Request for comments

RFC20060703ARa: Incorporation of a "Dead from Disease" state

1st draft: A. Reeves, July 3, 2006
2nd draft: N. Harvey, September 23, 2009. Added notes on detection.
3rd draft: N. Harvey, October 16, 2009. Changes recommended on Oct. 13 conference call: change name of new state, options to apply costs to Dead units.

Applies to: Model description v1.2.0 (June 11, 2009)

Type of change: Conceptual change, for the next major release of the model

Summary and justification: This RFC introduces a state for units that that die as a result of disease, as might be the case with highly pathogenic strains of avian influenza. A prototype of a this state exists in the experimental version of NAADSM named "Riverton", and has been used successfully by a group in Manitoba.

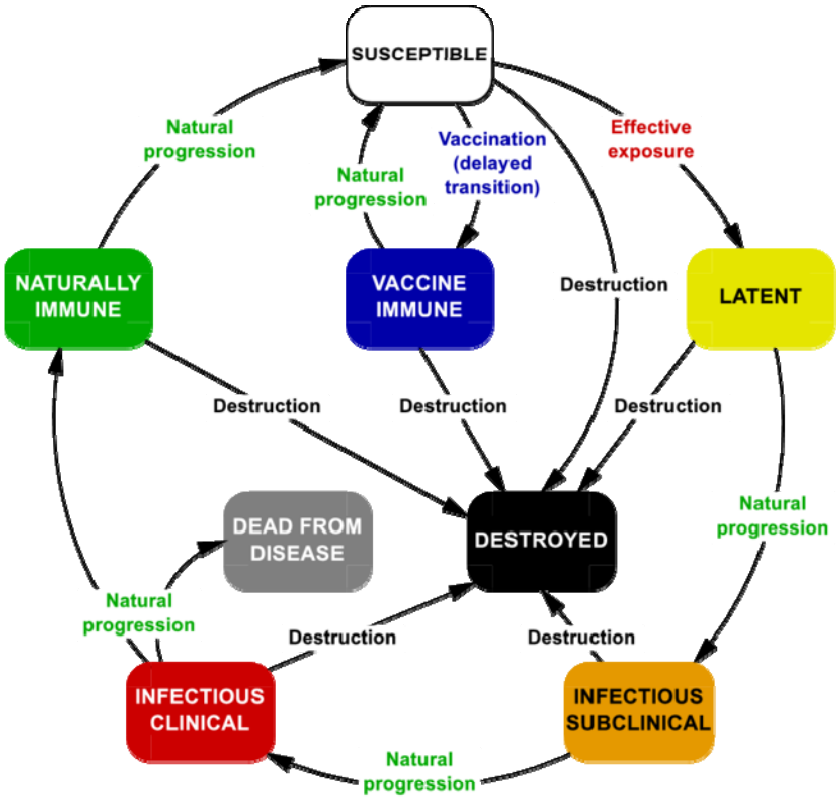
Change: These changes applies to Section A3, Disease. Current text to be deleted is struck out, proposed replacement text is highlighted:

> When a Susceptible unit is infected, it becomes Latent. The infection progresses in the unit from Latent to Infectious Subclinical (shedding agent without visible signs of disease), to Infectious Clinical (shedding agent with visible signs of disease), to either Natural Immune ~~and back to the Susceptible state~~ or Dead from Disease. From the Natural Immune state, a unit will eventually return to Susceptible, unless destroyed. Probability functions characterize the length of the periods and this length is determined stochastically for each new infection. ~~The disease is never fatal: that is, all infected units will eventually return to Susceptible unless destroyed~~ If time-frames for simulations are long, a particular unit may progress through the infected states more than once, provided that it is not destroyed or does not die from disease.
>
> Because the simulation operates at the level of the entire unit, and because the number of animals in each unit is assumed never to change, mortality is given as the probability that most or all animals in a unit will die of disease.

Change: This change also applies to Section A3. The parameters section is changed as follows:

> **Disease parameters**
>
> ***Parameters specified for each production type:***
>
> - latent period (days) 
> - infectious subclinical period (days) 
> - infectious clinical period (days) 
> - natural immune period (days) 
> - prevalence (0-1) vs. time (optional) 
> - mortality: the probability (from 0 to 1) that a unit will die rather than recover

Change: This change applies to Figure A3-1. This diagram replaces the old one:



Change: This change applies to Section A4.1, Direct contact spread:

3. For each shipment,
   a) Make a list of units that can be the recipient of a contact, that is, those that are not Destroyed, detected as Dead from Disease, quarantined, or are the source.

Change: This change applies to Figure A4-1, part 2, the task where a list of possible recipients is created. New text proposed is highlighted:

Create a list of possible recipients of the desired production type, which are not destroyed, detected as dead from disease, or quarantined, and are not the source unit

Change: This change applies to Section A5, Detection:

2. For each unit that is Infectious Clinical or Dead from Disease and not yet detected,
   (a) Look up the probability of detecting signs of disease based on the number of days the unit has been Infectious Clinical or Dead from Disease.
   (b) If the unit is not inside a zone focus,

i. Compute the probability of detection and reporting as P = (probability of detecting signs of disease or mortality) × (probability of reporting) Go to step d.

(c) If the unit is inside a zone focus,

i. Compute the probability of detection and reporting as P = (probability of detecting signs of disease or mortality) × (zone multiplier) Note that the probability of reporting is assumed to be 1 inside a zone focus, so that value drops out of the calculation.

(d) Generate a random number *r* in [0,1).

(e) If $r < P$, the disease is detected and reported.

Change: This change also applies to Section A5. The parameters section is changed as follows:

Detection parameters

Parameters for each production type:

- probability of reporting vs. days since the first detection 
- probability of detection vs. days the unit has been Infectious Clinical 
- probability of detection vs. days the unit has been Dead from Disease 

Change: This change applies to Section A6.1, Trace surveillance:

When a unit is identified by a trace investigation, it will be quarantined. Units showing mortality or clinical signs of disease can be detected with a specified probability (see below). Optionally, the unit may also be:

- preemptively destroyed (see Section A7.2)
- tested for disease
- tested for disease and preemptively destroyed

When a unit that is Infectious Clinical or Dead from Disease ~~unit~~ is identified by a trace investigation, it can be detected by the following method:

1. Compute the probability of detection and reporting as P = (probability of detecting signs of disease or mortality) × (multiplier)
2. Note that the probability of reporting is assumed to be 1 when a unit is identified by tracing, so that value drops out of the calculation.
3. Generate a random number *r* in [0,1).
4. If $r < P$, the disease is detected and reported.

If a unit is not detected based on clinical signs or mortality, it may still be detected by a diagnostic test. When a unit is tested for disease, the sensitivity and specificity of the test and a random number r in [0,1) are used to determine the test result as follows:

Unit is Latent, Infectious Subclinical, Infectious Clinical, Naturally Immune, or Dead from Disease:

$r < \text{sensitivity} \rightarrow$ test-positive (true positive)
$r \geq \text{sensitivity} \rightarrow$ test-negative (false negative)

Unit is Susceptible or Vaccine Immune

$r < \text{specificity} \rightarrow$ test-negative (true negative)
$r \geq \text{specificity} \rightarrow$ test-positive (false positive)

Unit is Destroyed

No testing can occur: the effect is functionally equivalent to a test-negative result.

If the test result is positive, the unit is considered to have been "detected" as diseased (see Section A5). Detection either by clinical signs, mortality, or diagnostic testing may trigger subsequent control actions, including further traces.

Change: This change applies to Section A7.2.2, Destruction priorities:

If a unit is marked for destruction but cannot be destroyed immediately, it is quarantined and goes onto a prioritized waiting list. If a unit is detected as Dead from Disease while on the waiting list for destruction, it is dropped from the list.

Change: This change applies to Section A7.3.3, Vaccination priorities:

If a unit is marked for vaccination but cannot be vaccinated immediately, it goes onto a prioritized waiting list. If a unit is detected as Dead from Disease while on the waiting list for vaccination, it is dropped from the list.

Change: This change applies to Section A10.1, Costs associated with destruction:

There is a fixed cost associated with appraisal of each destroyed unit, regardless of the number of animals in the unit. The cost associated with cleaning and disinfecting each unit is also fixed regardless of the number of animals in each unit.

Beyond these fixed per-unit costs, the per-animal costs for euthanasia, carcass disposal, and indemnification apply.

The total cost of destruction *for each unit* of a particular production type is calculated as follows:

(Appraisal cost + Cleaning and disinfection cost)
+ [(Number of animals in the unit) × (Cost of euthanasia + Cost of indemnification + Cost of disposal)]

The total cost of destruction *for each production type* is calculated as:

(Number of units destroyed) × (Appraisal cost + Cleaning and disinfection cost)
+ [(Total number of animals destroyed) × (Cost of euthanasia + Cost of indemnification + Cost of disposal)]

The same costs may also apply to units that die from disease. Each cost except for euthanasia may apply to death from disease *always*, *never*, or only when death occurs *after* the unit has already been marked for destruction.

Parameters for destruction costs

Parameters specified for each production type:

- Appraisal cost **per unit**
- Appraisal cost applies to units that die from disease (yes / no / only when death occurs after unit has been marked for destruction)
- Cost of cleaning and disinfection **per unit**
- Cost of cleaning and disinfection applies to units that die from disease (yes / no / only when death occurs after unit has been marked for destruction)
- Cost of euthanasia **per animal**
- Cost of indemnification **per animal**
- Cost of indemnification applies to units that die from disease (yes / no / only when death occurs after unit has been marked for destruction)
- Cost of carcass disposal **per animal**
- Cost of carcass disposal applies to units that die from disease (yes / no / only when death occurs after unit has been marked for destruction)

End of changes