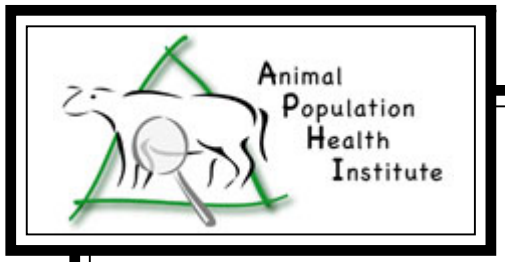

Versioning, stability, verification, and validation of *NAADSM*

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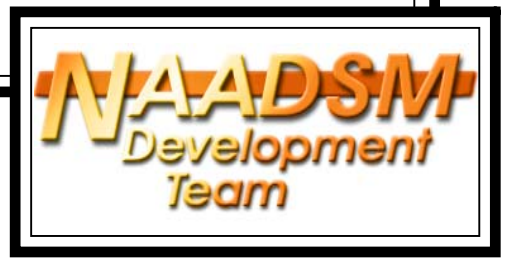

The *NAADSM* development team (past and present)

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  - Ric Hupalo
  - Ashley E. Hill
  - Dustin Pendell
  - Aaron Reeves
  - Mo D. Salman
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  - Neil Harvey
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Key objectives for *NAADSM* development

- Production of a sound conceptual model and a practical modeling tool for the evaluation of proposed disease control strategies and preparedness planning
- Ease of use
  - New users should be able to understand, build, and use models relatively quickly
- Suitability as a research tool
  - Researchers should be able to construct models needed to address real research problems
- Transparency
  - Model users should have a very clear understanding and intuition about how the model operates
  - If a model is to be used in the development of emergency response or regulatory programs, it is essential users and decision makers know the assumptions and limitations of the model
- Application for a wide range of diseases and situations
  - Not just in North America
- Accessibility
  - The model, documentation, and training should be widely available to the scientific, regulatory, and veterinary communities

Registered and/or trained *NAADSM* users

Country	***Number of users***
USA	179
Canada	52
Brazil	12
China	9
Chile	7
Mexico	7
Uruguay	4
Australia	3
Denmark	3
Ireland	3
Argentina	2
Colombia	2
Finland	2
New Zealand	2
Nigeria	2
Panama	2
Russian Federation	2
Thailand	2
Uganda	2
Other	12
Unknown	8
Total	*317*

January 2007 – July 2009

Desirable characteristics in a model...

- ...as a policy tool:
  - Computationally correct
  - Flexible
  - Stable
  - Credible
  - Useful today
- ...as a research tool:
  - Computationally correct
  - Flexible
  - Dynamic and evolving
  - Testable
  - A basis for continuing investigation

Applications of *NAADSM*

- *NAADSM* is a conceptual modeling framework, not a single model
- Recent applications:
  - Pseudorabies (Portacci *et al.* 2007, 2009)
  - Foot-and-mouth disease (Pendell *et al.* 2007, Sanderson *et al.* 2009, USDA 2009)
  - Highly pathogenic avian influenza (Patyk *et al*. submitted for publication, Green *et al*. in preparation)

A logistical issue: How do we keep track?

NAADSM versioning

- Every version of *NAADSM* corresponds to a published model specification
- As the changes are made to the conceptual model, new versions of the specification are produced and published
- All application versions are written to implement a specific version of the specification, but several application versions may correspond to a single specification version

NAADSM versioning

Major version	***Specification version***	***Most recent application release***	***Older releases***
NAADSM 5.0	Model specification 3.0	In semi-private beta testing	
NAADSM 4.0	Model specification 2.0	In private beta testing	
NAADSM 3.2	Model specification 1.2 Latest version: 1.2.0, released July 11, 2009	In final beta testing	
NAADSM 3.1	Model specification 1.1 Latest revision: 1.1.1, released Sept. 18, 2008	*NAADSM* 3.1.24, released May 20, 2010	3.1.23, 3.1.22, 3.1.21, 3.1.20, 3.1.19, 3.1.18, 3.1.17, 3.1.16, 3.1.15
NAADSM 3.0	Model specification 1.0 Latest revision: 1.0.7, released Apr. 24, 2007	*NAADSM* 3.0.84, released Oct. 30, 2006	3.0.83, 3.0.82, 3.0.81, 3.0.80, 3.0.79

Upcoming versions of *NAADSM*

Version	***Features***	***Status***
NAADSM 3.2	• Enhanced tracing capabilities • Disease detection by diagnostic testing after tracing	In final beta testing
NAADSM 4.0	• Unit-based disease mortality • More conceptually sound approach for airborne and local area spread	In initial private beta testing
NAADSM 5.0	• Fully stochastic, animal-level disease dynamics and disease mortality; Stochastic, variable, animal-level vaccine efficacy (Reeves *et al*., submitted for publication[a]) • Explicit modeling of surveillance and detection activities	In initial semi-private testing

Model verification: How do we prove that *NAADSM* does what we claim?

Verification procedures used by *NAADSM*: Automated and manual testing

- Simple scenarios are designed to test every aspect of the *NAADSM* program
  - Tests are developed based on information in the model description
- Before an updated version of *NAADSM* is released for use, it must pass every test
  - There are currently 1000+ tests in the test suite
- New tests are continually being developed and incorporated into the test suite
- Every test is published with the source code for the *NAADSM* application on the website[1]
- Prior to the initial public release of *NAADSM*, every aspect of the model framework was examined by an independent analyst
- New components of *NAADSM* are subjected to similar manual testing prior to every new release of the model

[1] http://www.naadsm.org

Model validation: How do we evaluate our models?

The meaning of “validation”

- Validation does not prove that a model is “true”
- Validation does not demonstrate that a model is “realistic” or “accurate”
- Validation is the process of evaluating models in order to have a justifiable level of confidence in their results before they are used to influence policy or management decisions

Reeves *et al.* submitted for publication[b]

The process of “validation”

- Just as the development of epidemiologic models is a subjective, ongoing process subject to change and refinement, so too is the evaluation of models
- Through validation efforts, models are subjected to continuing scrutiny so that they may be used with an appropriate degree of confidence as an aid to the decision-making process

Suggestions for the construction of useful, credible models

Reeves *et al.* submitted for publication[b]

Suggestions for the construction of useful, credible models (I)

- Provide a detailed description of the conceptual model, and documentation concerning the assumptions and limitations of the model
  - In the case of *NAADSM*, this is the model specification document

Suggestions for the construction of useful, credible models (II)

- Describe the data used to develop model parameters, and provide documentation for the approaches and assumptions used to produce model parameters from data
  - Model = conceptual framework + data
  - The process of translating raw data into parameters suitable for use in models is seldom straight-forward, and should be described in detail
  - Patyk *et al.*, submitted for publication: parameters for a model of highly pathogenic avian influenza in the state of South Carolina in the US

Suggestions for the construction of useful, credible models (III)

- Involve independent experts in the evaluation of models and their outcomes

Dates	Location	Number of participants	Countries represented
July 9 – 11, 2002	Fort Collins, Colorado	41	Australia, Canada, Mexico, The Netherlands, the United States
June 15 – 17, 2004	Fort Collins, Colorado	22	Australia, Canada, New Zealand, the United States, Uruguay
March 30 – April 4, 2008	Rio de Janeiro, Brazil	21	Argentina, Brazil, Canada, Chile, Colombia, Paraguay, the United States, Uruguay
March 8 – 12, 2010	Rio de Janeiro, Brazil	28	Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Equador, Guyana, Paraguay, Peru, Suriname, the United States, Uruguay, Venezuela

Suggestions for the construction of useful, credible models (IV)

- When possible, use existing information for data-driven validation of models or their components
  - Dubé *et al*. submitted for publication: a comparison of networks as produced by *NAADSM* to real-world network data
    - Farm-to-farm movement data for adult dairy cattle in Ontario, Canada
    - Conclusions: the approach used in *NAADSM* performed reasonably well in simulating average network characteristics observed in real-world movement data, but did not perform as well in simulating extreme upper percentiles of movement network components

Suggestions for the construction of useful, credible models (V)

- Compare the purposes, conceptual bases, and outcomes of different models
  - Dubé *et al*. 2007: A comparison of three models
    - Conclusions: although statistically significant differences were observed among model outputs, results from all three models supported the same or very similar conclusions regarding approaches for disease control
  - A follow-up study is forthcoming (Sanson *et al.* submitted for publication)

Model validation: Final thought

"*[Modelers do not] have sole responsibility for validating models. To the extent that the model is a scientific experiment and theoretical development, its testing and validation are within the purview of the scientific community.*"

(Rykiel, 1996)

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