Request for comments

RFC-20090429AR: Elimination of delay parameters

1st draft, Aaron Reeves, 29 April, 2009
2nd draft, Aaron Reeves and Neil Harvey, 8 May, 2009

Applies to: Model document 1.1.1. Proposed for model description 2.0.0.

Summary: This RFC proposes the elimination of rarely used and problematic parameters for delay in the effect of disease exposure by direct contact, indirect contact, and airborne/local-area spread. These changes are proposed for *NAADSM* 4.0.

Justification:

NAADSM 3 incorporates several delay parameters, initially designed to account for the time it takes for disease to be transmitted from a source to a recipient unit: for example, long-distance shipments might take longer to arrive at their destinations than short-distance shipments.

In *NAADSM 3*, however, there is no association between distance and delay: these parameters operate independently and in an unrealistic way. Additionally, because of the way the model is structured, there is already an implicit one-day delay: the effect of exposures occurs on the simulation day after the exposure took place. Further complications arise when control measures that would impact the outcome of a contact (*e.g.*, quarantine or destruction) take place while such contacts between units are pending. Behavior of the model under these conditions is not well defined. The appendix to this document identifies additional problems with existing delay parameters.

The additional delay parameters in *NAADSM* 3 are rarely used. Our practice over at least the last two years has been to discourage the use of these delay parameters (*e.g.*, by assigning a fixed 0-day delay), but we have preserved them in *NAADSM* 3 for the sake of backward compatibility. Because backward compatibility will be broken in *NAADSM* 4, these parameters can now be eliminated.

Changes to specification:

Change 1. The final step in the description of direct contact in section 4.3 of the model specification would be updated as shown below:

(i) If $r < P$, turn B Latent ~~after a shipping delay~~.

Change 2. The parameters for direct contact in RFC-20090428AR would be updated as shown below:

Parameters for direct contact spread

Parameters for each combination of source production type and recipient production type:

- Mean rate of movement (recipient-units for shipments per source-unit per day)
- use fixed movement (yes/no)
- movement distance (km) 
- ~~shipping delay (days)~~ 
- probability of infection given exposure (required if within-unit prevalence is not used)
- proportion of the unit included in a shipment  (required if within-unit prevalence is used)

- movement rate multiplier vs. days since the first detection (for units not inside a zone focus) 

Parameters for each combination of source production type and zone:

- movement rate multiplier vs. days since the first detection (for units inside a zone focus) 

Change 3. The parameters for indirect contact (section 4.2) would be updated as shown below:

Parameters for indirect contact spread

Parameters for each combination of source production type and recipient production type:

- Mean rate of movement (recipient-units for shipments per source-unit per day)
- use fixed movement (yes/no)
- movement distance (km) 
- ~~shipping delay (days)~~ 
- probability of infection given exposure
- movement rate multiplier vs. days since the first detection (for units not inside a zone focus) 

Parameters for each combination of source production type and zone:

- movement rate multiplier vs. days since the first detection (for units inside a zone focus) 

Change 4. The final step in the description of airborne or local area spread will be updated as shown:

v. If $r < P$, turn B Latent ~~after a delay~~.

Change 5. The description of parameters for local-area spread (see RFC-20070313SD, 2nd draft) would be changed as shown below:

Parameters for local-area spread

Parameters for each pair of production types:

- d_{ij}, the distance between two arbitrary herds i and j
- n_i, the number of infectious animals in source herd i
- n_j, the size of a susceptible recipient herd j
- P_{fixed}, the probability that, on any given day, unit i will infect unit j by local-area spread
- wind direction, given as a range (*start* and *end*) in degrees
- ~~airborne transport delay (days)~~ 

End of changes.

Appendix: Effects of Delays in Direct/Indirect Contact

(Neil Harvey, April 2007)

Delays in direct and indirect contact are a feature of *NAADSM* whose consequences have not been examined or specified in detail. This document steps through several questions about how delays currently work in *NAADSM*. Along with each question, I attempt to list any problems with the way *NAADSM* currently works, and how severe those problems might be.

In the questions below I talk about "shipments" being sent and received, which is specific to direct contact. With indirect contact it would be more appropriate to talk about various carriers of infection leaving and arriving, but that bit of terminology aside, the same questions apply.

Q. Is shipment delay related to the distance a shipment travels?

A. No. The shipment delay is specified as a distribution parameter. It is independent of the shipment distance distribution parameter and it is independent of the distance chosen for a particular shipment.

Possible problems:

- Users may find this to be counter-intuitive.

Possible solutions:

- Change the units of the shipment delay parameter to days per kilometer instead of simply days.

Severity: **MEDIUM**

Q. Exposure and infection events are listed in the output tables as happening on a particular day. Which day is listed, when the shipment is sent or when it is received?

A. Exposures and infections are listed on the day the shipment is received.

Possible problems:

- If a simulation terminates early because it has reached the maximum number of days, the number of shipments recorded may be lower than expected because shipments that are still "on the road" have not been counted.

Possible solutions:

- See next point below.

Severity: **MILD**

Q. If the source herd ceases to be infectious while a shipment is "on the road", does the shipment still infect the recipient herd?

A. Yes. The animals "on the road" do *not* cease to be infectious when their source herd does.

Possible problems:

- The infections table may be confusing to the user. It can show infections being caused by herds that are no longer infectious.

Possible solutions:

- When a shipment is received, check the status of the source herd. If the source herd is no longer infectious, do not infect the recipient herd. This might not apply to indirect contact?
- Expand the infections & exposures table and/or the apparent events table to treat the sending of a shipment, the receiving of a shipment, an exposure, and an infection as separate events.

Severity: **MEDIUM**

Q. Movement controls are applied to the source herd type. Does this affect shipments that are already "on the road"?

A. No. Movement controls only affect the number of new shipments generated after movement controls are applied.

Possible problems:

- With delayed shipments, there will appear to be a "lag" before movement controls take effect.

Severity: **MILD**

Q. The source herd is detected and quarantined while a shipment is "on the road". What happens to the shipment?

A. The shipment still gets to the recipient. Quarantine only stops further shipments from being sent.

Possible problems:

- With delayed shipments, there will appear to be a "lag" before quarantine takes effect.

Possible solutions:

- See question about tracing, below.

Severity: **MEDIUM**

Q. The recipient herd is detected and quarantined while a shipment is "on the road". What happens to the shipment?

A. The shipment still gets to the recipient. Quarantined herds are ruled out as potential recipients when the shipment is *sent*, but the status of the recipient is *not* checked when the shipment is received.

Possible problems:

- The recorded shipment will appear to break quarantine. However, since the recipient herd is already infected (it must be, to be detected) there will be no additional disease spread.

Severity: **MILD**

Q. The recipient herd is destroyed while a shipment is “on the road”. What happens to the shipment?

A. The shipment still gets to the recipient. Destroyed herds are rules out as potential recipients when the shipment is *sent*, but the status of the recipient is *not* checked when the shipment is received.

Possible problems:

- An exposure will be recorded to a destroyed herd.

Possible solutions:

- This is another case where it may be good to record the sending of a shipment, the receiving of a shipment, and an exposure as separate events. In this case we would want to record the sending of the shipment (so that the number of shipments recorded will be as expected) but we would not want to record an exposure to a destroyed herd.

Severity: **MEDIUM**

Q. The source herd is detected and outgoing contacts from it are traced. Are shipments that are “on the road” at the time of the trace discovered?

A. No. The trace will only discover shipments that have been received as of the time of the trace.

Possible problems:

- Even with tracing effectiveness set to 100%, delayed shipments will escape the tracing.

Possible solutions:

- Have tracing discover *and stop* shipments that are still “on the road”. (That is, make the trucks turn around.)

Severity: **HIGH**