

Animal Disease Spread Model (ADSM)

Text Support Document for Training

The slide-based training was designed to optimize visual interest. This format does not always create a slide bank that is printer friendly. In some sections, there are many images and little text. This text support document is intended to be a printer-friendly version of the slides that can be used as a reference. This document is not intended to take the place of the main training slides.

Training 9 Vaccination

Slide	Image	Text
1	Laying Hens	Animal Disease Spread Model Vaccination Strategy
2	ADSM Application Sample Scenario with Outputs	Table of Contents Overview Between Production Types To a specific Production Type Across all Production Types What's Next?
3	No Image	Document Conventions The following conventions are used throughout the training modules: <u>TRAINING MODULES</u> other than the one you are current in will use all capital letters, bold face, italics and underline. <i>Rhetorical questions</i> and <i>extra notes</i> 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. <i>Parameter fields</i> (inputs) are in blue italics and <i>Variables</i> (outputs) are in green italics. <u>Navigation Tabs</u> > <i>Parameter field</i> indicates to go to the given navigation tab to find the given field. Hyperlinks appear in bright green type with underline http://navadmc.github.io/ADSM/
4	Gear Section Break	Overview
5	No Image	Vaccination Strategy – <i>What does that mean?</i> ADSM allows great flexibility in how it can apply the vaccination parameters. Your goal might be to compare different aspects of vaccination and the results affecting the outbreak. For example: <i>What happens if we increase the vaccination ring size?</i> <i>What happens if we vaccinate only production types that have long production cycles (dairy cows) and omit those production types that are scheduled for harvest (feedlot cattle)?</i> <i>What are the costs if we vaccinate all susceptible animals, and can we reduce the total cost by vaccinating only a subset of animals?</i>

		<p><i>What happens if we vaccinate large units before we vaccinate small units?</i></p> <p>You can explore many questions by modifying parameters to create varied results.</p>
6	Why, Where, What, When, How	<p>Vaccination Strategy – Flexibility</p> <p>Vaccination is more than a yes/no decision. Providing flexibility means that ADSM has complexity in the ways it allows you to parameterize a vaccination strategy. The inputs are in different tabs depending on how you apply the parameters.</p> <p>Why start? - Trigger</p> <p>Why stop? - Trigger</p> <p>Where? – Ring Radius</p> <p>Who? – Ring Radius, by production type, upon detection, priority</p> <p>When? – Priority, by production type, time between doses</p> <p>How? - Capacity and retrospective</p> <p>Effects? -By production type – immune window, days to immunity</p>
7	Animal icons in a queue	<p>Vaccination Strategy – Vaccination Queue</p> <p>The vaccination queue is a construct that is active behind all parts of the vaccination strategy.</p> <p>In very simple words, we know that the units must be put into an order for the simulation to determine the next action.</p> <p>The parameters related to vaccination interact with the queue. We will discuss the queue in more detail later in this training.</p>
8	Animal icons in a queue	<p>Vaccination Strategy – Vaccination Queue</p> <p>Here are examples of how parameters alter the vaccination queue.</p> <p>A trigger starts the queue</p> <ul style="list-style-type: none"> • A ring defines which units go into the queue • Capacity sets how fast the vaccination event happens to the unit • Control Protocol – Vaccination defines the time frame to a second vaccination • Control Protocol – Vaccination defines the time immunity will persist
9	Sheep	ADSM vaccination has several features that were modified or were not available in NAADSM.
10	Bull	<p>Functionality in ADSM that was not in NAADSM</p> <p>Additional Triggers</p> <p>Start, Stop and Restart</p> <p>Retrospective Vaccination</p> <p>Vaccination Rings</p> <p>Vaccination Priorities</p> <p>We will discuss each parameter block in detail in this training.</p>
11	No Image	<p>Vaccination parameters are applied at 3 levels:</p> <p>Some vaccination parameters interact with a specific production type.</p> <p>Some vaccination parameters happen when an event in one production type triggers an event in another production type.</p> <p>Some vaccination parameters happen across all production types.</p> <p>As a result, Vaccination parameters are not in a single navigation tab in ADSM. This training is organized to look at parameters in these groups.</p>

12	Gear Section Break	Between Production Types
13	Production type images	<p>What does “Between Production Types” mean?</p> <p>There are times when we want detection in one production type to start the vaccination strategy in certain production types.</p> <p>If the detected unit was a cattle production type, the vaccination strategy could start in cattle, and in swine and small ruminants.</p>
14	Image of ADSM navigation tabs	<p>The 2 parameter blocks that are implemented between production types are:</p> <ul style="list-style-type: none"> • Vaccination Rings • Vaccination Triggers <p>We are starting with these items for an important reason, as they are the parameters that start the vaccination strategy.</p> <ul style="list-style-type: none"> • Ring starts a strategy if certain conditions have been met. • Triggers detail the conditions needed to start vaccination.
15	Control Zone example and image of hover text	<p>Vaccination Rings</p> <p>The navigation tab named Vaccination Ring holds the ring parameters. The ring indicates the area to be covered by a vaccination strategy. The Sample Scenario has a ring rule implemented. Hover your mouse over the name to see the full text.</p> <p>Use the + <i>New Vaccination Ring Rule</i> to add an additional ring.</p>
16	ADSM Vaccination Ring Rule form	<p>Sample Scenario’s ring rule</p> <p>The ring rule:</p> <p style="text-align: center;">Cattle detection triggers Cattle vaccination within 5.0 km</p> <p><i>Hint: Select the yellow box first; the box will have a highlight outline when selected. Click on production type from list to add to box. Click again on production type within yellow box to remove. Hover text appears on both Add and Remove.</i></p>
17	ADSM Vaccination Ring Rule form	<p>Cattle detection triggers Cattle vaccination within 5.0 km</p> <p>Let’s break this down</p> <ol style="list-style-type: none"> 1) After trigger conditions are fulfilled (set on <u>Vaccination Triggers tab</u>), then... 2) Detection of disease in Cattle production type... 3) Results in vaccination in Cattle production types, and... 4) A vaccination ring around each detected unit will include all units of Cattle with a radius of 5 km. <p>Note that the vaccination pattern can omit an inner section if needed by including an inner radius value.</p>
18	ADSM Vaccination Ring Rule form	<p>Using an inner radius</p> <p><i>In what situation would an inner radius make sense?</i></p> <p>There may be many reasons to use an inner radius. One example is when a destruction ring has been set to pre-emptively depopulate units that are within 1 km. There is no reason for the simulation to apply both a destruction event and attempt to apply a vaccination event.</p>
19	ADSM Vaccination Ring Rule form	<p>Production types in rings</p> <p><i>Which production types can be used?</i></p> <p>The Sample Scenario is a very simple example and shows Cattle or Swine as trigger and Cattle and Swine as recipient.</p>

		The combinations are only constrained by the number of production types you have used in your scenario. One or more production types can be added in the detection box, and one or more production types can be added in the resulting vaccination box.
20	ADSM Vaccination Trigger form	<p>Sample Scenario Vaccination Trigger</p> <p><i>What are the conditions that start vaccination?</i></p> <p>The Sample Scenario has a trigger implemented as the condition to start vaccination, named <i>3 infected units detected in Swine, Cattle</i>. ADSM has 6 conditions that can be set by one or more production types.</p> <p>In addition, there is also a trigger you can set to stop vaccination. If vaccination has been stopped, it is possible to restart vaccination with the same 6 triggers that are used to start the vaccination strategy initially.</p> <p>We will cover capacity for vaccination later. Note that start capacity and restart capacity can be different.</p>
21	ADSM Vaccination Trigger form	<p>Trigger - 3 infected units detected in Swine, Cattle</p> <p>In this example, the trigger group contains both Swine and Cattle. The Sample scenario example is triggered by the number of units detected. Therefore, the trigger name reflects the details of the trigger. To make the trigger a restart trigger, use the yes/no checkbox at the bottom of the parameter.</p> <p><i>Hint: Select the yellow box first; the box will have a highlight outline when selected. Click on production type from list to add to box. Click again on production type within yellow box to remove. Hover text appears on both Add and Remove.</i></p>
22	Vet vaccinating an animal	<p>Trigger order</p> <p><i>What if I have multiple triggers? Which one starts vaccination?</i></p> <p>You can use multiple triggers. When any one of the triggers meets the requirements, vaccination will start.</p>
23	Animal icons in a queue	<p>Vaccination queue – the simulation determines an order</p> <p>We have the ring rule</p> <p>Cattle detection triggers Cattle vaccination within 5.0 km</p> <p>And the trigger</p> <p>3 infected units detected in Swine, Cattle</p> <p>Note these assumptions as we step through this example:</p> <p>Vaccination has been triggered.</p> <p>Vaccination Capacity is set to allow unlimited vaccinations in a day.</p> <p>Detected units are not being vaccinated (simpler than the Sample Scenario).</p> <p>Events happen in a daily step, with detection happening on one day, and vaccination happening on the next day.</p> <p><i>The vaccination queue is happening in the simulation's processes and is not visible.</i></p>
24	Stylized rolling hills with animal icons	<p>Vaccination Ring, Day 1 post trigger event</p> <p>A trigger event happens.</p> <p>3 infected units detected in Swine, Cattle</p>

		A 5km vaccination ring (grey circle) is created around a detected unit. These units are now considered to be in the queue waiting for vaccination.
25	Stylized rolling hills with animal icons, icons in a row to show queue	Vaccination Ring, Day 1 post trigger event Units are placed into the queue according to order set in Vaccination Priorities; cattle first. We will cover Vaccination Priorities in more detail later in this training. We are only vaccinating cattle, according to the ring rule. All cattle units are vaccinated in a day, as capacity is unlimited.
26	Stylized rolling hills with animal icons, icons in a row to show queue	Vaccination Ring, Day 2 post trigger event A second ring is created due to detection event, with some of the same units as on Day 1. All units go into the queue. The minimum time between vaccinations is set to 90 days. Therefore, only 2 units of cattle are eligible to be vaccinated on Day 2, as one unit was vaccinated the previous day. The simulation assesses which units are eligible as it encounters them in the queue.
27	Stylized rolling hills with animal icons	Vaccination Ring, Day 3 post trigger event A third ring is created, with some of the same units as Day 2. All units go into the queue.
28	Stylized rolling hills with animal icons, icons in a row to show queue	Vaccination Ring, Day 3 post trigger event Only 1 unit of cattle is eligible to be vaccinated on Day 3. This determination of eligibility continues until the simulation ends.
29	Stylized rolling hills with animal icons	Vaccination Ring, Day 3 post trigger event The results set is capturing information about the queue. It is important to understand what these variables mean. vacwU – the count of units waiting for vaccination, including those units that will be determined later to be ineligible for vaccination on that day vacwUMax – the maximum number of units that have been waiting for vaccination, including those units that will be determined later to be ineligible for vaccination vacwUMaxDay – the day of the simulation where the maximum number of units were waiting for vaccination vacwUDaysInQueue – Number of days units have been waiting in the queue for vaccination, including those unit days that will be determined later to be ineligible for vaccination vacwUTimeAvg – Average number of days that units have been waiting for vaccination, including those unit days that will be determined later to be ineligible for vaccination. vacwUTimeMax – Maximum number of days that a unit had to wait for vaccination, including those units that will be determined later to be ineligible for vaccination
30	Stylized rolling hills with animal icons	Vaccination – who is eligible? The last slide described some units as “ineligible”. <i>What does that mean?</i>

		<p>The input parameters determine which units are eligible, and which are ineligible. Here are a few examples of ineligible units.</p> <p>Vaccination ring input for the field “will result in vaccination of units of these production types” must include the production types intended for vaccination.</p> <p>A unit will not be vaccinated the second (or more) time it is identified in the queue, unless the “minimum time between vaccinations” has been met. This parameter stops repeated vaccination events. The lowest number accepted in this field is 1, so vaccination could repeat in one day if needed. The default value in this field is 99,999 days, which makes it extremely unlikely that a repeated vaccination event will happen unless the parameter is modified to a lesser number of days that is appropriate for a given strategy.</p> <p>When a unit within the ring is detected, it relies on the parameter “Vaccinate detected units” to determine if the unit is eligible.</p> <p><i>All the eligible/ineligible decisions are happening in the simulation’s processes.</i></p>
31	Stylized rolling hills with animal icons	<p>Vaccination Queue Summary</p> <p>The vaccination queue is a process taking place in the simulation to determine which units to vaccinate. This process is mostly invisible to the end user. It requires extensive research and comparison of various outputs to follow through the decision that takes place regarding each unit.</p> <p>The vaccination queue in ADSM uses the same process as NAADSM 3.X. NAADSM 4.x uses a different methodology to determine the vaccination queue. ADSM will place units in the vaccination queue more than one time if they are identified by more than one vaccination ring. However, ADSM will not vaccinate the unit more than one time unless parameters allow that to happen.</p> <p>The input parameters drive all the decisions in the queue. Modifying the parameters will change the vaccination strategy.</p> <p>Daily output parameters around vaccination should not be treated as an indicator of a vaccination event or the day-to-day need for vaccination resources. The Supplemental File Daily_events_X.csv list vaccination events but doesn’t indicate vaccine immunity. Daily_states_X.csv will indicate by iteration by day, by herd which units have transitioned into vaccine immune state indicated with the letter “V”.</p>
32	Mixed species animals in a field	<p>Summary - Between Production Types</p> <p>This section has looked at parameters that allow events in one production type to result in action on other types. These parameters are set to start vaccination.</p> <p>Next, we will review the vaccination parameters that are assigned to a specific production type.</p>
33	Gear Section Break	To a specific Production Type
34	Production type images	<p>What does “To a specific Production Type” mean?</p> <p>There are times when we want parameters to act a certain way for a specific production type.</p>

		For example, Cattle may only require a single dose of vaccine to gain immunity. However, Swine might require an initial dose, and a secondary dose (booster) to reach the desired level of immunity. Therefore, specific parameters are set to each production type.
35	ADSM Control Protocols form	Vaccination Parameters to a specific Production Type Vaccination parameters within a Control Protocol are assigned to specific production types. Recall that a Control Protocol allows integrated control measures to be applied at a production type level. The Sample Scenario is a very simple example and shows only Cattle Control as a control protocol. Notice that the vaccination option is both checked and is set as inactive (greyed out). The reason the parameter is greyed out is because the Control Protocol is not the place to flip the switch to turn the vaccination strategy on. Recall that the vaccination switch was turned on because of the vaccination ring. If the vaccination box is checked, there are parameters that need to be set in that form. Click on Vaccination to open the form. Use the + <i>New Control Protocol</i> to add an additional control protocol.
36	Control Strategy image	Integrated control measures – what does that mean? Control Protocols allow multiple control interventions It is possible to depopulate one production type, change movements of a different production type, and vaccinate a third production type. All actions are flexible to allow a customized vaccination strategy.
37	ADSM Control Protocol Vaccination form	Sample Scenario’s Control Protocol Cattle Control Recall that the protocol will be assigned to a production type once completed. There are 4 parameters to set. Vaccinate Detected units is a yes/no option. Minimum time between vaccinations. This field allows for a secondary (booster) vaccination to happen a number of days after the initial vaccination. The default value is set to 99,999 days, which makes only one vaccination per unit happen during the iteration. If needed, the parameter is changed to a more reasonable value, down to 1 day between vaccinations. The parameter cannot be empty. Days to Immunity describes the number of days (whole number) that are needed for the vaccine to generate an immune response. This field is required. Vaccine Immune period is a probability density function that allows a range to be set for the window of vaccine-induced immunity.
38	ADSM Assign Control Protocol form	Assign Control Protocol Cattle Control The navigation tab Assign Protocol is used to associate a Control protocol to a specific production type. The list of available production types is presented by the application. A pull-down list is provided of all the Control Protocols that have been created. The ----- indicates that no assignment has been made. Assign Control protocols as needed to a given production type. In the Sample Scenario, the Swine Production type is set to null, or no assignment. Notice the lack of assignment can also be seen in the Production Type panel, indicated by an uncolored circle.
39	Cattle	Summary - To a Specific Production Type

		<p>This section has looked at parameters that are specific to a production type. These parameters can be built in blocks and assigned to one or more production types. This process supports the vaccination strategy after it has been started.</p> <p>Next, we will review the vaccination parameters that are assigned to all production types.</p>
40	Gear Section Break	Across all Production Types
41	ADSM Navigation tabs	<p>Terminology - Global</p> <p>There are 2 blocks of parameters that apply across all production types. The word “Global” is used to describe these parameters.</p> <p>Vaccination Global</p> <p>Destruction Global</p> <p>This section will explore the Vaccination Global parameter blocks in detail.</p>
42	Map of the Americas	<p>Vaccination Global</p> <p>Vaccination Global are the parameters that apply across all production types. For example, let’s say we want to set a high priority for vaccination on a certain production type and a low priority for vaccination on other production types. In that case, we must look across all the production types to set the priority order.</p>
43	Vaccination priority image	<p>Vaccination Global - Priority</p> <p>On the previous slide, we gave the example of setting a high priority for vaccination on a certain production type and a low priority for vaccination on other production types. Production type is one of the reasons that you can use to set priority, but there are several more options. You also have the ability to set a secondary priority.</p> <p>Additional information about priority concepts with descriptive images is available at https://github.com/NAVADMC/ADSM/wiki/RFC-20121101%3A-New-Vaccination-Priorities.</p> <p>Let’s start by reviewing all reasons:</p>
44	ADSM Priority widget image	<p>Vaccination Global- Round Robin</p> <p>There is an assumption operating in the background of vaccination priority. We call that assumption the “Round Robin” approach. This approach takes all the vaccination resources that are available and applies them equally to the units that have been identified for vaccination. Round Robin runs as the default when the simulation needs to decide about the next action to take. Round Robin is overridden when other priorities have been set in the Priority widget.</p> <p>The Priority Widget is the drag and drop section of the ADSM application that allows you to drag items up and down to set the preferred order. The hover text gives the hint to drag items.</p>
45	ADSM Priority widget image	<p>Vaccination Global - Priority Specifics</p> <p>Reason for vaccination is included in the priority list. There is only one option, which is “Ring”. This indicates that the priority will be set simply because the unit has fallen within a vaccination ring. You could think of this as the default setting.</p> <p>Production Type in the priority list will provide a secondary sorting option. The list of available production types will be presented, and you can rearrange with drag and drop.</p>

		Days Holding is included in the priority list. The options are “Oldest” meaning those units that have been waiting the most days, or “Newest” meaning the units that have been waiting the fewest days. These options are presented, and you can rearrange with drag and drop.
46	ADSM Priority widget image and outside- in, inside-out	Vaccination Global- Priority Specifics Size of unit is included in the priority list. The options are “Largest” meaning those units that have a higher animal count, or “Smallest” meaning the units that have the fewest animals. These options are presented and can be rearranged with drag and drop. Direction is included in the priority list. The options are “Outside-in”, or “Inside-out”. What does this mean? The units closest to the outside of the ring can be vaccinated first or the units closest to the center of the ring (closest to the detected unit) can be vaccinated first. These options are presented, and you can rearrange with drag and drop.
47	Simulation timeline to start events	Retrospective vaccination parameter requires you to think like the simulation. During an actual vaccination in real life, we might automatically vaccinate around all detections regardless of when they happened. However, the simulation is much simpler, and only knows to start vaccination after the trigger has been reached. The ‘Retrospective days’ setting allows you to consider all detections that have happened X days before the trigger and include those units (rings) in the vaccination queue. These units could be considered “older,” and therefore have a specific priority that can be used.
48	Cattle	Summary – Across all Production Types This section has looked at parameters that apply across all production types. This process supports the vaccination strategy after it has been started.
49	Gear Section Break	What’s Next?
50	Flock of Sheep	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
51	Goat on with green foliage	What’s Next? Addition training materials are posted at http://navadmc.github.io/ADSM/ Training includes: Overview 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
52	Cows grazing with blue sky and green grass	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.
53	Cattle image	This work was funded in whole through Cooperative Agreement AP18VSCEAH00C005 with the University of Tennessee Department of Animal Science by the Animal and Plant Health Inspection Service, an agency of the United States Department of Agriculture. University of Tennessee Animal Science logo Photo credits Canva.com Pinecroft Farms, Woodstock CT, Mariah Chapman Dr. Stormy Schwarzenberger Stacy Bird Icons made by Eucalyp, Pixel Buddha from www.flaticon.com
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