Animal Disease Spread Model

An Overview

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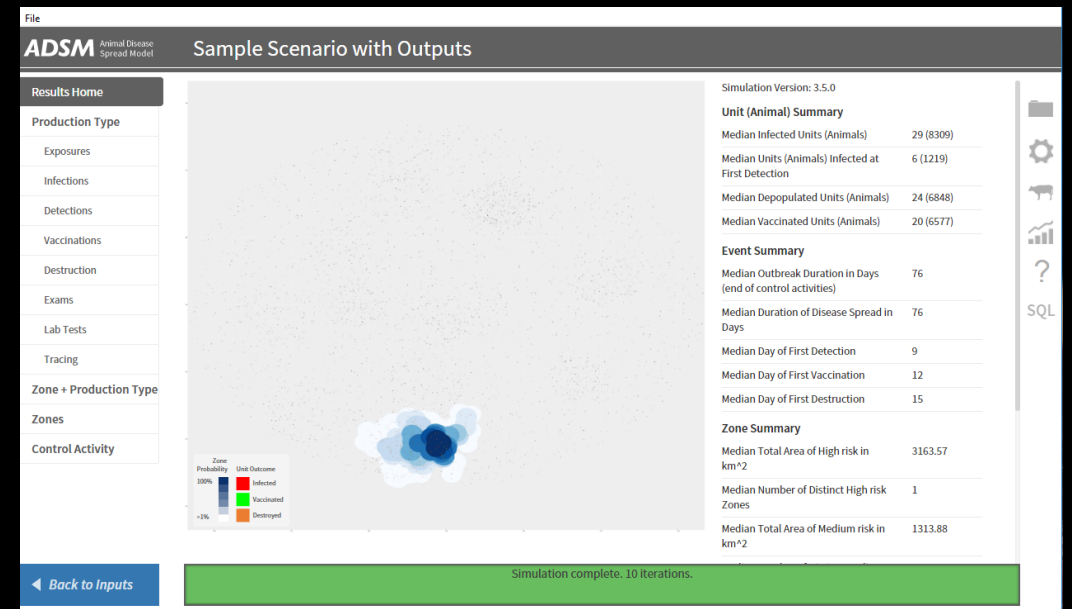# Document Conventions

The following conventions are used throughout the training modules:

<u>TRAINING MODULES</u> other than the one you are currently in will use all capital letters, bold face, italics and underline.

Rhetorical questions and _extra notes_ will be in orange italics.

Conventions applying to the ADSM application are:

Navigation tabs on right and Admin panels on left are designated with an underline. Examples are <u>Project Panel</u> or <u>Population tab.</u>

Items with an action on click, such as [Apply] Button or [Save As] icon are enclosed in square brackets.

Parameter fields (inputs) are in blue italics and _Variables_ (outputs) are in green italics.

<u>Navigation Tabs </u>> _Parameter field_ indicates to go to the given navigation tab to find the given field.

Hyperlinks appear in bright green type with underline <u>http://navadmc.github.io/ADSM/</u>
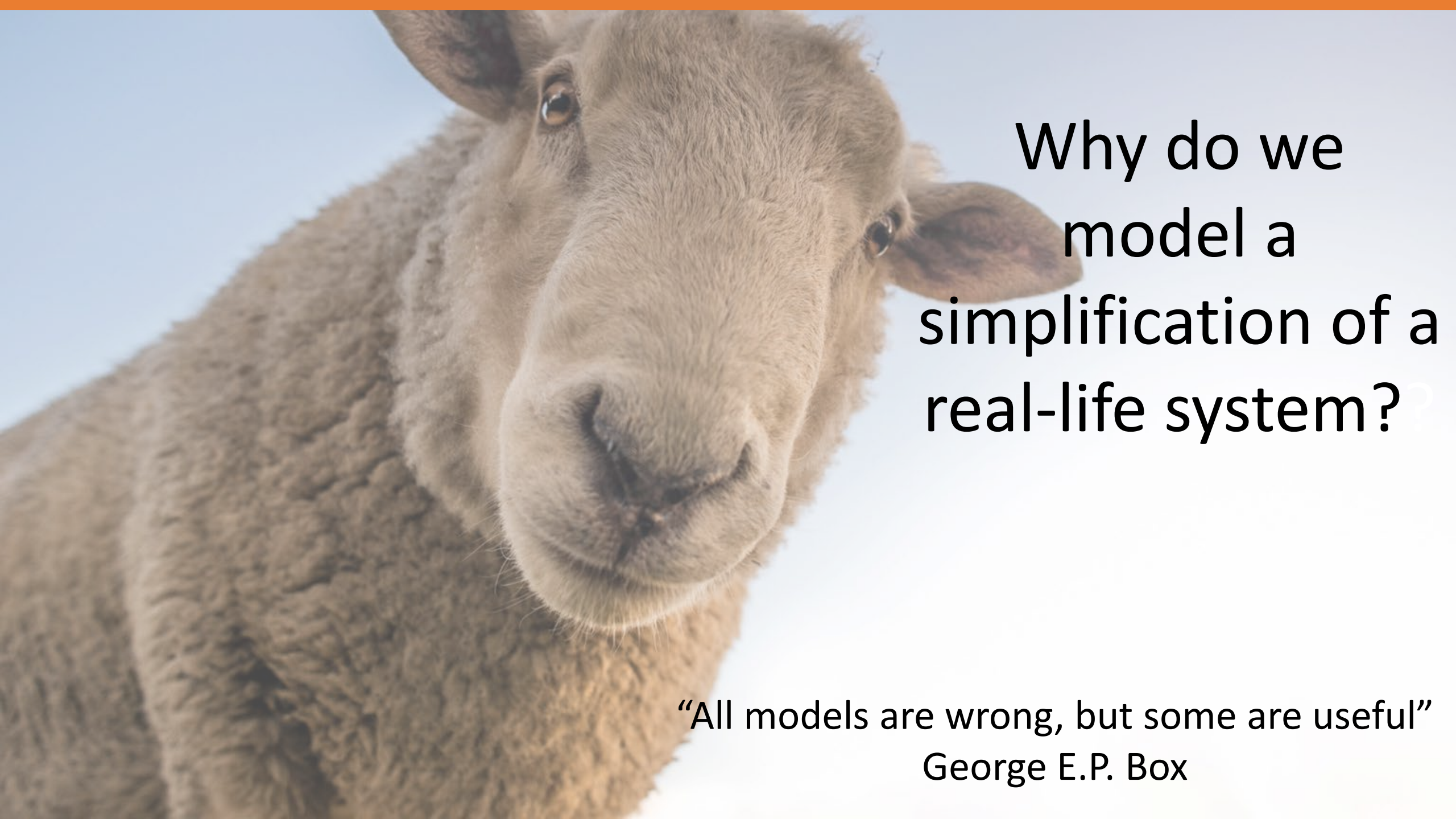
Model Concepts

Models simplify complex systems to represent them in ways we can understand and analyze.

Why do we model a simplification of a real-life system?

"All models are wrong, but some are useful"
George E.P. Box

The simplicity of the model creates a useful tool

Model parameters represent biological processes, and parameters can easily be modified to try many options.

Often, we learn more in just attempting to set up the model and finding where there are gaps in our knowledge of a system.

When we run the model, we can exercise the estimates and assumptions. And, we can analyze a range of results. Model outcomes can help us understand disease spread and control options.

Sometimes models can produce outcomes that we don't expect and we have to re-think the whole paradigm of our problem.

Simulation modeling is a well-established and essential tool that can be used to study the dynamics of disease spread. It is also valuable to evaluate a variety of mechanisms for disease control. There are many times the real-life observation of disease spread is impractical, undesirable, or impossible. A simulation environment allows customized parameterization and exercise of assumptions in a low-risk environment.

About ADSM

What is ADSM?

ADSM is a software application to simulate an outbreak of a highly contagious animal disease. The software allows a variety of control measures to be implemented.

ADSM is currently available at
https://github.com/NAVADMC/ADSM/releases/latest

Concepts central to understanding ADSM

Jennie Steiner

ADSM is unit-based

Disease manifestation and transmission are represented
at the level of a herd/flock or group of animals (unit),
rather than at the individual animal level.

ADSM is spatial-temporal

Each unit in a scenario is assigned a physical location, and disease progression occurs in a time step. The application uses a distance between units during simulations.

ADSM is not geospatial in the same way a geographic information system (GIS) would be in recognizing layers such as bodies of water or road networks. However, some distance-based features may be represented in other ways using parameters.
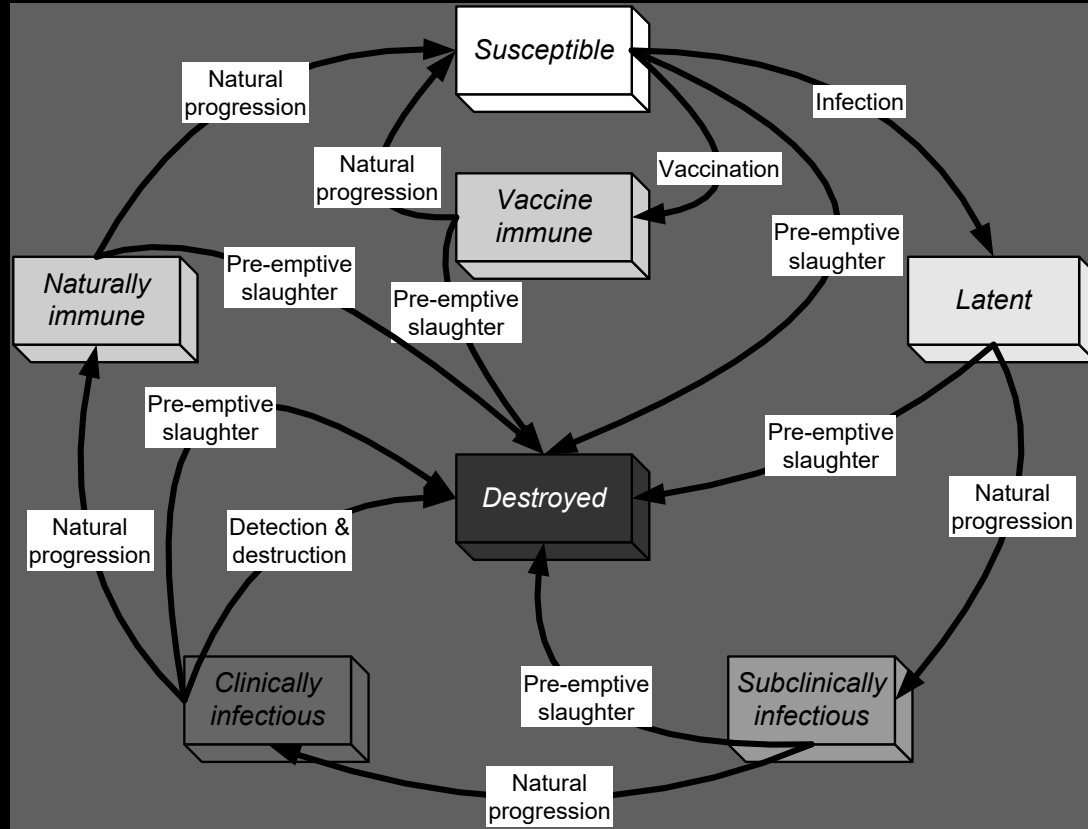
ADSM is stochastic

The model accounts for variability in input parameters and chance through the running of multiple iterations.

ADSM is a state transition model

In ADSM, units move through the natural progressions of disease states starting as susceptible to disease (S), latent disease (L), infectious (I), and recovered (R). The model is compartmental, since a unit can only be in one disease state at a time. This is like the concepts in a S-L-I-R epidemiological framework.

ADSM can use a variety of control measures that may be combined and applied in specific ways to modify the disease outbreak
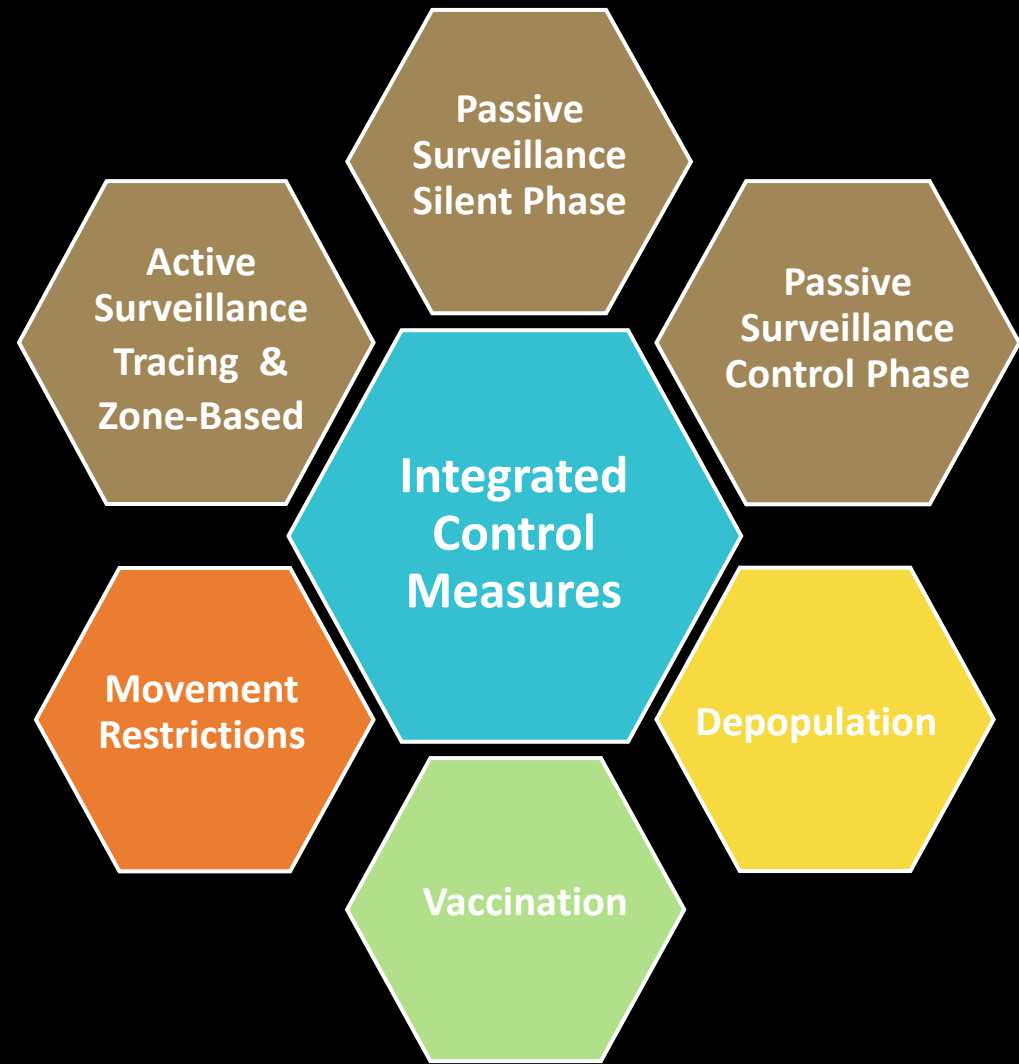
ADSM can simulate "what-if" questions

Some questions might include:

In each environment, what management practices result in decreased disease spread?

What are the potential impacts of resource limitations, such as vaccination capacity or depopulation capacity on our ability to control a disease outbreak?

What parameters is the model most sensitive to that would identify data collection needs?

What are the potential consequences of the introduction of a foreign animal disease into a population?

What might be the most cost-effective response to an outbreak?

What might the silent spread phase of a disease outbreak look like?

Resources

Sample Scenarios

ADSM is installed with example scenarios, named Sample Scenario and Sample Scenario with outputs. These simple examples have a circular population that is located in an unlikely location for disease spread. As indicated by the name, one scenario has been run and already has results in the database.

The Sample Scenario includes a variety of relational functions and probability density functions. These functions are also just examples and not intended as scientific inputs into a specific simulation modeling question.

Parameters have been named to give you an example of the importance of following a consistent naming strategy throughout the application. Parameter names are all user-defined.
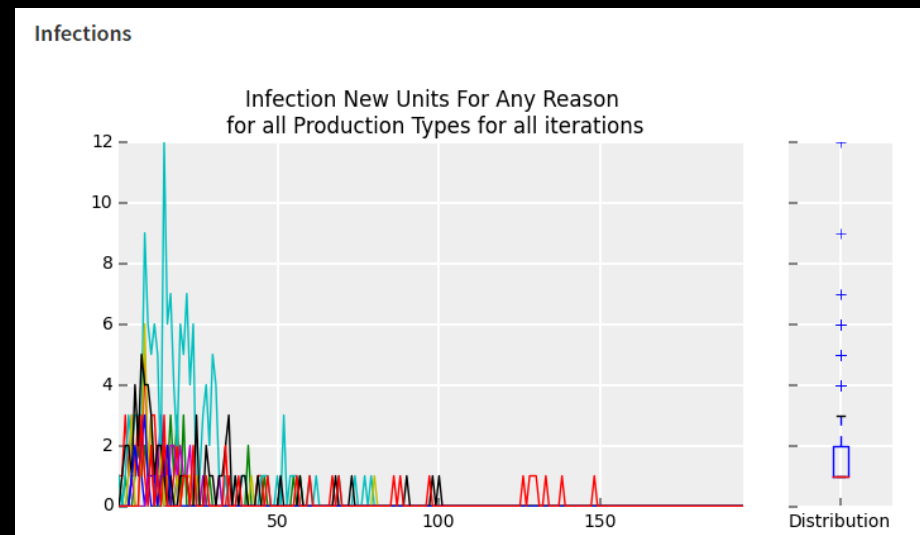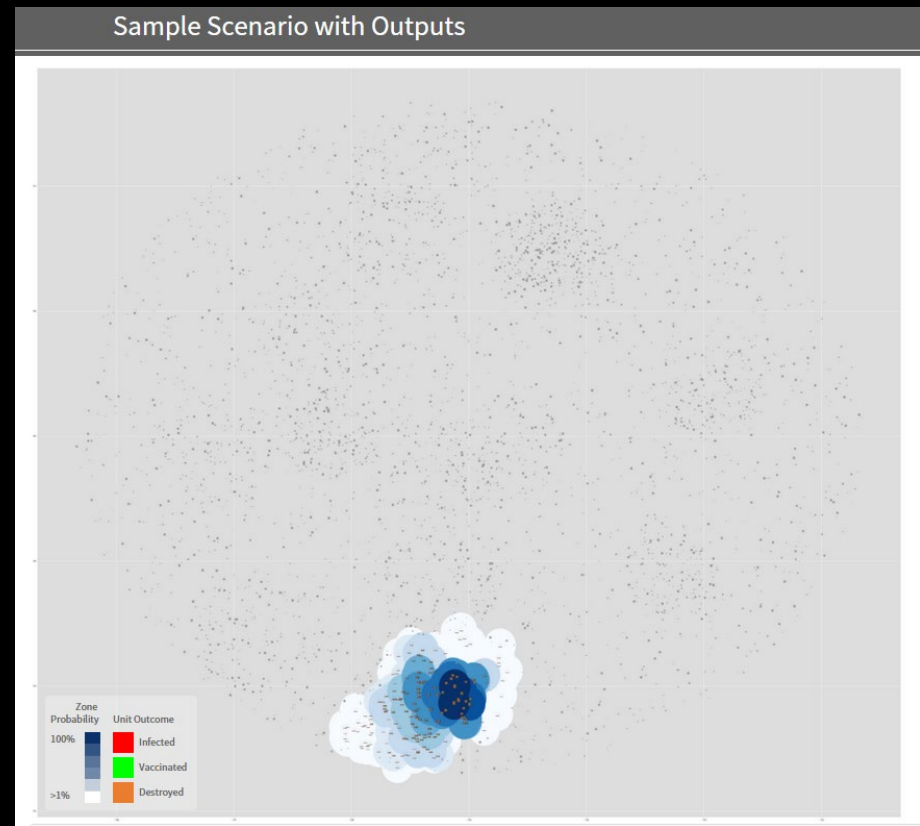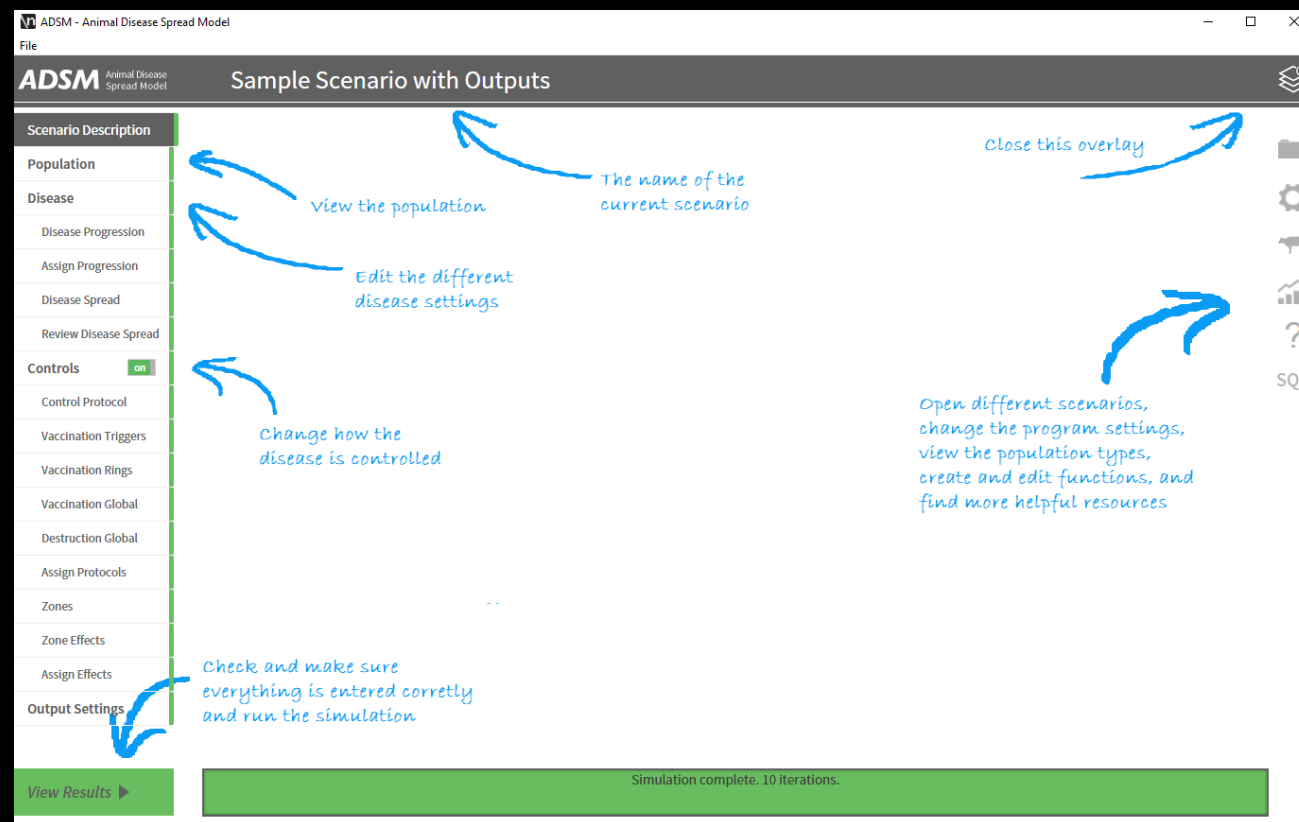
Overlay

The overlay is to help first-time users become familiar with the different parts of the ADSM screen.

Once you know your way around, toggle the overlay off with the stacked pages button in the top right corner.

Documentation Panel

The Documentation Panel will fly out from the right side of the application when you push the ? button.

The Documentation Panel includes links to the top items to help users get started using ADSM. It also contains a link to the general wiki pages.
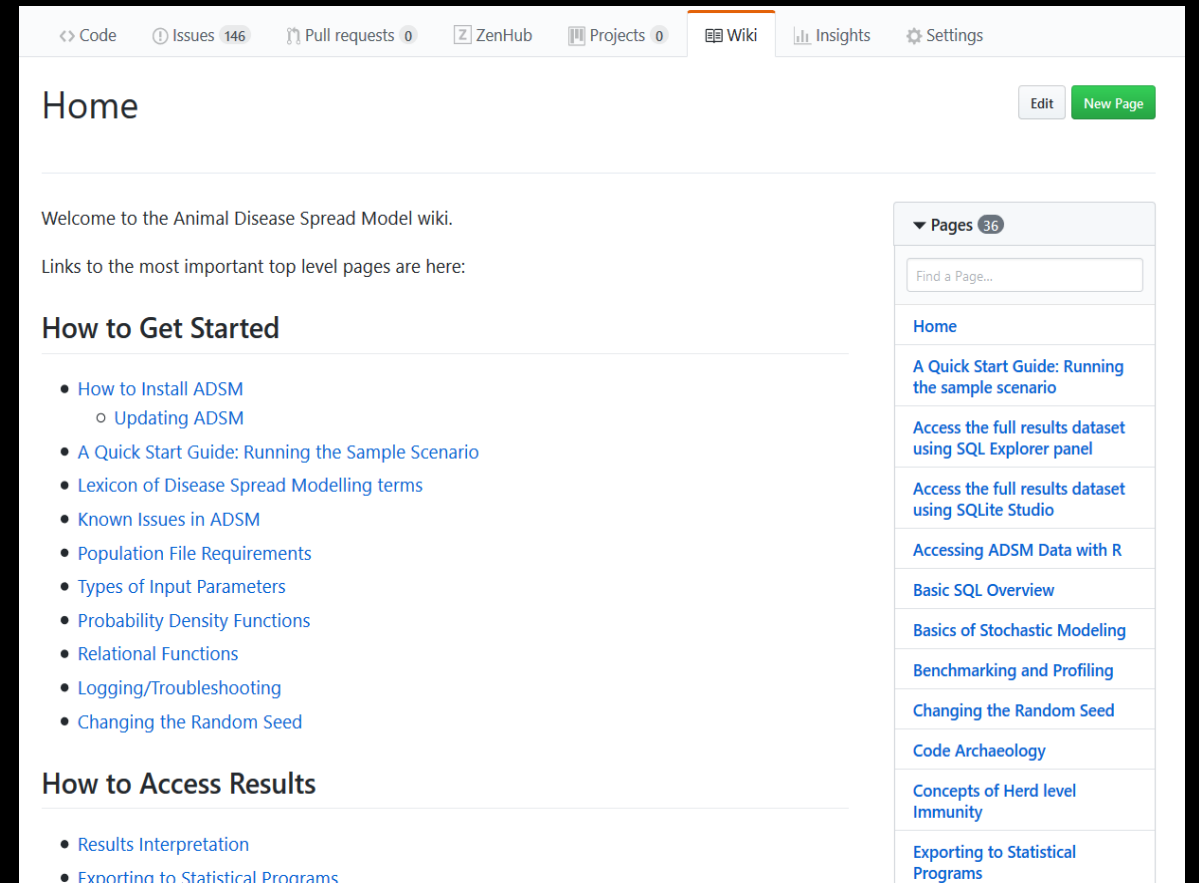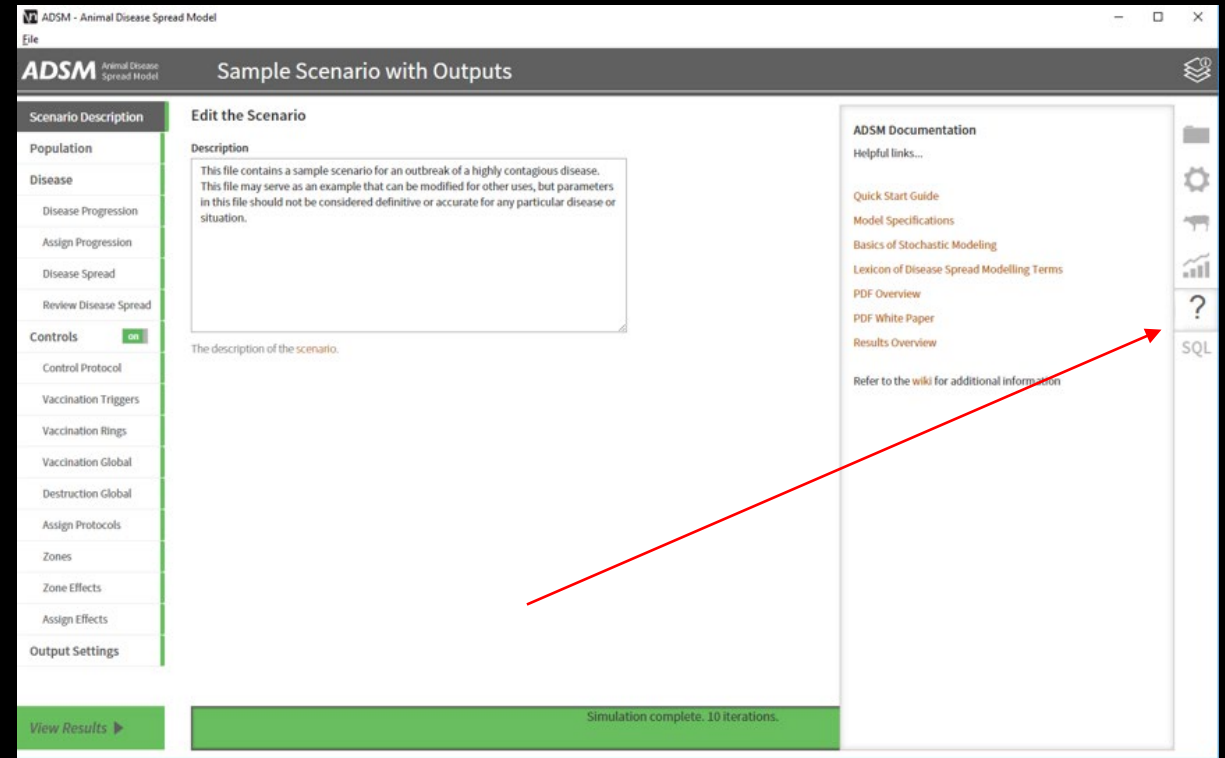
Wiki Pages

The ADSM Github site hosts the ADSM Wiki.
https://github.com/NAVADMC/ADSM/wiki

The wiki is the first location where documentation is posted. The documentation includes items for end users of the application. It also includes technical documentation that supports the developers and technical team that works behind the scenes on ADSM.

The in-line help that is within the ADSM application is hosted from the wiki site.

There is also useful information to help understand some of the complex concepts, such as the Model Specifications. We will never be able to fit everything into training materials, so please dig into the wiki to learn more.

History

The History of ADSM

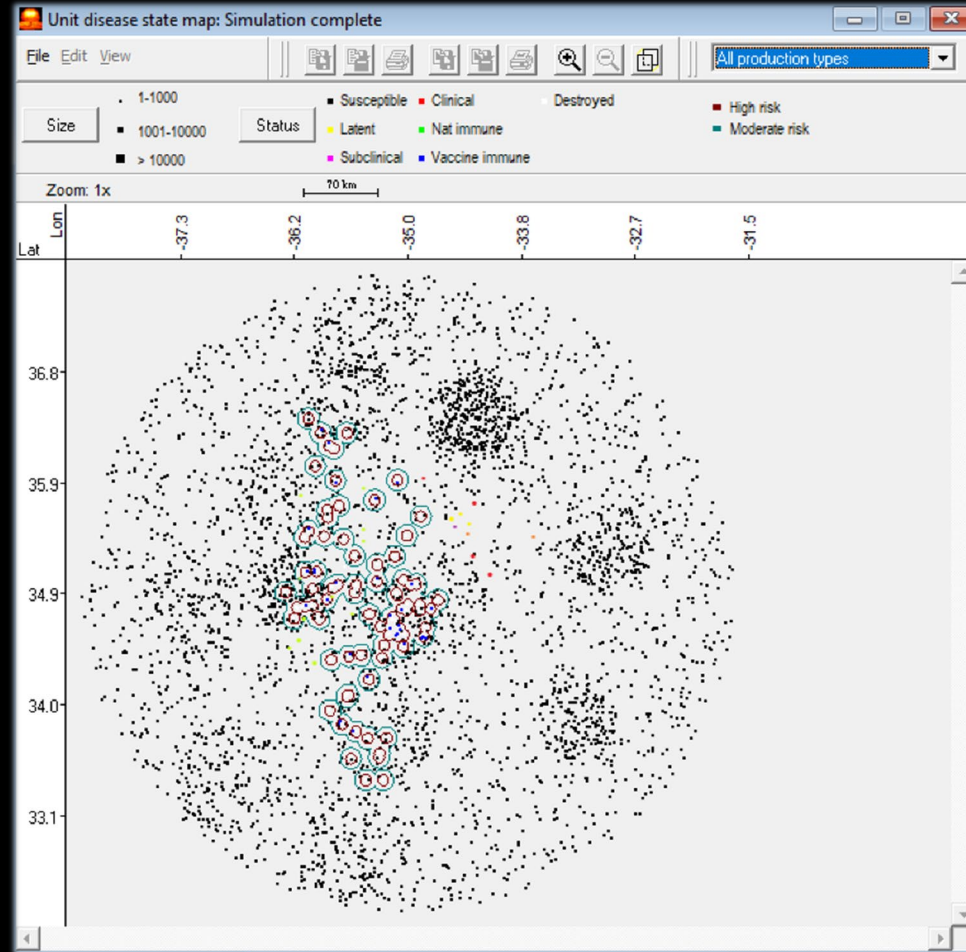ADSM is based on the North American Animal Disease Spread Model (NAADSM). The models share the same logic engine to drive the spread and control of highly contagious animal disease.

NAADSM has been used to simulate avian influenza, foot-and-mouth disease (FMD), classical swine fever and other highly contagious diseases. NAADSM has been featured in many publications since its release in 2006.

ADSM Focus

NAADSM and therefore ADSM were originally designed for North America, to simulate the highly contagious diseases that are of most interest to users in Canada, the United States and Mexico. Users in other parts of the world should consider the complexity of the disease situation they intend to model before deciding if ADSM is the best tool for their research.

For example, ADSM is not specifically suited for the complexity of endemic disease. Endemic disease response would likely involve long-term vaccination strategies that were initiated as animal health maintenance programs. ADSM initiates vaccination only in response to an outbreak.

However, limited simulation tools are available to address animal disease spread. ADSM was built as a simplistic framework that can be used to answer a portion of a question. A tool that is parameterized with scientific inputs representing aspects of a biological system can be more informative than a guess.

For an additional example, ADSM does not specifically address the complexity of disease vectors or vector-borne diseases. However, ADSM could be used to follow the spread of disease after the introduction of a vector-borne disease when contact results in continued disease spread.

What's Next

Join the flock!
Learn more about ADSM or try an example

ADSM is currently available at https://github.com/NAVADMC/ADSM/releases/latest

Try the sample scenario
https://github.com/NAVADMC/ADSM/wiki/A-Quick-Start-Guide:-Running-the-sample-scenario

Read the wiki pages link
https://github.com/NAVADMC/ADSM/wiki

Additional training materials will be posted at
http://navadmc.github.io/ADSM/

Training includes:

> **Populations and Production Types**
> **Getting Started**
> **Disease Parameters**
> **Control Parameters**
> **Output settings and Run**
> **Results**
> **Detailed Evaluation of Results - Verification and Validation**
> **Vaccination Strategy**
> **Administration**

The outcome of an ADSM simulation (as with any computer simulation model) depends heavily on the quality of the scenario input parameters; the assumptions of the modeler who created the scenario; and the capabilities and limitations of the model framework itself. The utility of disease models like those created with ADSM critically depends on input and interpretation of experts familiar with the behavior of disease within populations, and with the limitations, assumptions, and output of the model. While ADSM is available as a service to animal health communities, the ADSM team does not necessarily endorse results obtained with the ADSM application or any conclusions drawn from such results. Note that the parameters provided in the Sample Scenario are simple examples to clarify concepts in the application. These parameters do not represent any real population or disease event.
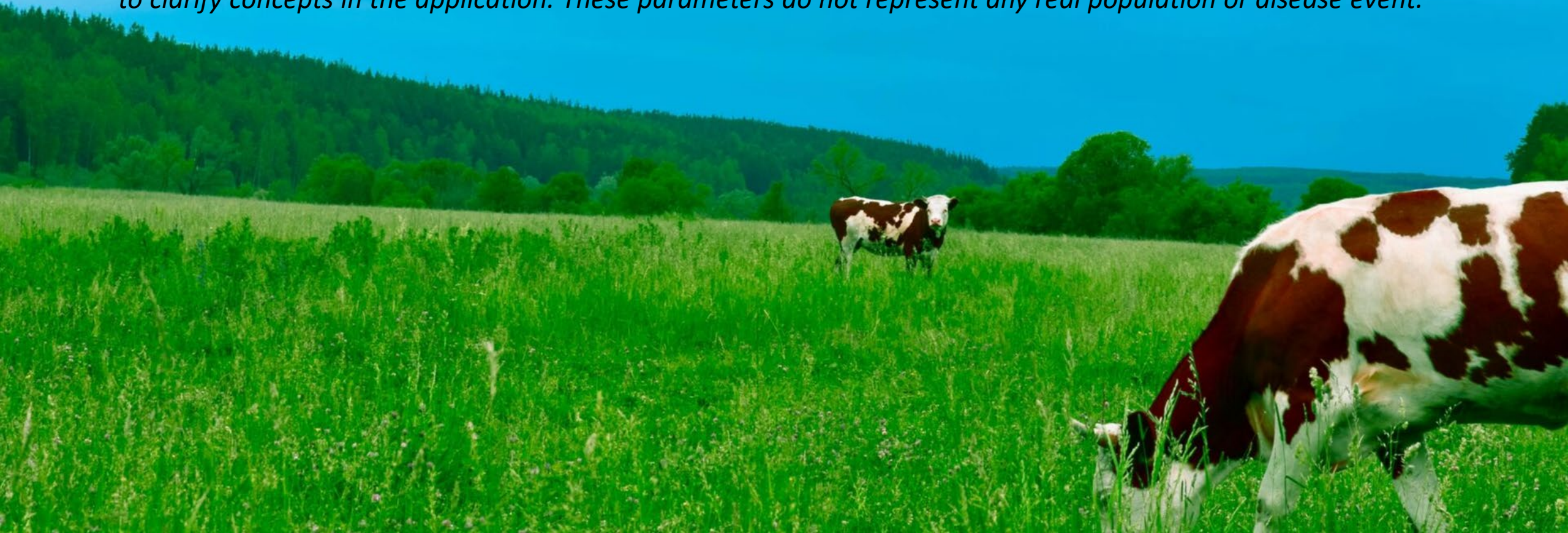
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UT

Animal Science