Preview of Wednesday:

Modeling principles in *NAADSM*

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Today in review (I)

- Stochasticity, the random, variable, or uncertain aspects of a system, can be incorporated in disease models with Monte Carlo methods
- Monte Carlo methods rely heavily on stochastic processes and probability density functions
- Stochastic models produce a range of possible outcomes and offer some indication about the potential likelihood of each outcome

Today in review (II)

- State transition modeling provides a basis for potentially quite complex disease models, which incorporate many pathways for and probabilities of various state transitions
- While fairly detailed stochastic models can be produced with a spreadsheet and some specialized software, these approaches are still limited

Re-examining the assumptions of the models used so far…

Homogenous mixing (I)

- All models we've used assume that individuals within the population are equally likely to come into contact with any other individual
  - This assumption may be acceptable for animals within a herd or for people within a household
  - It is certainly not valid for more complex situations

Homogenous mixing (II)

- What happens when we redefine “individual” and “population” as:
  - “Individual” – a single herd, flock, or farm
  - “Population” – all of the herds, flocks, or farms in a specified region
- Herds, which have a fixed location and are more or less immobile, certainly do not come in contact with one another by mixing randomly
  - *Teaser:* Dr. McNab will discuss ways to examine and model very non-random contact structures on Friday

Temporal aspects of disease spread

- The chain binomial and state transition models used so far handle time, but only in a simplistic way
  - Time is treated as a series of intervals of equal duration
  - The occurrence of every event is forced to take place within these exact intervals
  - We have already seen that this is not an appropriate assumption, due to the natural variability in the duration of disease states

Spatial aspects of disease spread

- None of the models we've used have incorporated any kind of spatial information
- The consideration of a spatial component is especially important for herd-level modeling
  - Distance between herds or flocks
  - Localized population (farm) density

Mechanisms of disease spread

- The Reed-Frost model explicitly assumes that disease spreads only by direct contact
- A state transition matrix contains no information about the mechanism of disease spread
- In life, diseases may be spread by other mechanisms
  - Fomites
  - Contaminated equipment or personnel
  - Aerosol spread
  - Atmospheric plumes have been suggested in some cases

NAADSM addresses some of these limitations

What is *NAADSM*? (I)

- *NAADSM* is a framework for the development of simulation models of animal disease

What is *NAADSM*? (II)

- *NAADSM* is a state transition model

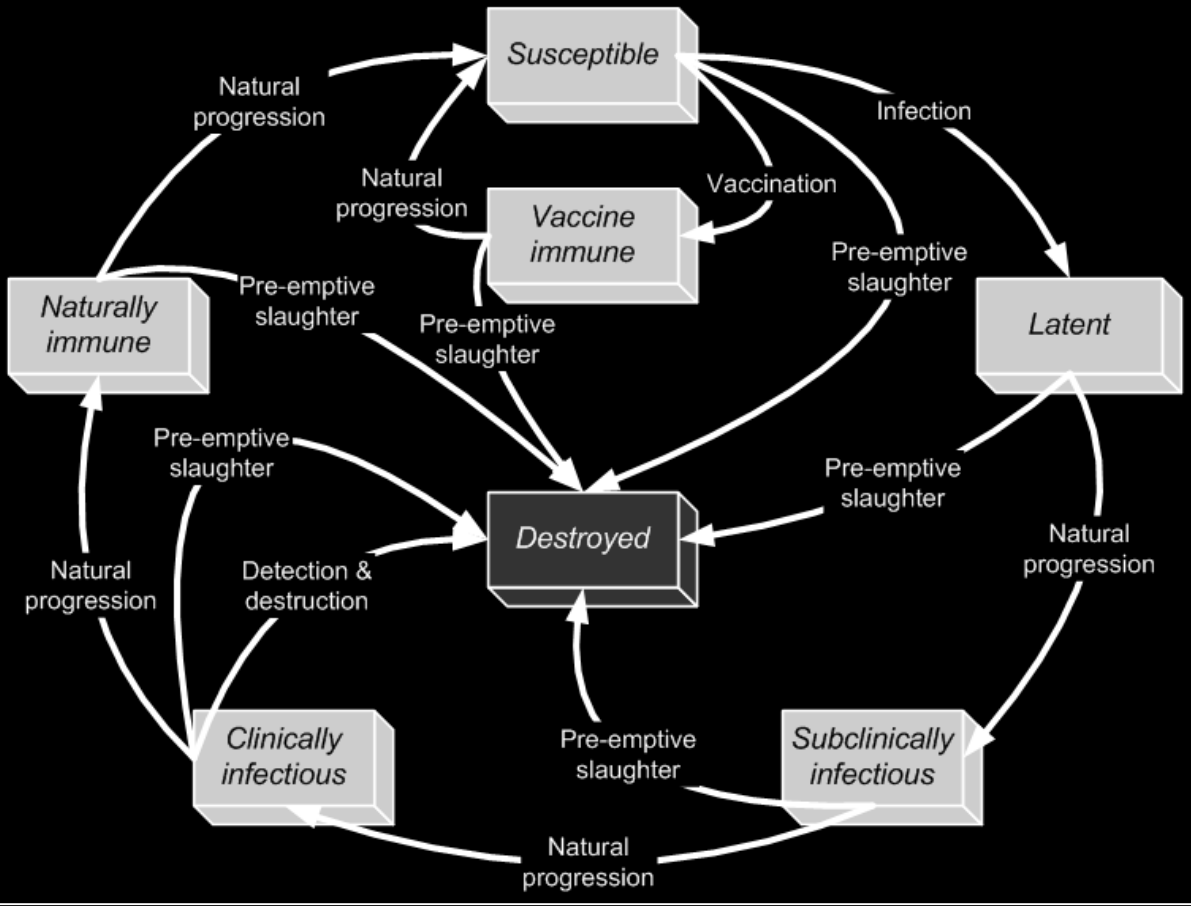


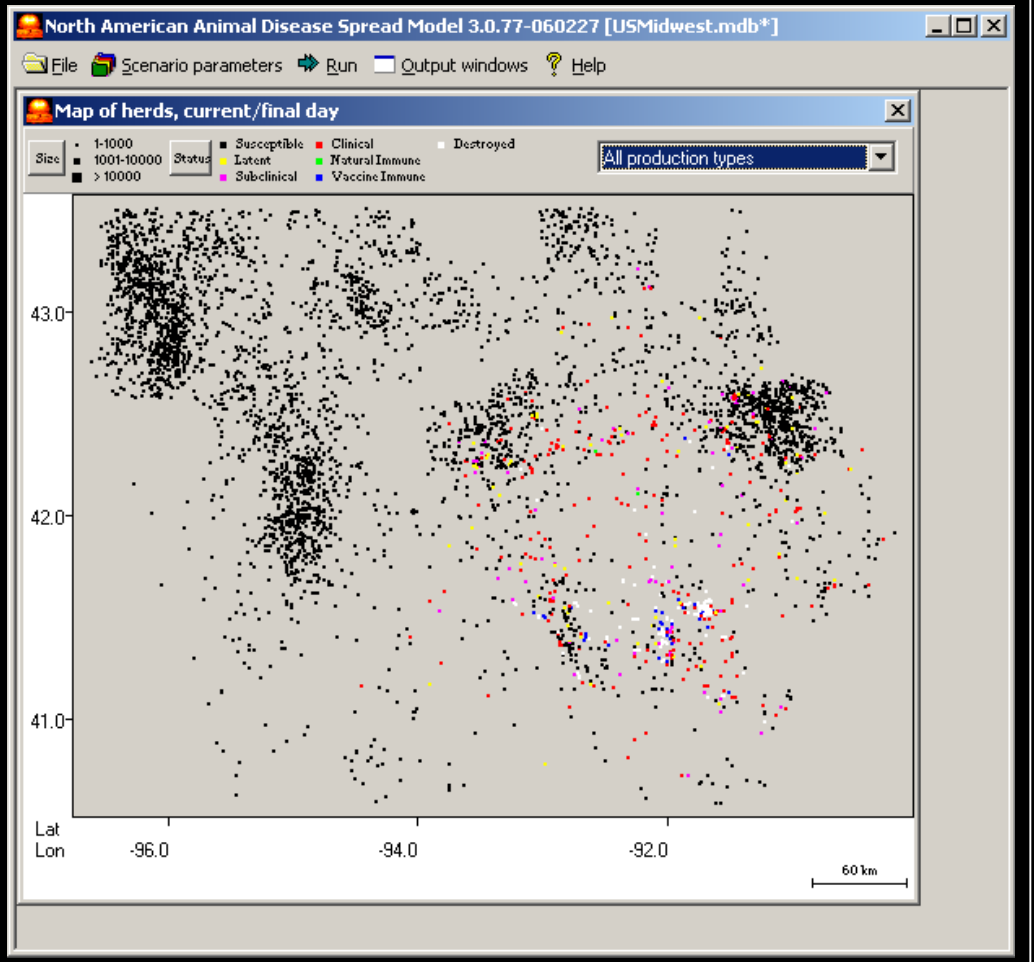
Figure modified from Harvey *et al.*, 2007

What is *NAADSM*? (III)

- *NAADSM* is a Monte Carlo model
  - NAADSM does not explicitly use a state transition matrix
  - The probabilities of the state transitions that occur in *NAADSM* are determined using Monte Carlo methods
  - *NAADSM* attempts to simulate aspects of disease spread and control systems as realistically (and yet as simply) as possible

What is NAADSM? (IV)

- *NAADSM* is explicitly spatial
  - Population data includes precise location data for herds and flocks within the study area
  - Spatial context influences simulated disease spread



Coming up tomorrow

- We will begin (as we should) by discussing the assumptions and limitations of the *NAADSM* framework
- We will take a detailed look at all of the major components in *NAADSM*, for the simulation of:
  - Disease characteristics – how disease is modeled for an individual herd or flock
  - Disease spread
  - Disease detection and control
- We will spend the afternoon session learning to use the *NAADSM* application

Coming up on Thursday

- We will see how model parameters for *NAADSM* are developed
- We will construct a complete scenario within *NAADSM* to simulate the spread of a highly contagious foreign animal disease

Recommended reading & references cited

- Harvey, N., Reeves, A., Schoenbaum, M.A., Zagmutt-Vergara, F.J., Dubé, C., Hill, A.E., Corso, B.A., McNab, W.B., Cartwright, C.I., and Salman, M.D., 2007. The *North American Animal Disease Spread Model*: A simulation model to assist decision making in evaluating animal disease incursions. *Preventive Veterinary Medicine*, in press. *(A complete, although terse, description of the* NAADSM *framework)*
- Hill, A., and Reeves, A. 2006. User's Guide for the *North American Animal Disease Spread Model*, 2nd ed. Fort Collins, Colorado: Animal Population Health Institute, Colorado State University. Available at *http://wwww.naadsm.org (An indispensable, exhaustive, and delightfully humorous guide for* NAADSM *users. The 'must read' book of the summer!)*