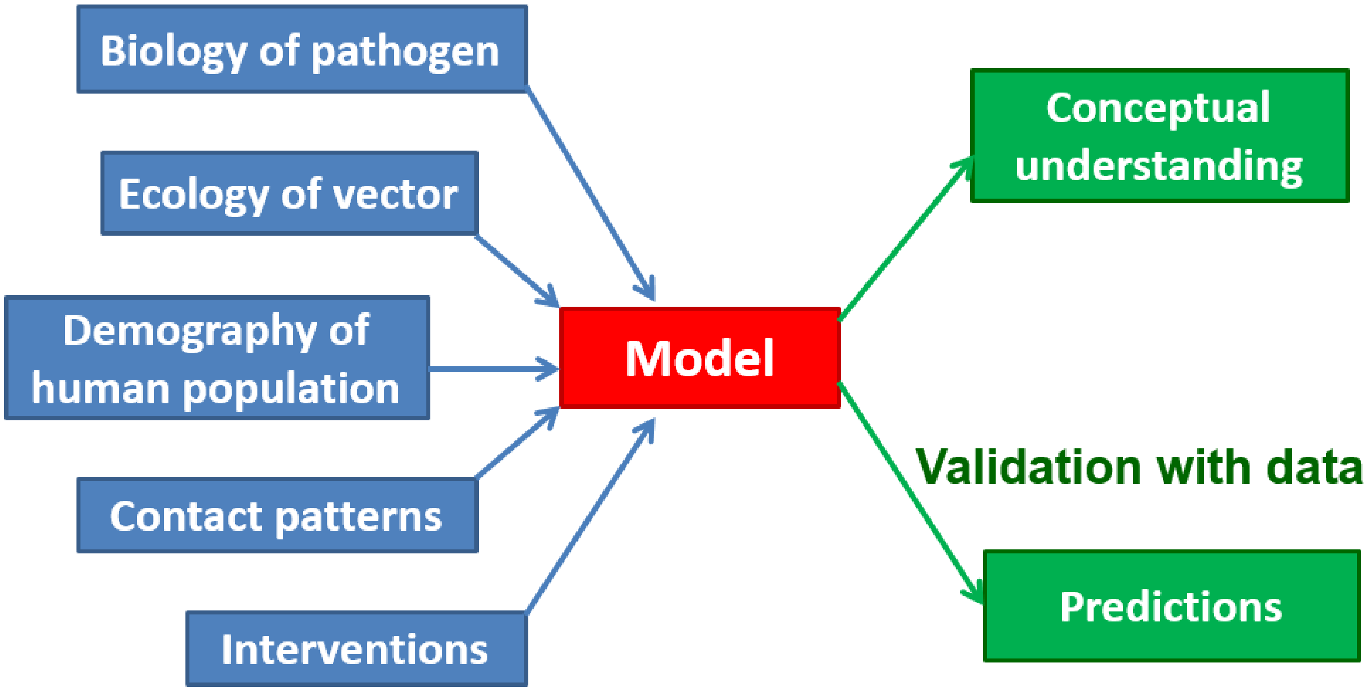
# Zika virus: Insights from mathematical models

*John Marshall, PhD*

University of California
San Francisco

# Modeling as data integration

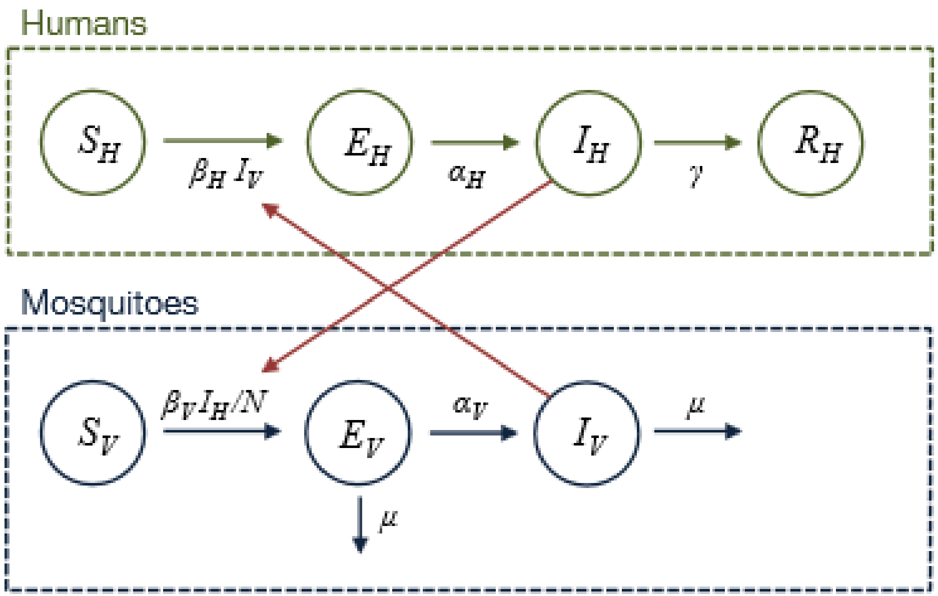


# Zika questions that modeling can help us to inform

1. What implications does the current outbreak in Latin America have for the US?
2. What is the expected time course of the current outbreak in Latin America?
3. Is Zika here to stay? What are the expected long-term dynamics of Zika in Latin America?
4. What impact can we expect vector control to have on Zika incidence and the incidence of Zika-induced microcephaly?
5. What about a Zika vaccine, if it becomes available?
6. What implications does the sexual transmission of Zika have on the population-wide dynamics?

# Transmission dynamics of Zika virus in island populations: a modelling analysis of the 2013–14 French Polynesia outbreak

Adam J. Kucharski[1,*], Sebastian Funk[1], Rosalind M. Eggo[1], Henri-Pierre Mallet[2], W. John Edmunds[1], Eric J. Nilles[3]



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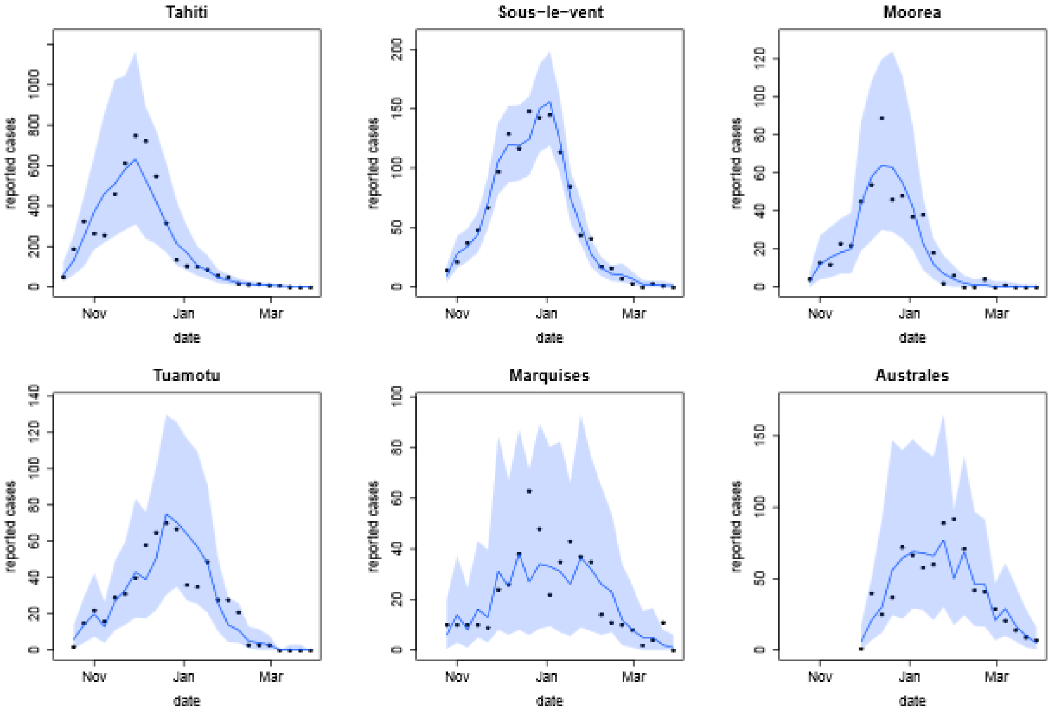
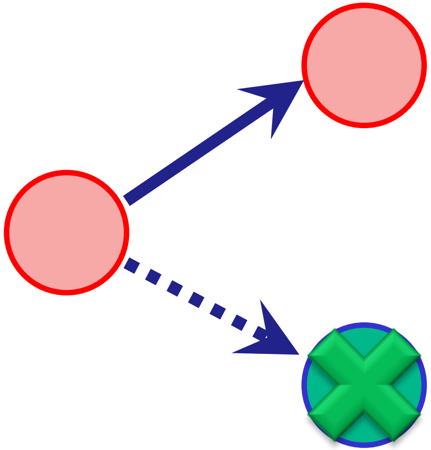
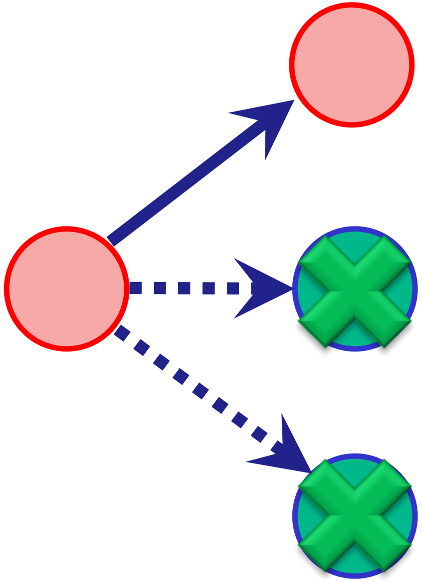


# Outbreak size depends on $R_0$





- $R_0 = 2$
- Outbreak slows down after 1/2 of population has been infected

- $R_0 = 3$
- Outbreak slows down after 2/3 of population has been infected

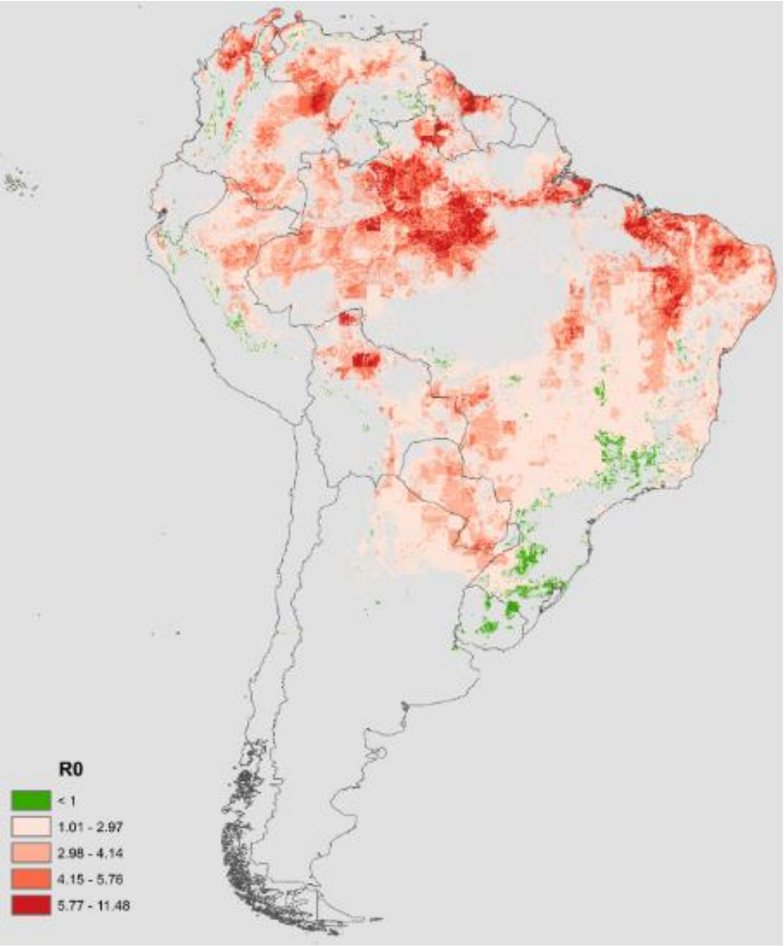
# Implications for Latin America

**Model-based projections of Zika virus infections in childbearing women in the Americas**

T. Alex Perkins[1*], Amir S. Siraj[1], Corrine Warren Ruktanonchai[2], Moritz U.G. Kraemer[3], Andrew J. Tatem[2,4]

$$R_0(T) = \frac{mbca^2 e^{-\mu(T)n(T)}}{\mu(T)r}$$

- $m$ = Number of mosquitoes per person (species mapping & economic index)
- $\mu$ = Mosquito death rate (function of temp.)
- $n$ = Virus incubation period in mosquito (function of temp.)



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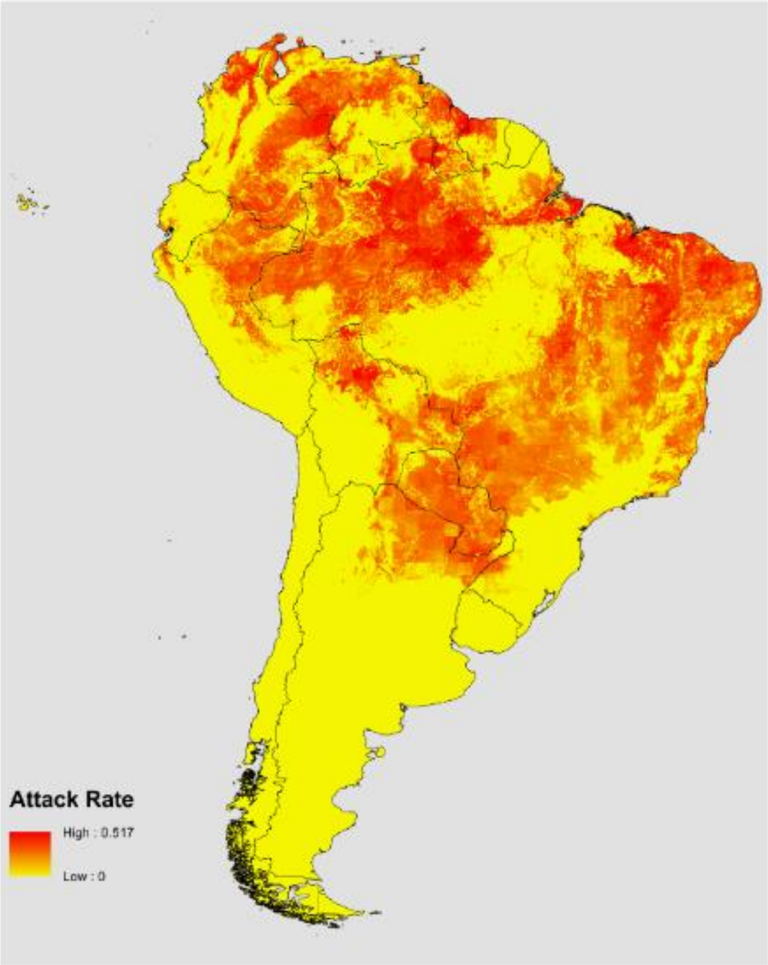


# Is Zika here to stay?

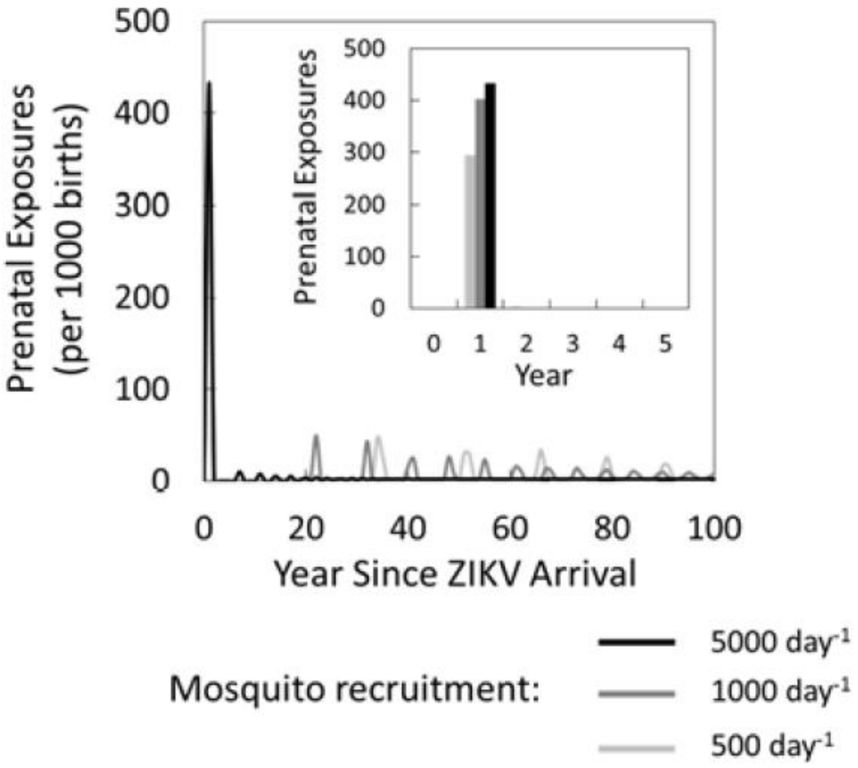
Zika Virus: Endemic Versus Epidemic Dynamics and Implications for Disease Spread in the Americas

Sharon Bewick[1], William F. Fagan[2], Justin Calabrese[2], Folashade Agusto[3,*]

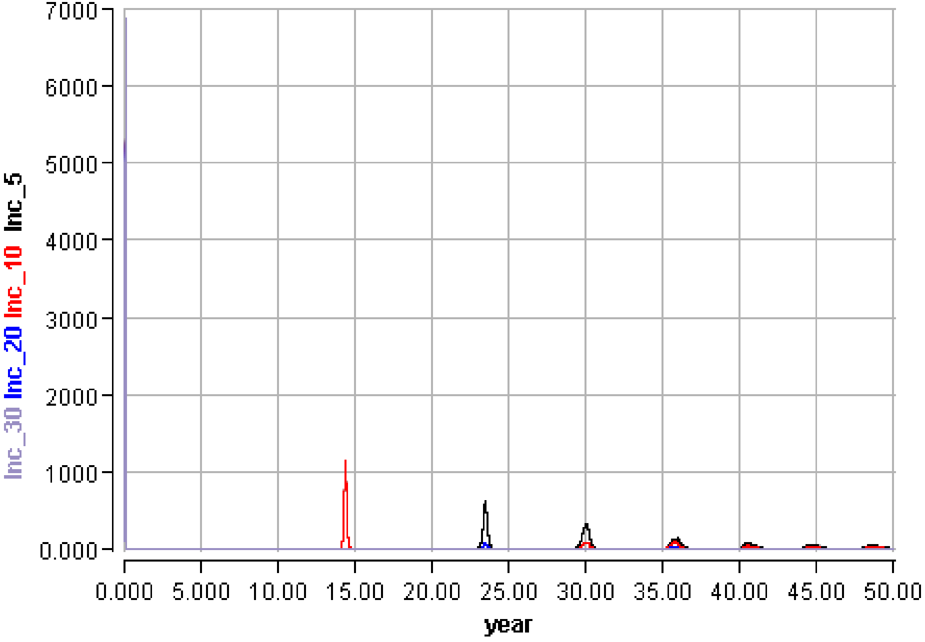
[1] Department of Biology, University of Maryland, College Park, MD 20742;

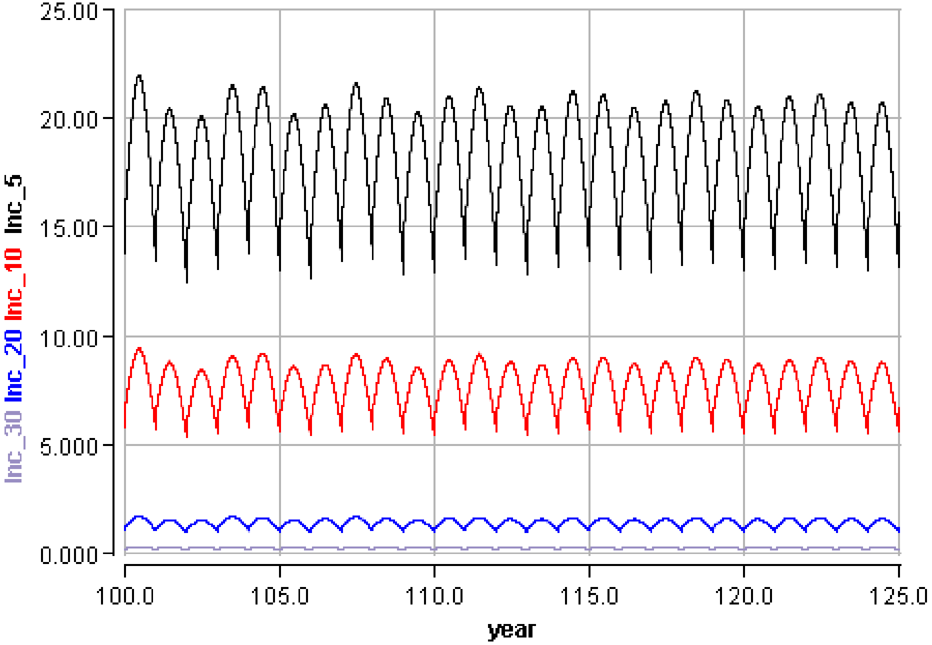
[2] Conservation Ecology Center, Smithsonian Conservation Biology Institute, Front Royal, VA 22630;

[3] Department of Ecology and Evolutionary Biology, University of Kansas State, Lawrence, KS 66045;

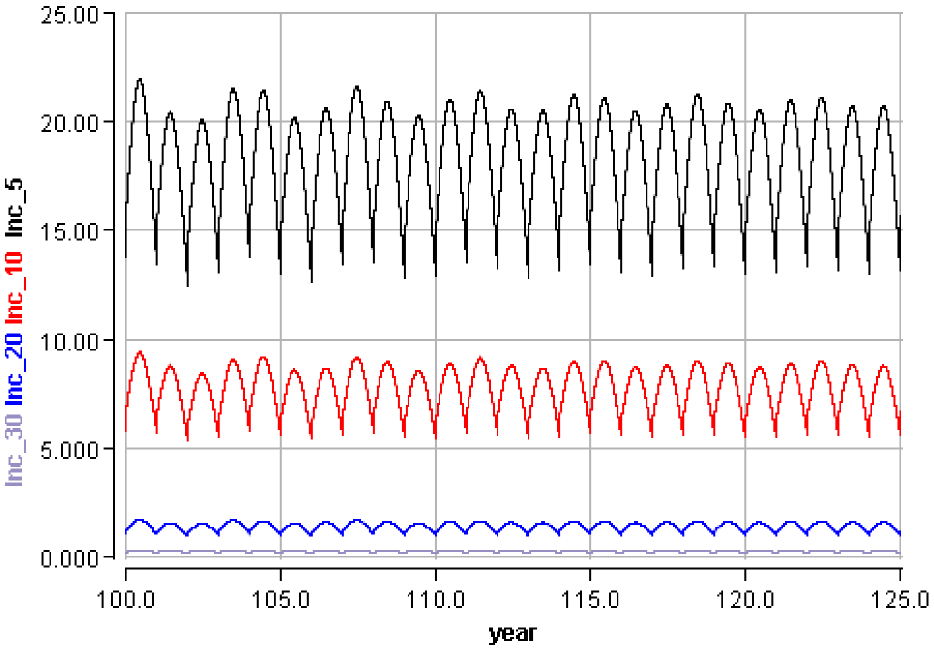


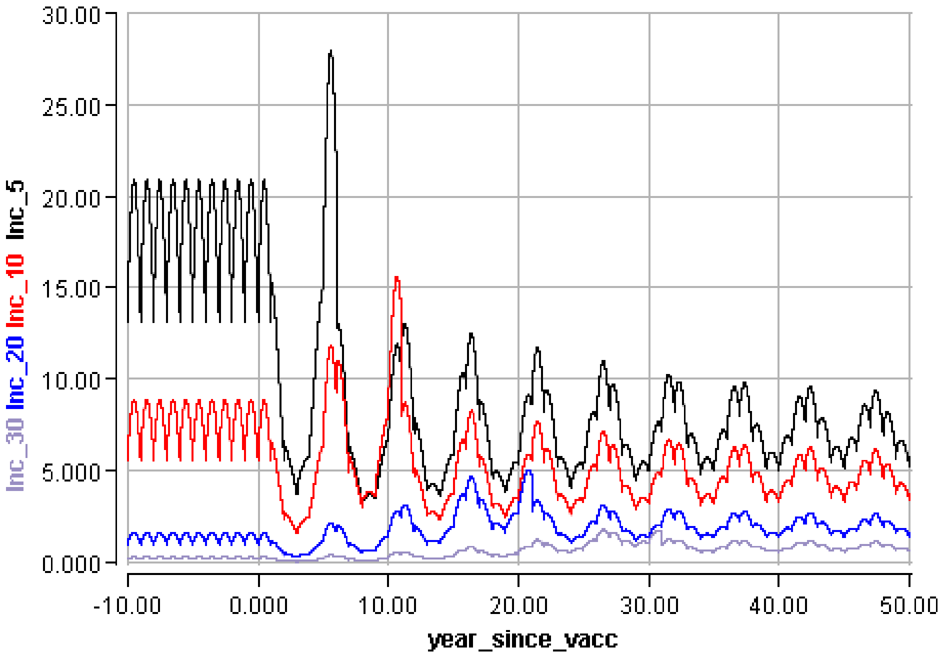
# What can we expect in the long-term? (c.f. Rubella)



# What about a vaccine? (c.f. Rubella)



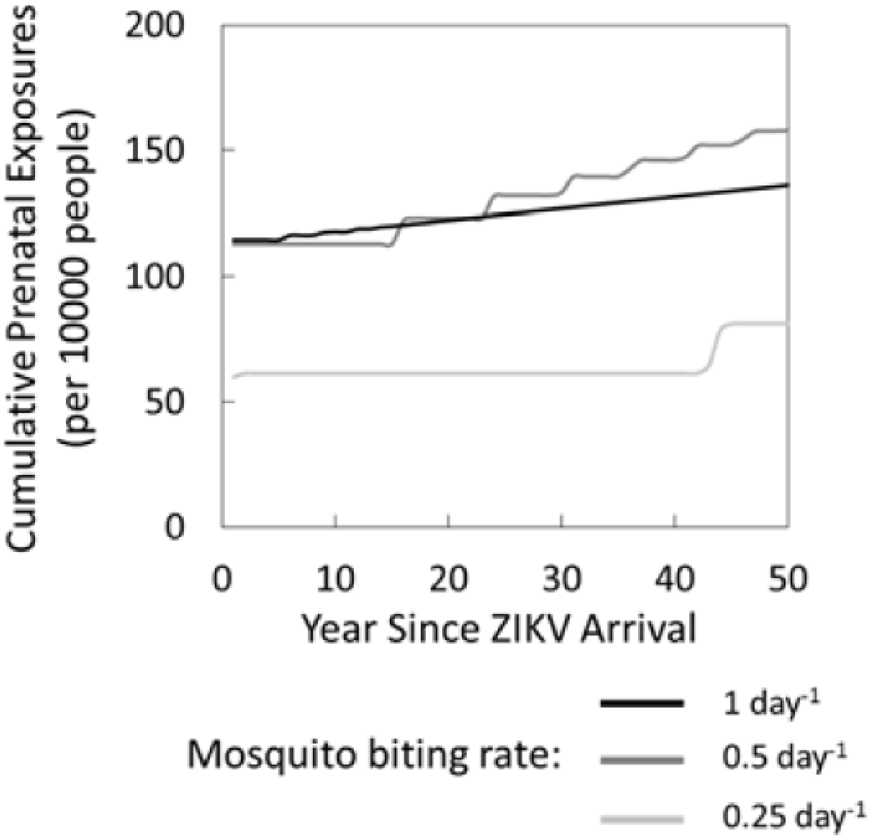
Probability of infection per year
$\approx$ 1 / Mean age of infection

# What about vector control?

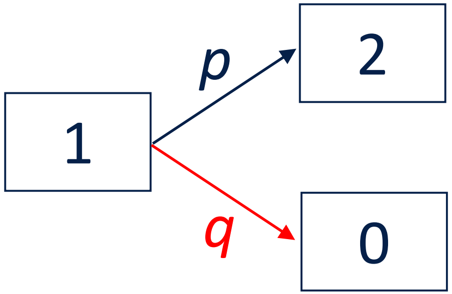
$$R_0(T) = \frac{mbca^2 e^{-\mu(T)n(T)}}{\mu(T)r}$$

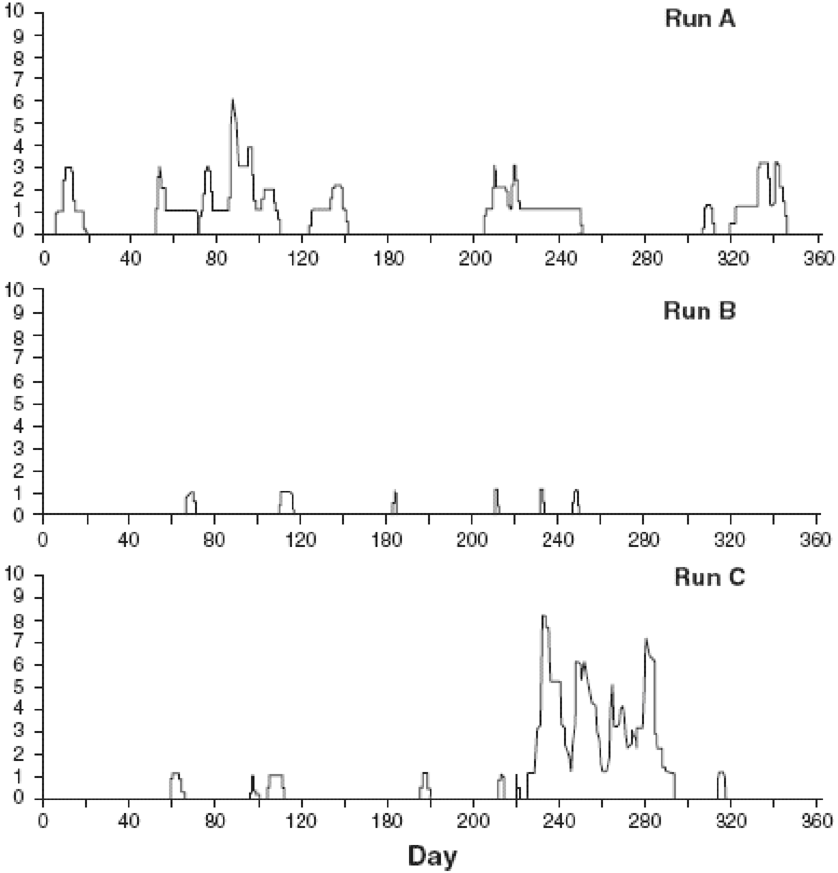
Vector control may impact:

- *m* = Number of mosquitoes per person
- *a* = Mosquito biting rate
- $\mu$ = Mosquito death rate



# Implications for the US



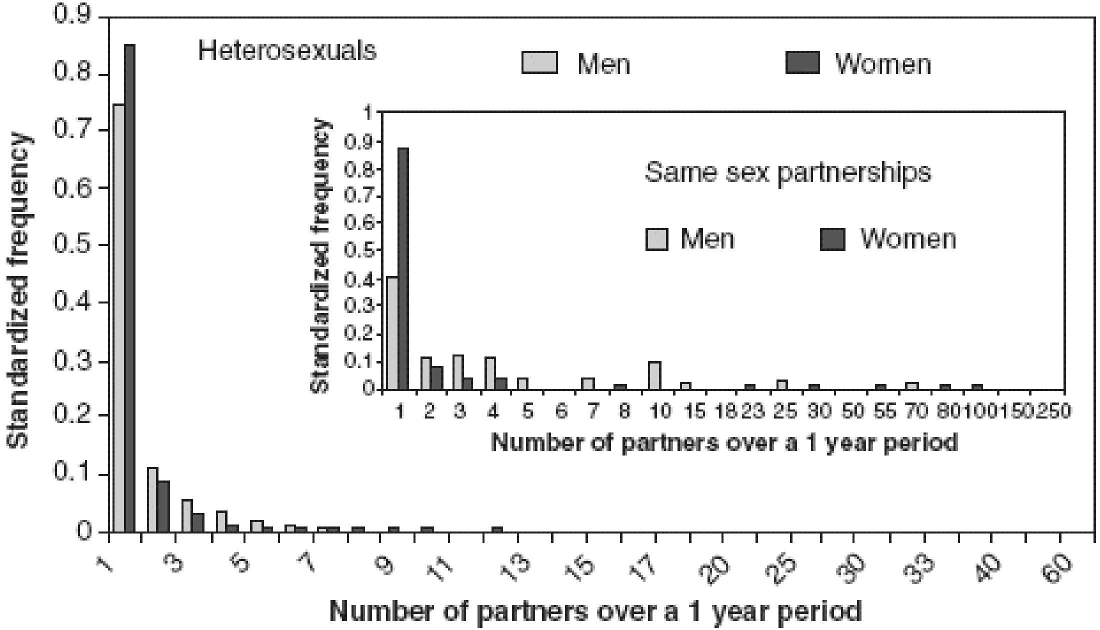




- $R_0 < 1$ so outbreaks are stochastic events

# Implications of sexual transmission

- $R_0 =$
  Number of partners per year
  x Probability of transmission per partnership
  x Duration of infectiousness

- Potential to spread among high-risk groups
- Unlikely to persist among general population



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