and malaria burden reduces forest clearing. *Proceedings of the National Academy of Sciences*, 116(44), 22212–22218. <https://doi.org/10.1073/pnas.1905315116>
- Pounds, A. J., Bustamante, M. R., Coloma, L. A., Consuegra, J.

- A., Fogden, M. P. L., Foster, P. N., La Marca, E., Masters, K. L., Merino-Viteri, A., Puschendorf, R., Ron, S. R., Sánchez-Azofeifa, G. A., Still, C. J., & Young, B. E. (2006). Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature*, 439(7073), 161–167. <https://doi.org/10.1038/nature04246>
- Pulliam, J. R. C., & Dushoff, J. (2009). Ability to Replicate in the Cytoplasm Predicts Zoonotic Transmission of Livestock Viruses. *The Journal of Infectious Diseases*, 199(4), 565–568. <https://doi.org/10.1086/596510>
- Rohr, J. R., Civitello, D. J., Halliday, F. W., Hudson, P. J., Lafferty, K. D., Wood, C. L., & Mordecai, E. A. (2020). Towards common ground in the biodiversity–disease debate. *Nature Ecology & Evolution*, 4(1), 24–33. <https://doi.org/10.1038/s41559-019-1060-6>
- Rohr, J. R., & Raffel, T. R. (2010). Linking global climate and temperature variability to widespread amphibian declines putatively caused by disease. *Proceedings of the National Academy of Sciences*, 107(18), 8269–8274. <https://doi.org/10.1073/pnas.0912883107>
- Rohr, J. R., Raffel, T. R., Romansic, J. M., McCallum, H., & Hudson, P. J. (2008). Evaluating the links between climate, disease spread, and amphibian declines. *Proceedings of the National Academy of Sciences*, 105(45), 17436–17441. <https://doi.org/10.1073/pnas.0806368105>
- Walker, J. W., Han, B. A., Ott, I. M., & Drake, J. M. (2018). Transmissibility of emerging viral zoonoses. *PLOS ONE*, 13(11), e0206926. <https://doi.org/10.1371/journal.pone.0206926>