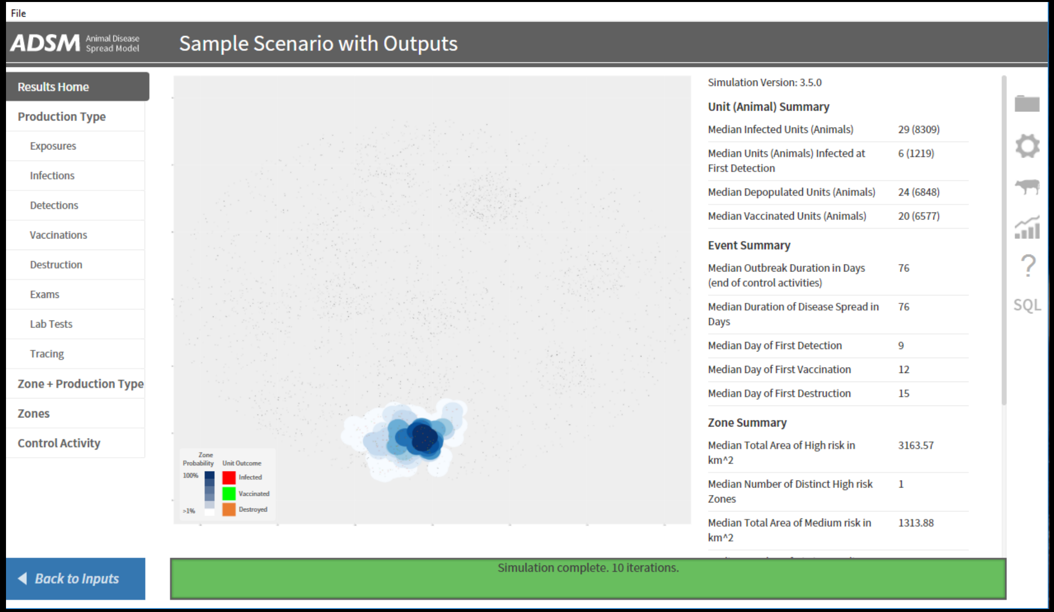
Animal Disease Spread Model

Detailed Evaluation of Results

Table of Contents

- Results Evaluation
- Verification
- Validation
- Example
- What’s Next?



Sample Scenario with Outputs

Simulation Version: 3.5.0

Unit (Animal) Summary

Median Infected Units (Animals)	29 (8309)
Median Units (Animals) Infected at First Detection	6 (1219)
Median Depopulated Units (Animals)	24 (6848)
Median Vaccinated Units (Animals)	20 (6577)

Event Summary

Median Outbreak Duration in Days (end of control activities)	76
Median Duration of Disease Spread in Days	76
Median Day of First Detection	9
Median Day of First Vaccination	12
Median Day of First Destruction	15

Zone Summary

Median Total Area of High risk in km^2	3163.57
Median Number of Distinct High risk Zones	1
Median Total Area of Medium risk in km^2	1313.88

Simulation complete. 10 iterations.

Document Conventions

The following conventions are used throughout the training modules:

Other ***TRAINING MODULES*** in this series will be referred to using 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 Project Panel or Population tab.

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.

Navigation Tabs > *Parameter field* indicates to go to the given navigation tab to find the given field.

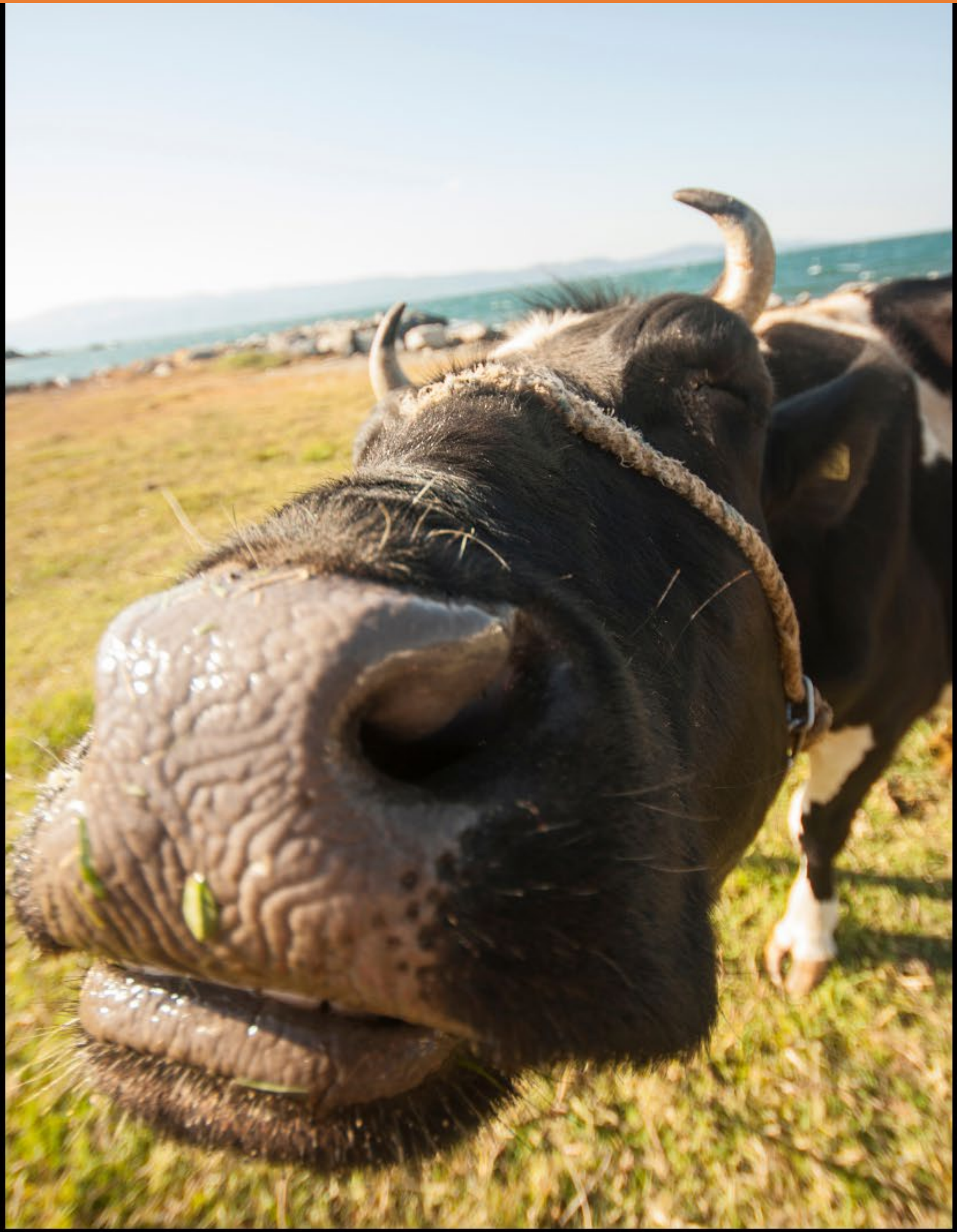
Hyperlinks appear in bright green type with underline http://navadmc.github.io/ADSM/

Results Evaluation

Once there is a simple understanding of what the results look like, it is important to evaluate those results. The training ***RESULTS*** goes through all the main outputs from ADSM.

It is critical to understand how the parameter inputs created the outputs. This allows you to determine if those outputs are a valid representation of the disease systems you are attempting to simulate.

This could be called a “Sniff Test.”



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 participation and interpretation of experts familiar with the behavior of disease within populations, and with the limitations, assumptions, and output of the model. **Without such participation, modeling results can be seriously misleading.**

While ADSM is available as a service to animal health communities, the ADSM development team does not necessarily endorse results obtained with the ADSM application or any conclusions drawn from such results.

It is important that the model be both accurate and credible.

Creating a meaningful results dataset requires both verification and validation. We will discuss each of these concepts.

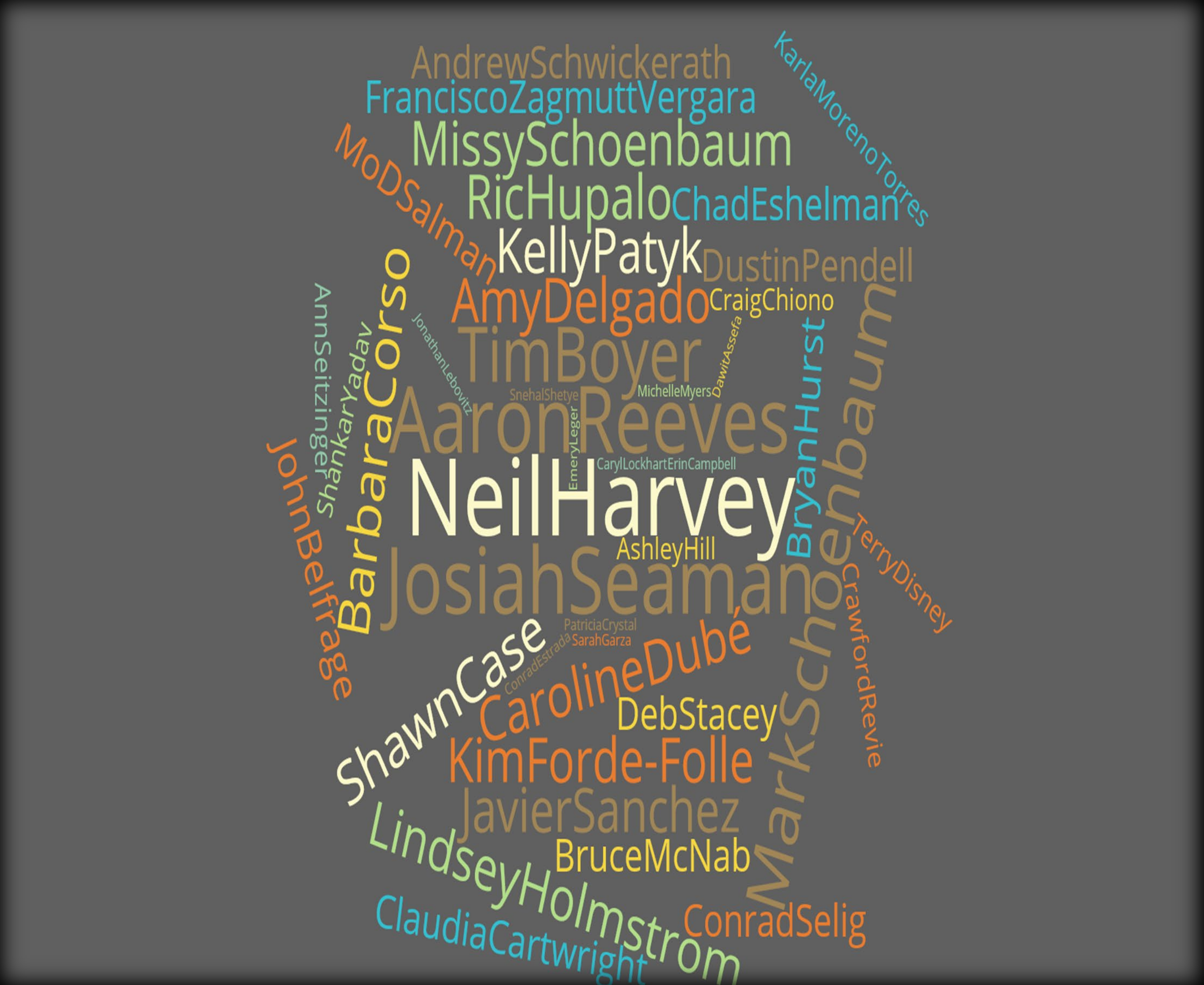
Verification

Verification of a model is the process of confirming that the software programming was correctly implemented with respect to the conceptual model. It means the simulation application is performing the calculations in the manner that is expected.

In other words, the model does what it was supposed to do.

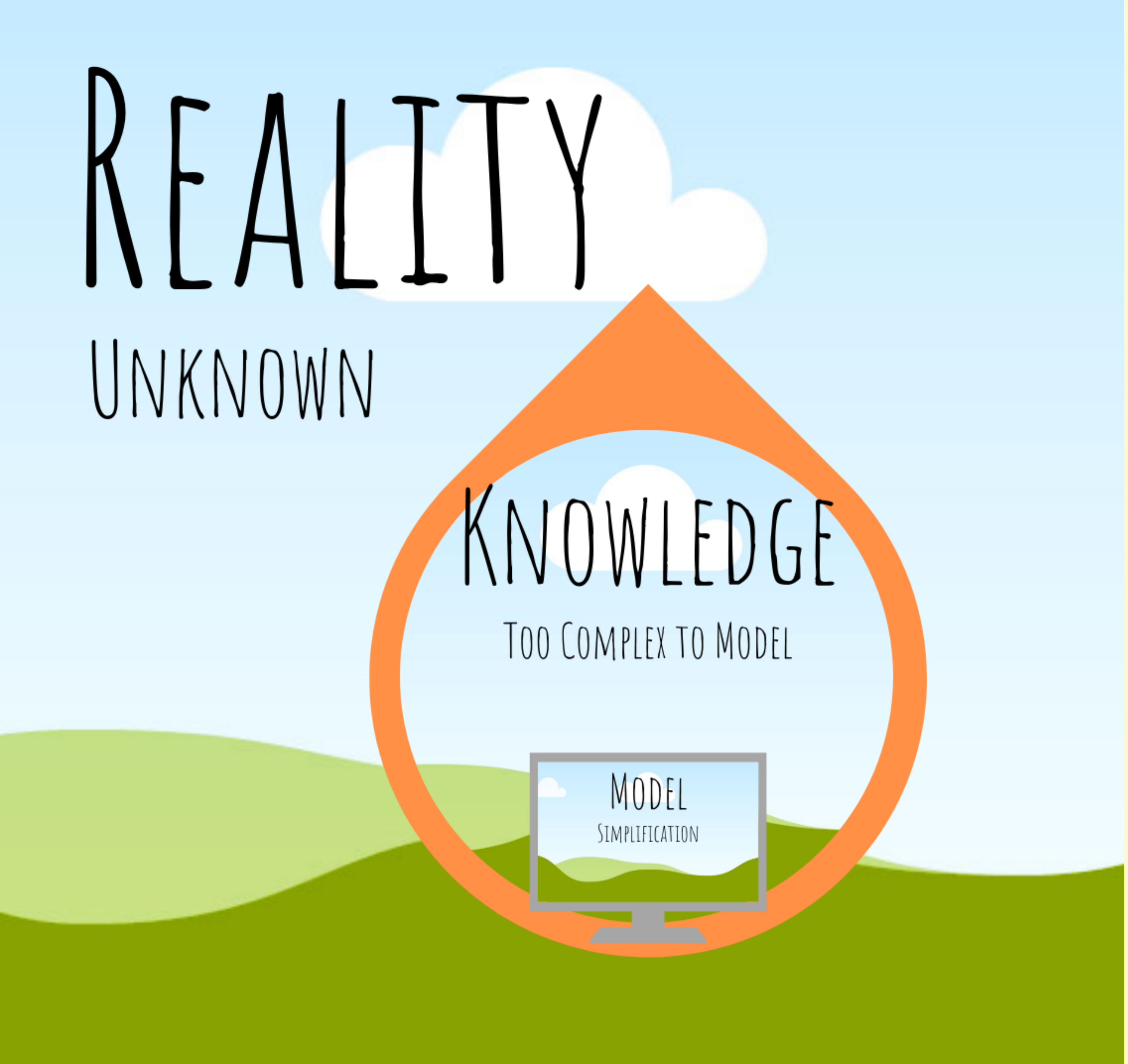
Verification has been the job of many people who have played a part in the ADSM and NAADSM Development Team as the applications have been created. Team members have spent many hours doing verification.

As such, this training will focus on validation.



Validation

Validation of a model confirms the accuracy of the model's representation of the real system you are attempting to simulate.



REALITY

UNKNOWN

KNOWLEDGE

TOO COMPLEX TO MODEL

MODEL

SIMPLIFICATION

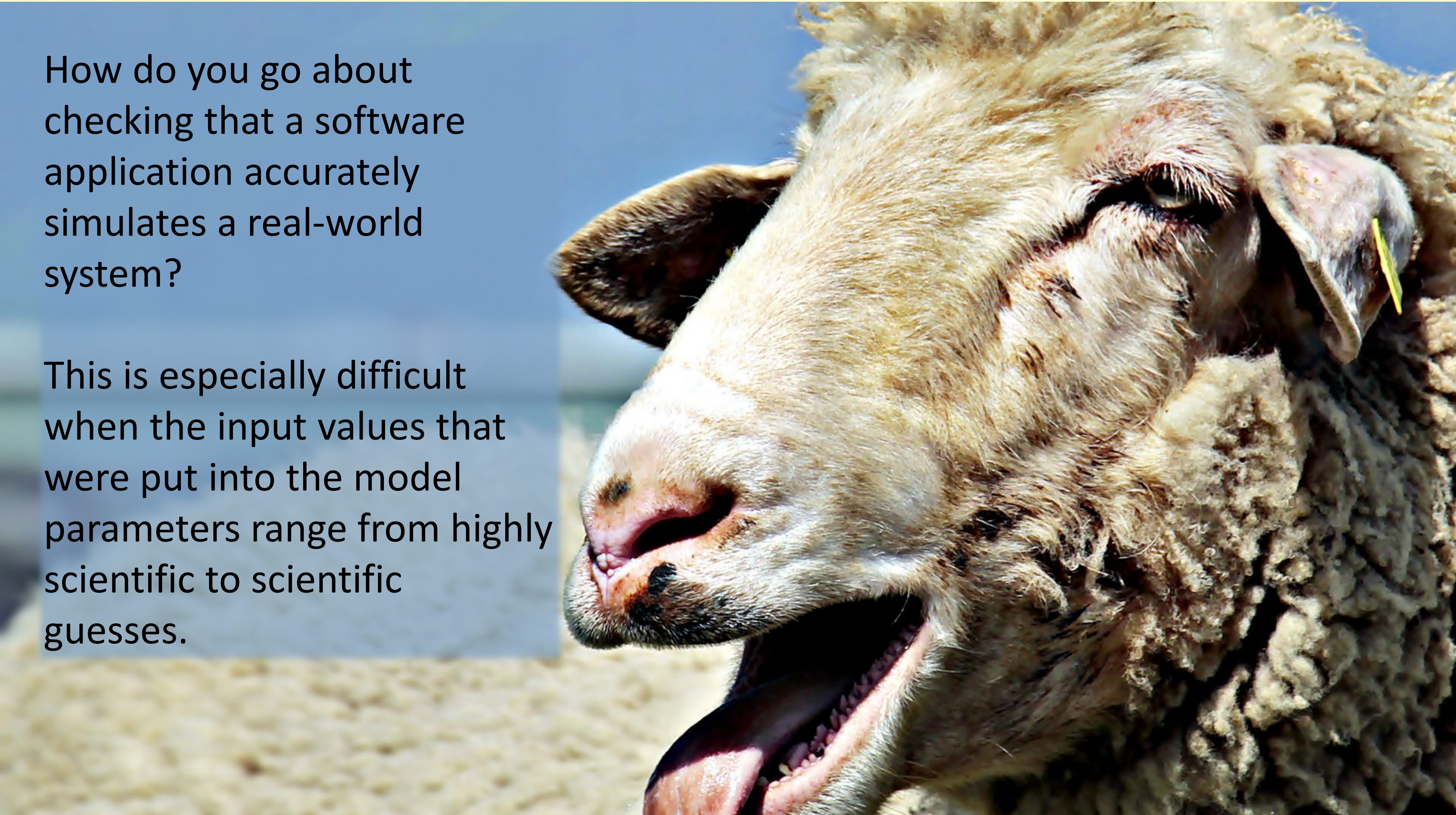
The ability to completely and accurately represent a real system is very complex.

Are the exact parameters known or are they unknown?

Can the parameters reproduce the exact population including the specifics of the animal management practices and every possible contact?

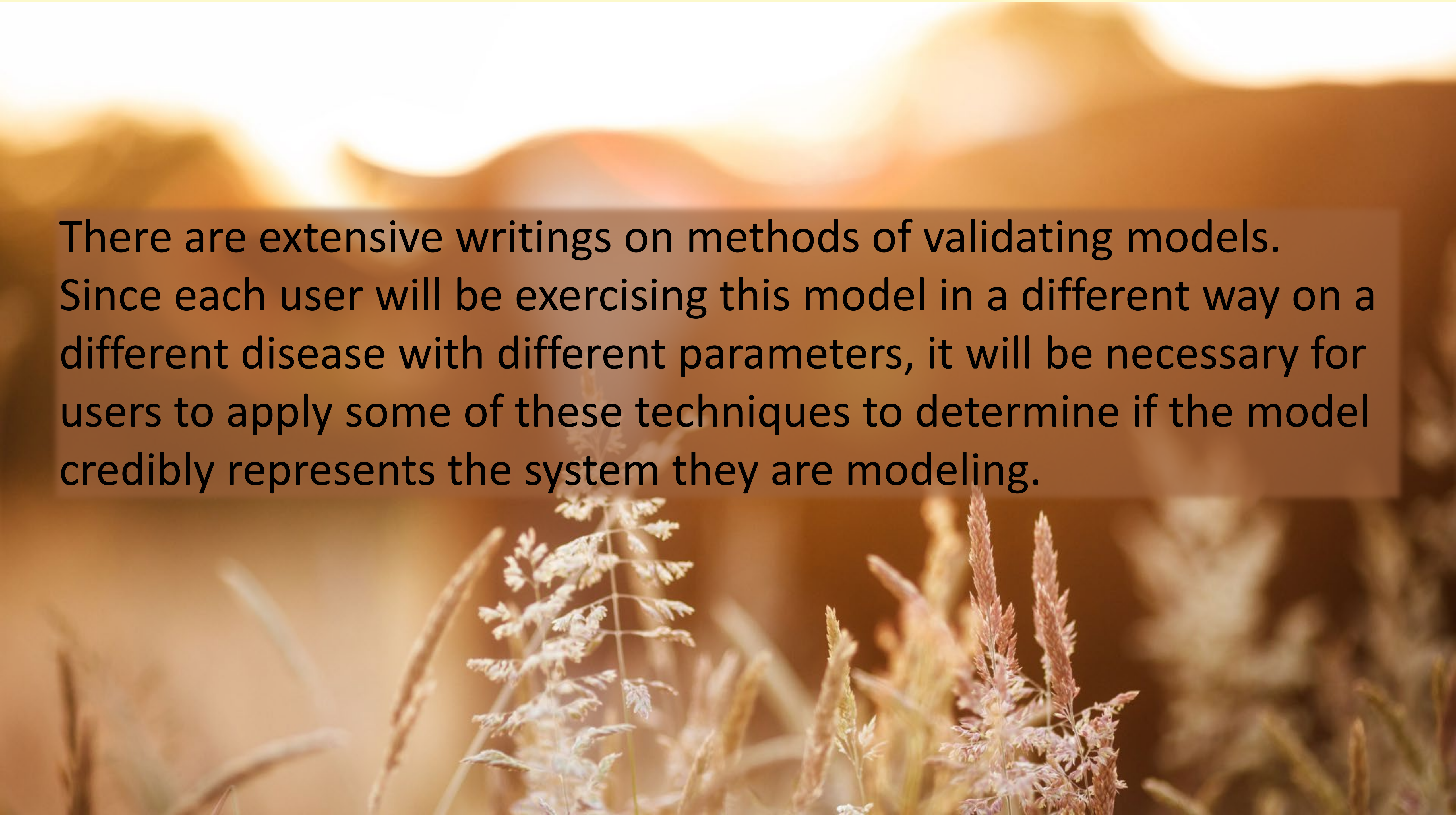
If these things were possible, a model would not be necessary.

Concept: Tariq Halasa

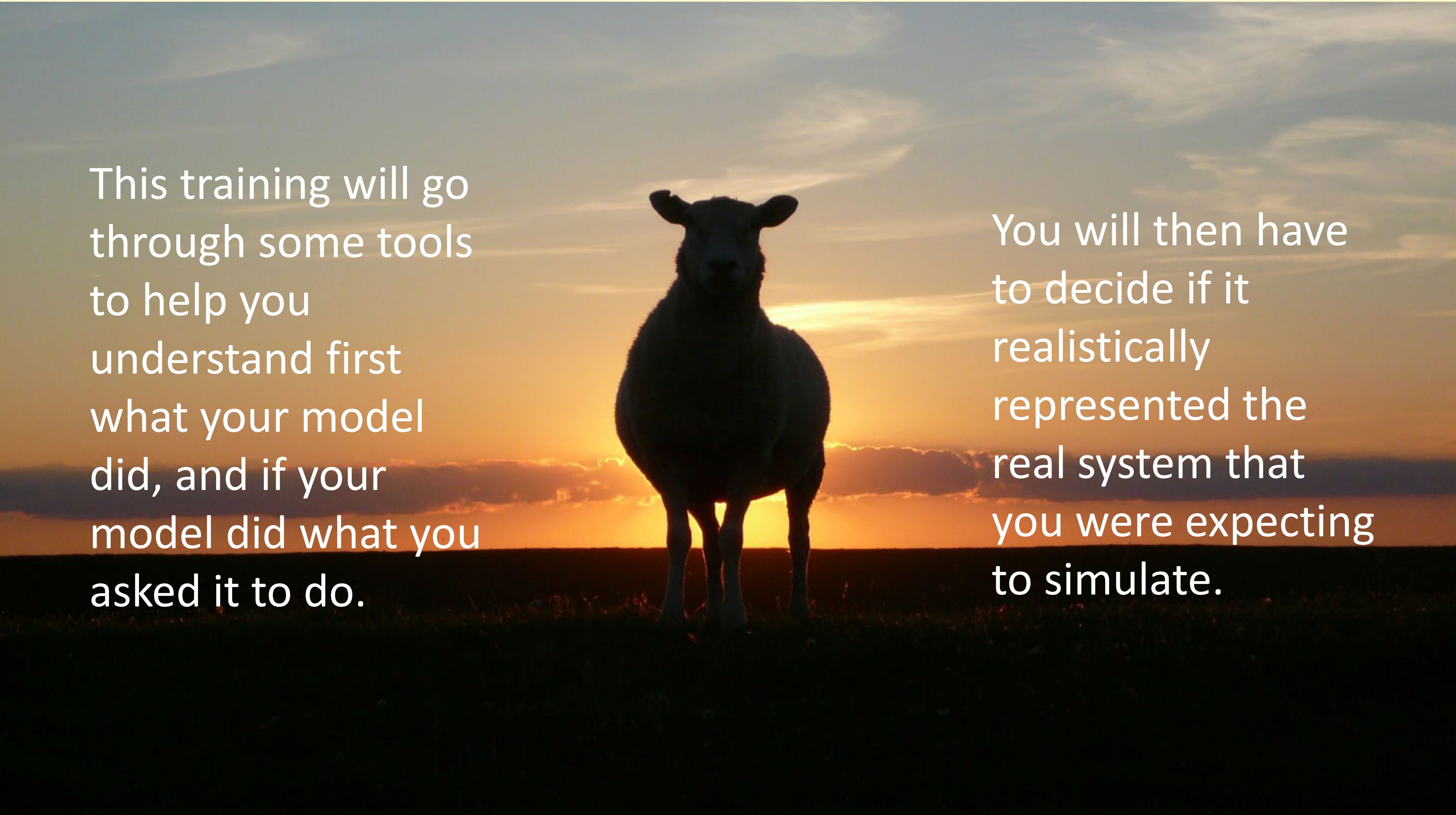


How do you go about checking that a software application accurately simulates a real-world system?

This is especially difficult when the input values that were put into the model parameters range from highly scientific to scientific guesses.



There are extensive writings on methods of validating models. Since each user will be exercising this model in a different way on a different disease with different parameters, it will be necessary for users to apply some of these techniques to determine if the model credibly represents the system they are modeling.

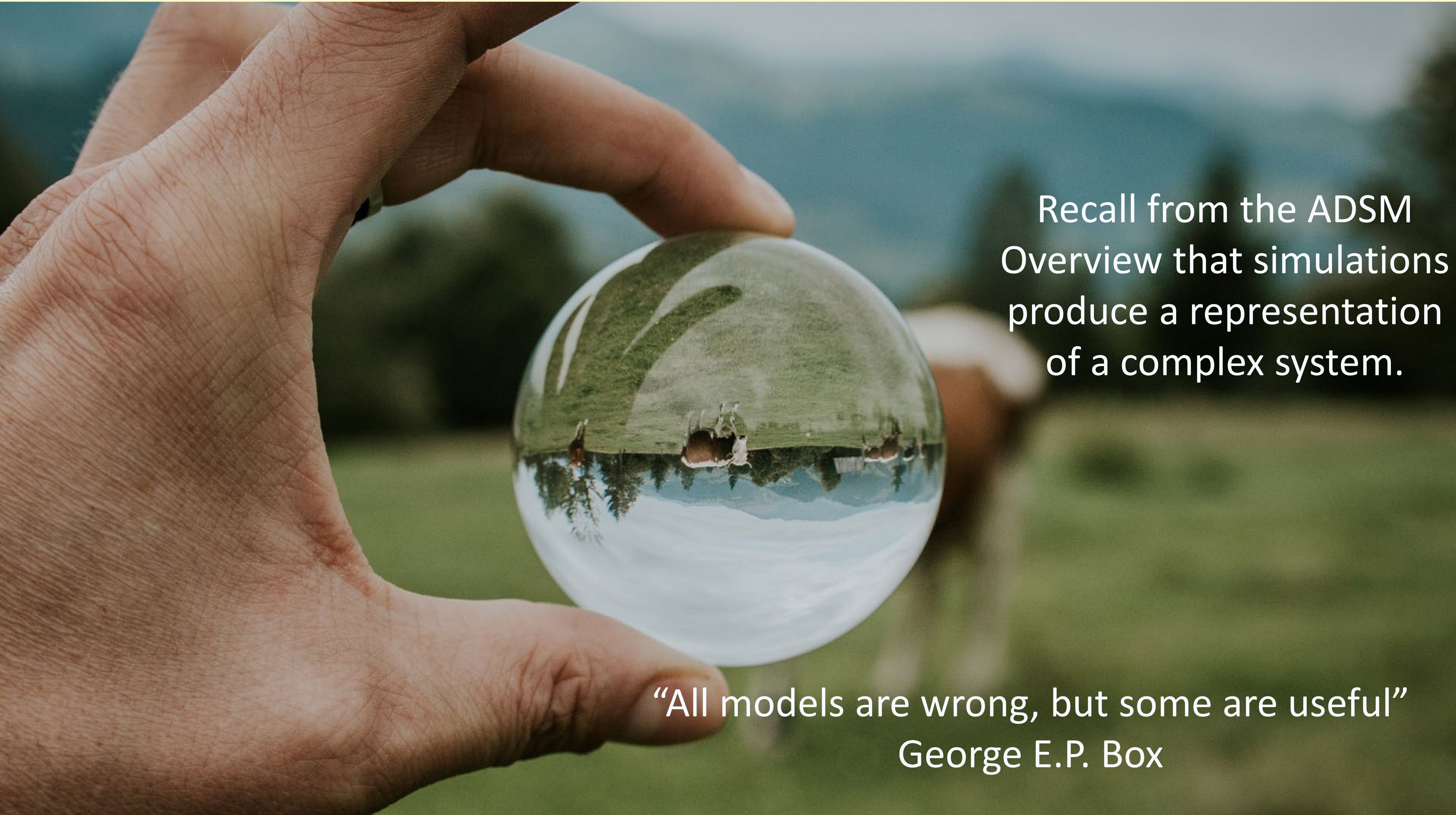


This training will go through some tools to help you understand first what your model did, and if your model did what you asked it to do.

You will then have to decide if it realistically represented the real system that you were expecting to simulate.

Validation: Some Helpful References

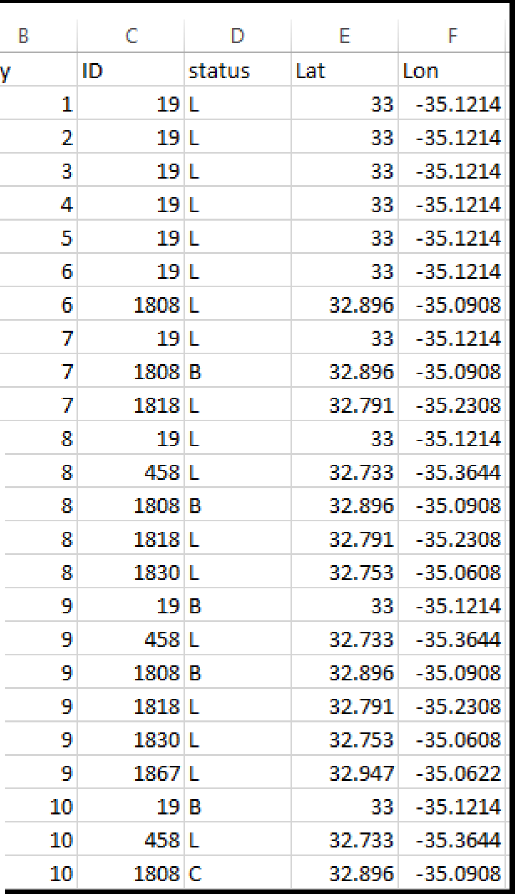
1. Reeves A, Salman MA, Hill AE. Approaches for evaluating veterinary epidemiological models: verification, validation and limitations. *Rev Sci Tech*. 2011;30(2):499-512. doi:10.20506/rst.30.2.2053
2. Kotiadis K, Robinson S. Conceptual modelling: Knowledge acquisition and model abstraction. 2008 Winter Simulation Conference, Miami, FL, USA, 2008, pp. 951-958, doi: 10.1109/WSC.2008.4736161.
3. Sargent RG. Verification and validation of simulation models. Proceedings of the 2003 Winter Simulation Conference, 2003. New Orleans, LA, USA, 2003, pp. 27-48 Vol.1, doi: 10.1109/WSC.2003.1261406.
4. Sargent RG. An introduction to verification and validation of simulation models. 2013 Winter Simulations Conference (WSC), Washington, DC, 2013, pp. 321-327, doi: 10.1109/WSC.2013.6721430.
5. Garner MG, Hamilton SA. Principles of epidemiological modelling. *Rev Sci Tech*. 2011;30(2):407-416. doi:10.20506/rst.30.2.2045
6. Sanson RL, Harvey N, Garner MG, et al. Foot and mouth disease model verification and 'relative validation' through a formal model comparison. *Rev Sci Tech*. 2011;30(2):527-540. doi:10.20506/rst.30.2.2051



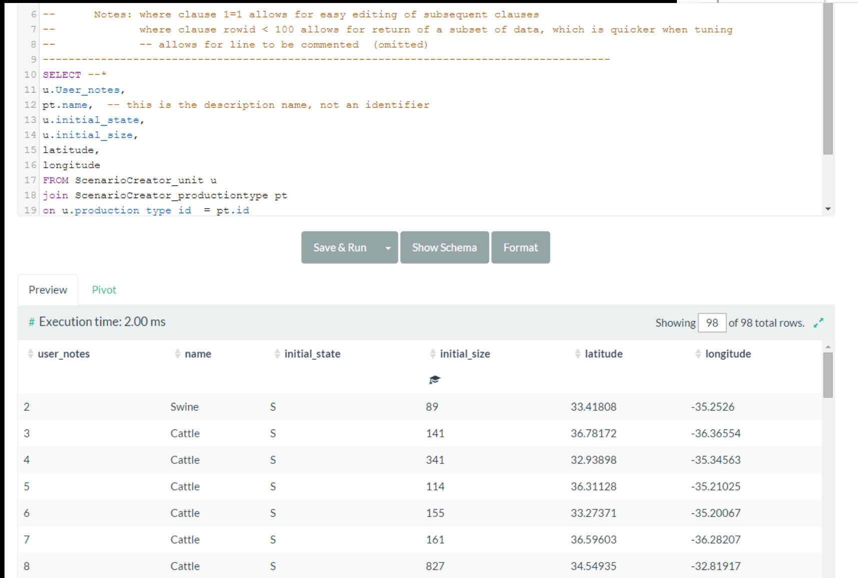
Recall from the ADSM Overview that simulations produce a representation of a complex system.

> “All models are wrong, but some are useful”
> George E.P. Box

We will use outputs provided by ADSM to evaluate if a scenario provided expected output based on the input parameters.



	A	B	C	D	E	F
1	run	day	ID	status	Lat	Lon
2	1	1	19	L	33	-35.1214
3	1	2	19	L	33	-35.1214
4	1	3	19	L	33	-35.1214
5	1	4	19	L	33	-35.1214
6	1	5	19	L	33	-35.1214
7	1	6	19	L	33	-35.1214
8	1	6	1808	L	32.896	-35.0908
9	1	7	19	L	33	-35.1214
10	1	7	1808	B	32.896	-35.0908
11	1	7	1818	L	32.791	-35.2308
12	1	8	19	L	33	-35.1214
		8	458	L	32.733	-35.3644
		8	1808	B	32.896	-35.0908
		8	1818	L	32.791	-35.2308
		8	1830	L	32.753	-35.0608
		9	19	B	33	-35.1214
		9	458	L	32.733	-35.3644
		9	1808	B	32.896	-35.0908
		9	1818	L	32.791	-35.2308
		9	1830	L	32.753	-35.0608
		9	1867	L	32.947	-35.0622
		10	19	B	33	-35.1214
		10	458	L	32.733	-35.3644
		10	1808	C	32.896	-35.0908

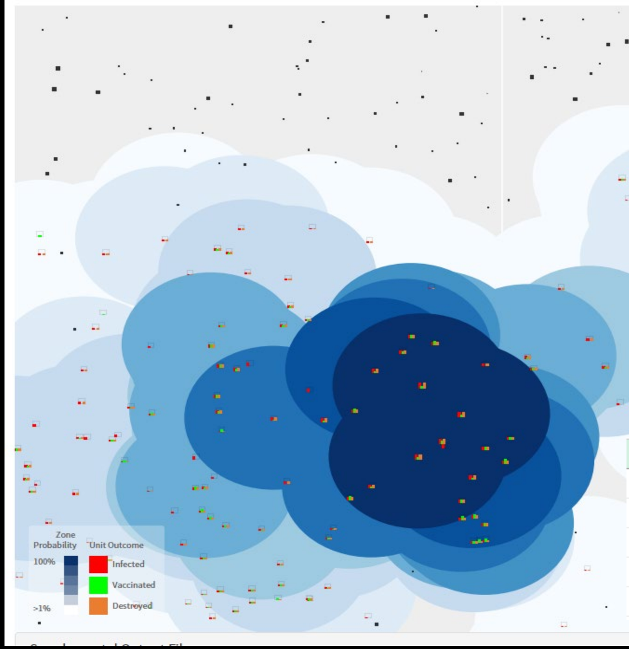


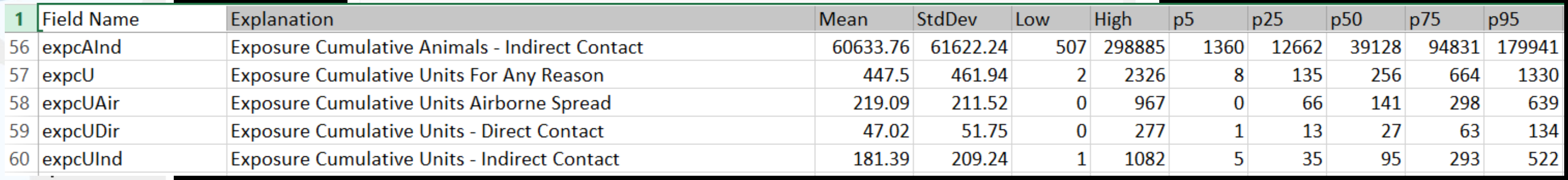
```
--      Notes: where clause 1=1 allows for easy editing of subsequent clauses
--             where clause rowid < 100 allows for return of a subset of data, which is quicker when tuning
--             -- allows for line to be commented  (omitted)
-----------------------------------------------------------------------------------------
SELECT --*
u.User_notes,
pt.name,  -- this is the description name, not an identifier
u.initial_state,
u.initial_size,
latitude,
longitude
FROM ScenarioCreator_unit u
join ScenarioCreator_productiontype pt
on u.production type id  = pt.id
```

Execution time: 2.00 ms

Showing 98 of 98 total rows.

user_notes	name	initial_state	initial_size	latitude	longitude
2	Swine	S	89	33.41808	-35.2526
3	Cattle	S	141	36.78172	-36.36554
4	Cattle	S	341	32.93898	-35.34563
5	Cattle	S	114	36.31128	-35.21025
6	Cattle	S	155	33.27371	-35.20067
7	Cattle	S	161	36.59603	-36.28207
8	Cattle	S	827	34.54935	-32.81917





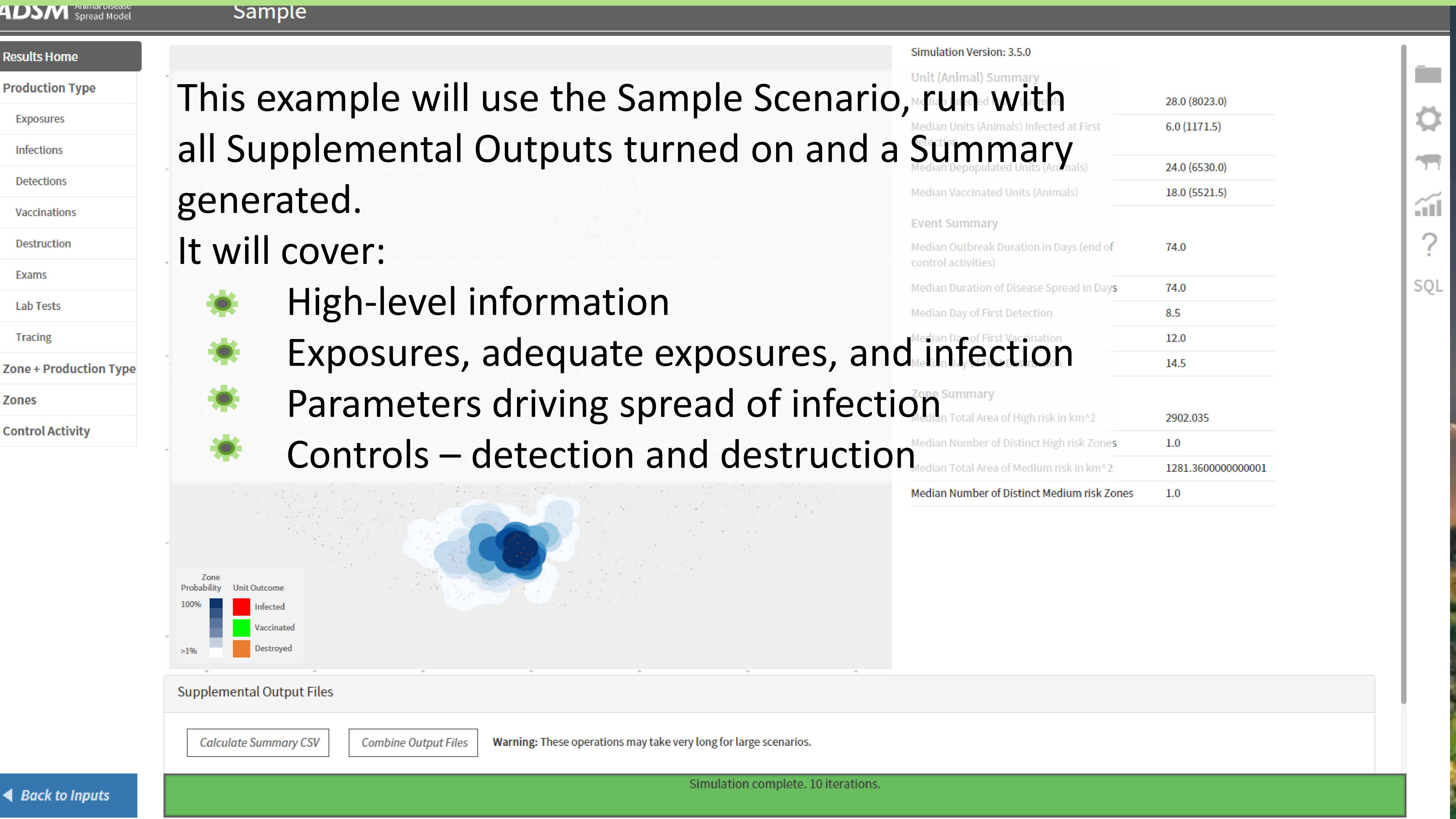
1	Field Name	Explanation	Mean	StdDev	Low	High	p5	p25	p50	p75	p95
56	expcAInd	Exposure Cumulative Animals - Indirect Contact	60633.76	61622.24	507	298885	1360	12662	39128	94831	179941
57	expcU	Exposure Cumulative Units For Any Reason	447.5	461.94	2	2326	8	135	256	664	1330
58	expcUAir	Exposure Cumulative Units Airborne Spread	219.09	211.52	0	967	0	66	141	298	639
59	expcUDir	Exposure Cumulative Units - Direct Contact	47.02	51.75	0	277	1	13	27	63	134
60	expcUInd	Exposure Cumulative Units - Indirect Contact	181.39	209.24	1	1082	5	35	95	293	522

Example

This example will use the Sample Scenario, run with all Supplemental Outputs turned on and a Summary generated.

It will cover:

- High-level information
- Exposures, adequate exposures, and infection
- Parameters driving spread of infection
- Controls – detection and destruction



Simulation Version: 3.5.0

Unit (Animal) Summary

Median Infected Units (Animals)	28.0 (8023.0)
Median Units (Animals) Infected at First Detection	6.0 (1171.5)
Median Depopulated Units (Animals)	24.0 (6530.0)
Median Vaccinated Units (Animals)	18.0 (5521.5)

Event Summary

Median Outbreak Duration in Days (end of control activities)	74.0
Median Duration of Disease Spread in Days	74.0
Median Day of First Detection	8.5
Median Day of First Vaccination	12.0
Median Day of First Destruction	14.5

Zone Summary

Median Total Area of High risk in km^2	2902.035
Median Number of Distinct High risk Zones	1.0
Median Total Area of Medium risk in km^2	1281.3600000000001
Median Number of Distinct Medium risk Zones	1.0

Supplemental Output Files

Warning: These operations may take very long for large scenarios.

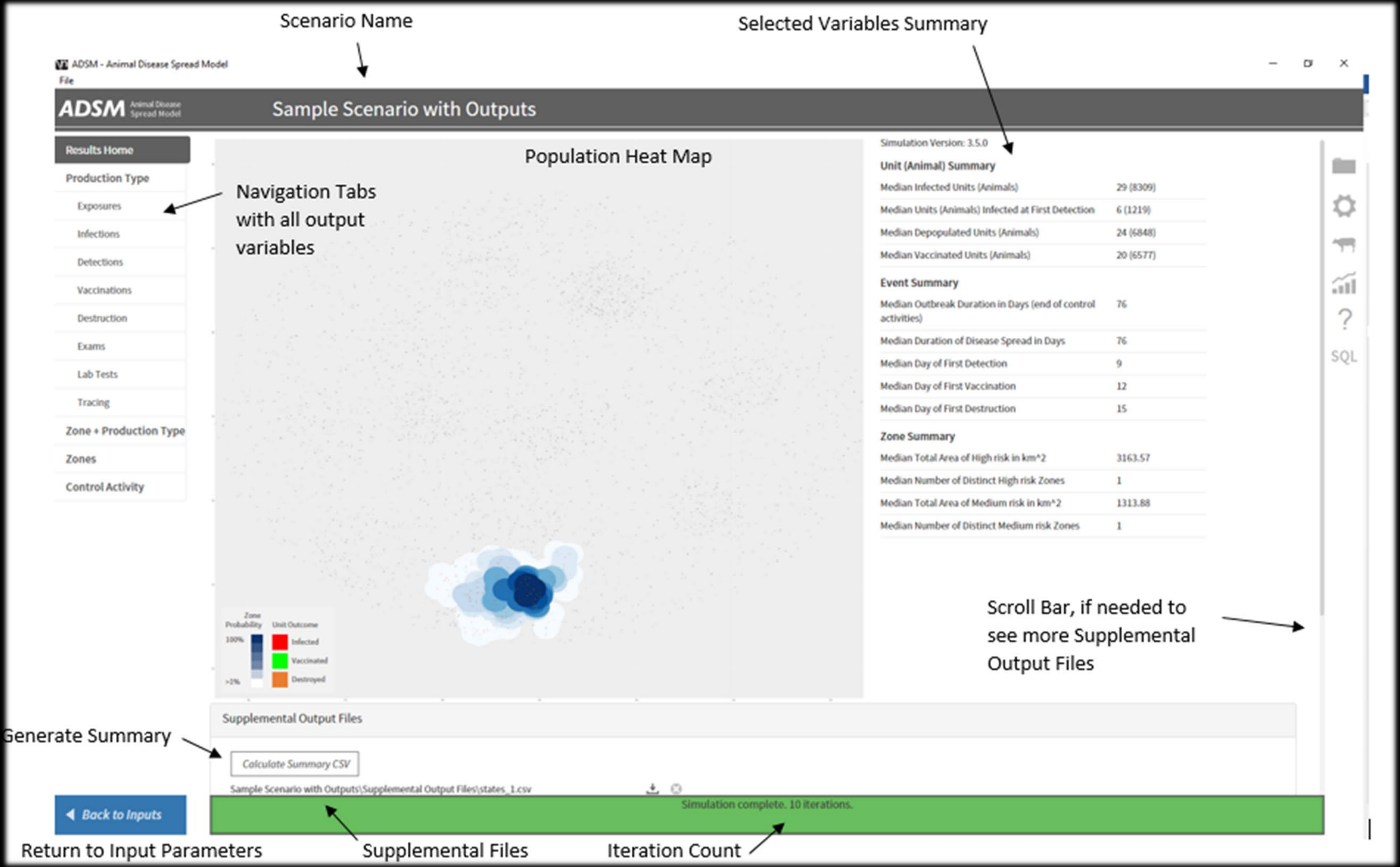
Simulation complete. 10 iterations.

Please note that we will review only a small subset of the ADSM output to demonstrate the research methods. You can apply the methods used in this training to any variable that is created from ADSM.

Review Results Home

Results Home is the best place to start evaluating the scenario.

It is important to know how to look at your results at both a high level and at a detailed level.



Scenario Name

Selected Variables Summary

Navigation Tabs with all output variables

Generate Summary

Scroll Bar, if needed to see more Supplemental Output Files

Return to Input Parameters

Supplemental Files

Iteration Count

ADSM - Animal Disease Spread Model

Sample Scenario with Outputs

Simulation Version: 3.5.0

Unit (Animal) Summary

Median Infected Units (Animals)	29 (8309)
Median Units (Animals) Infected at First Detection	6 (1219)
Median Depopulated Units (Animals)	24 (6848)
Median Vaccinated Units (Animals)	20 (6577)

Event Summary

Median Outbreak Duration in Days (end of control activities)	76
Median Duration of Disease Spread in Days	76
Median Day of First Detection	9
Median Day of First Vaccination	12
Median Day of First Destruction	15

Zone Summary

Median Total Area of High risk in km^2	3163.57
Median Number of Distinct High risk Zones	1
Median Total Area of Medium risk in km^2	1313.88
Median Number of Distinct Medium risk Zones	1

Supplemental Output Files

Sample Scenario with Outputs\Supplemental Output Files\states_1.csv

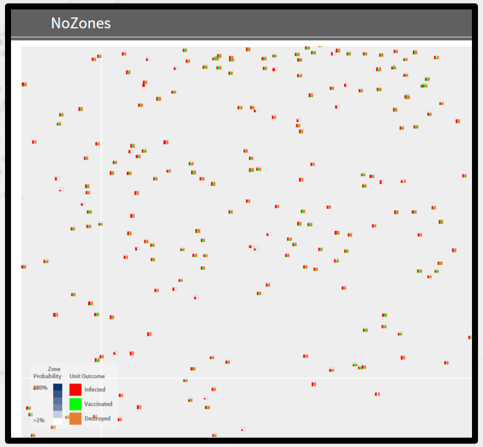
Simulation complete. 10 iterations.

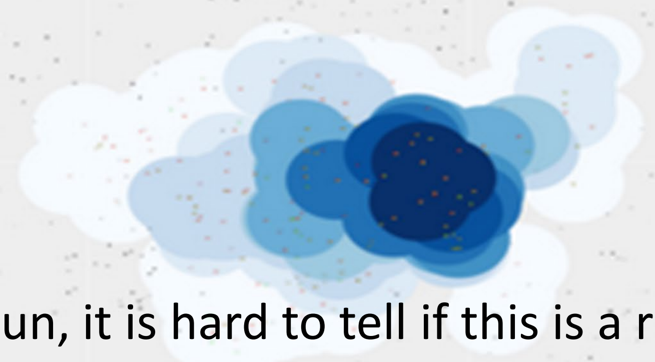
The Data Dictionary can provide field level definitions, use the ? Panel in the ADSM application to find the Data Dictionary.

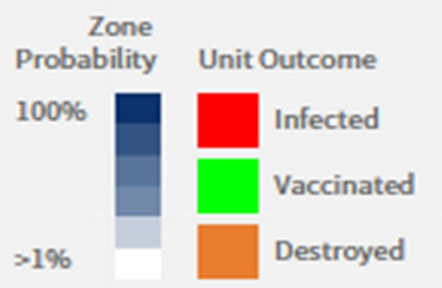
Sample Scenario Population Heat Map

The Population Heat Map gives you a quick visual summary of the scenario outcome. Recall that the Population Heat Map is a combination of all the iterations that were run. While it is a high-level view, it helps to understand the broad scope of the outbreak.

When using zones, the darker blue color indicates those areas that were involved in most or all iterations. As the color gets lighter, it means those areas were in involved in fewer iterations. Each unit will have a status graph to indicate the frequency of the unit outcomes. If Zones were not used, then no zone circles are drawn. Instead, each unit will have a status graph showing the frequency of unit outcomes. On a large population, the resolution may not allow you to scroll into the units to see the detail.

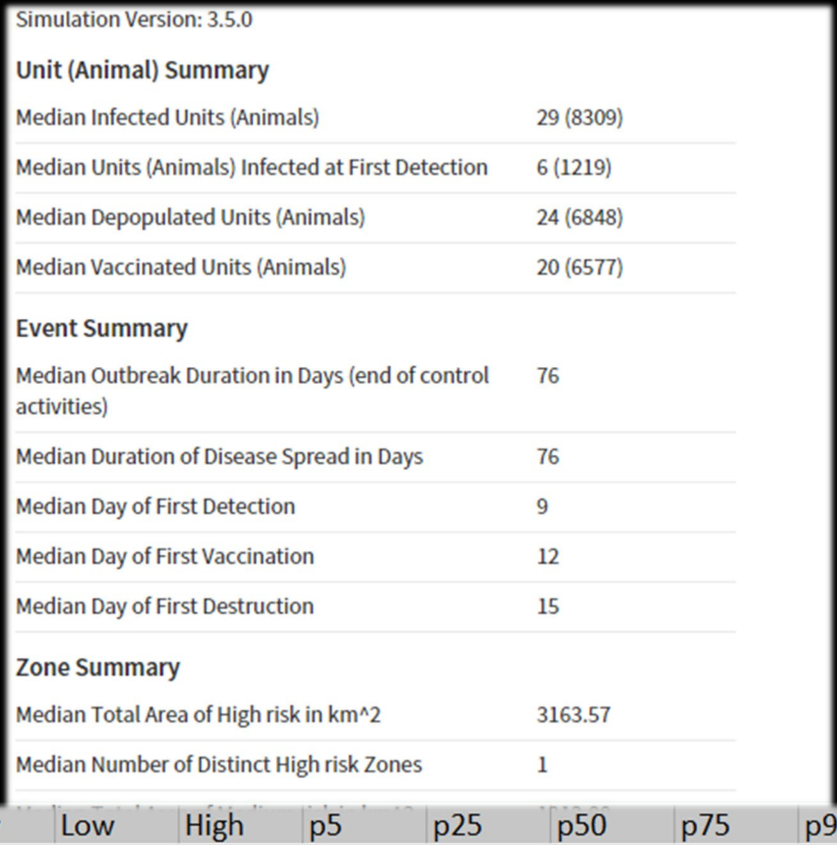






On the first run, it is hard to tell if this is a reasonable outcome. As you gain more experience, you will become more aware of population heat map changes in response to changes in the parameter input.

In addition to the Population Heat Map, the selected output variable and the summary file allow quick glances at results values at a high level.



Simulation Version: 3.5.0

Unit (Animal) Summary

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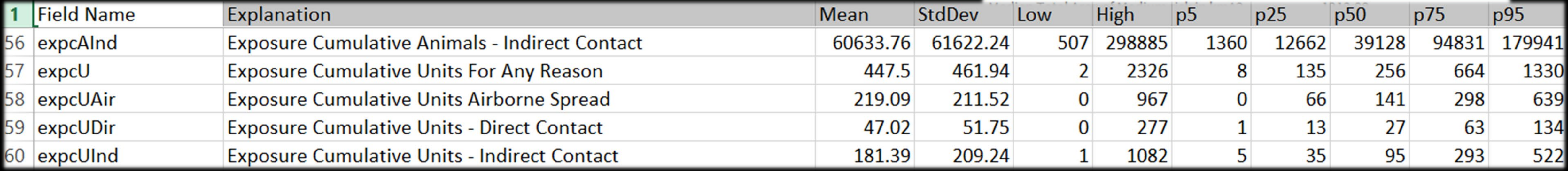
Median Day of First Vaccination	12
Median Day of First Destruction	15

Zone Summary

Median Total Area of High risk in km^2	3163.57
Median Number of Distinct High risk Zones	1



1	Field Name	Explanation	Mean	StdDev	Low	High	p5	p25	p50	p75	p95
56	expcAInd	Exposure Cumulative Animals - Indirect Contact	60633.76	61622.24	507	298885	1360	12662	39128	94831	179941
57	expcU	Exposure Cumulative Units For Any Reason	447.5	461.94	2	2326	8	135	256	664	1330
58	expcUAir	Exposure Cumulative Units Airborne Spread	219.09	211.52	0	967	0	66	141	298	639
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60	expcUInd	Exposure Cumulative Units - Indirect Contact	181.39	209.24	1	1082	5	35	95	293	522

Have you used the Sample Scenario several times and noticed that it gives you similar results every time?

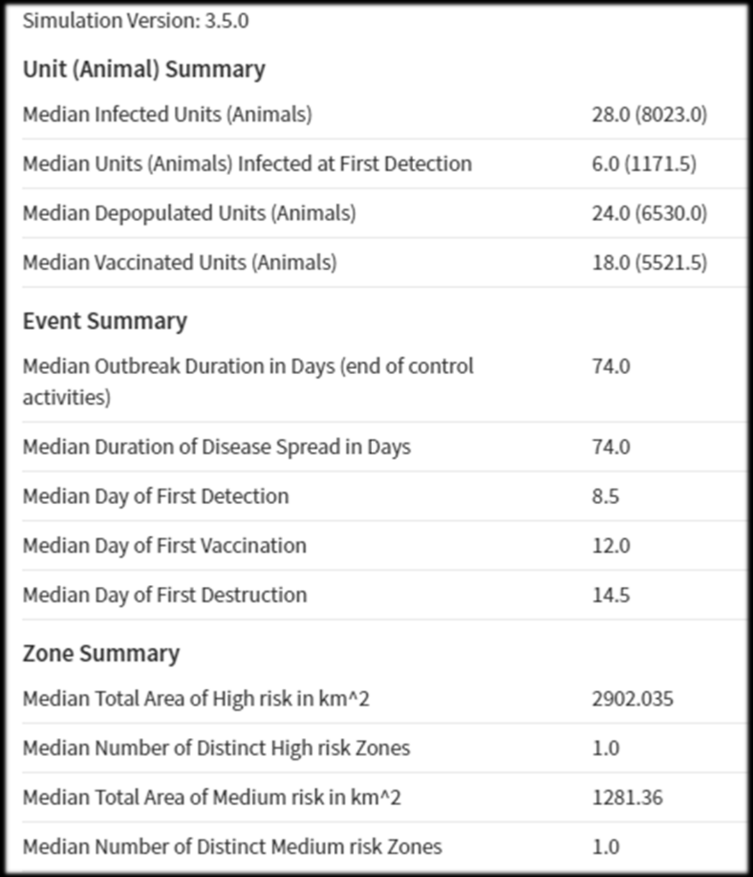
This is on purpose.

The Random Seed is a set value in the Sample Scenario. This causes the randomly varying parameters to draw the same values every time the model is run, resulting in the same results every time. When a seed value is specified, model results will only change when parameter inputs are changed, which can be useful for evaluation.

For the training example, it is important to have an example that can be explained consistently. Therefore, we are using the Sample Scenario.

High Level Indicators

The median outbreak duration and median numbers of infected units and animals can indicate unexpected results that require further exploration.



Simulation Version: 3.5.0

Unit (Animal) Summary

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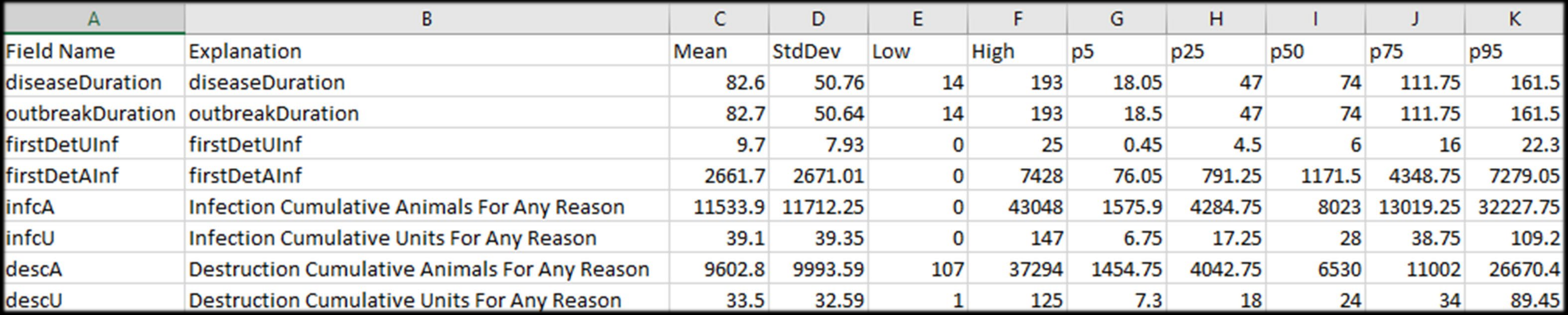
Median Day of First Destruction	14.5

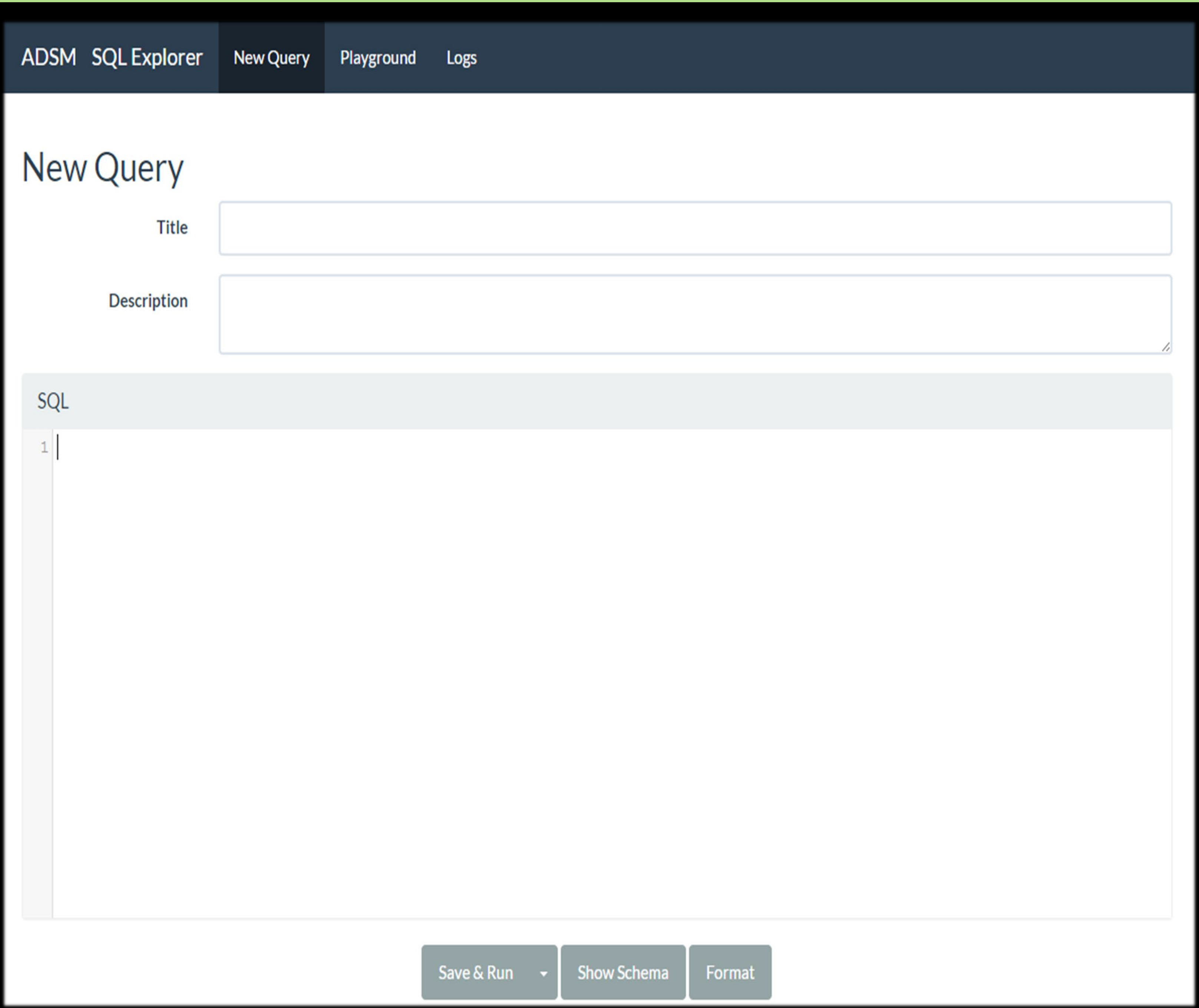
Zone Summary

Median Total Area of High risk in km^2	2902.035
Median Number of Distinct High risk Zones	1.0
Median Total Area of Medium risk in km^2	1281.36
Median Number of Distinct Medium risk Zones	1.0



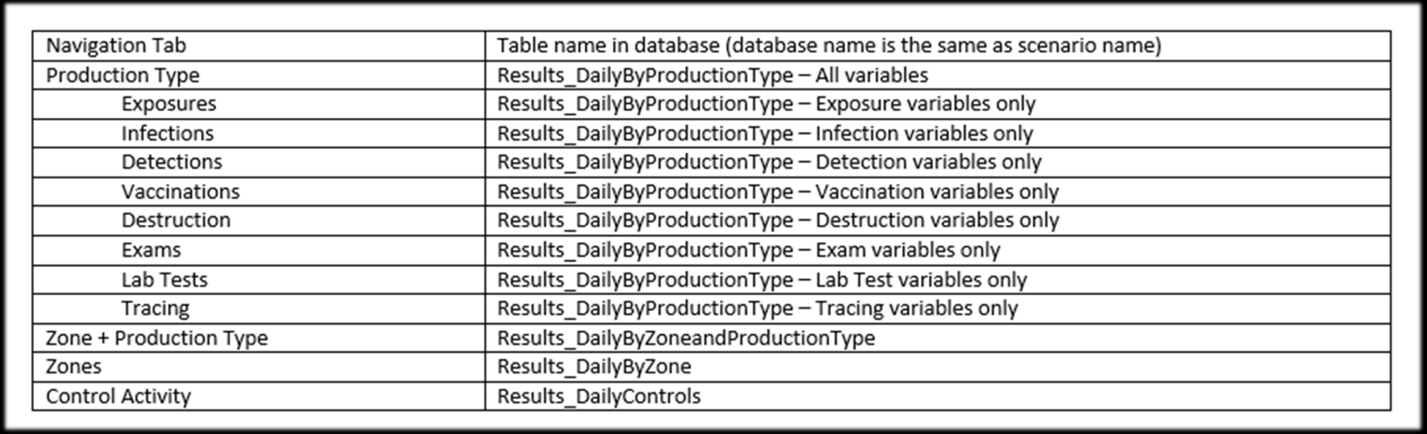
A	B	C	D	E	F	G	H	I	J	K
Field Name	Explanation	Mean	StdDev	Low	High	p5	p25	p50	p75	p95
diseaseDuration	diseaseDuration	82.6	50.76	14	193	18.05	47	74	111.75	161.5
outbreakDuration	outbreakDuration	82.7	50.64	14	193	18.5	47	74	111.75	161.5
firstDetUInf	firstDetUInf	9.7	7.93	0	25	0.45	4.5	6	16	22.3
firstDetAInf	firstDetAInf	2661.7	2671.01	0	7428	76.05	791.25	1171.5	4348.75	7279.05
infcA	Infection Cumulative Animals For Any Reason	11533.9	11712.25	0	43048	1575.9	4284.75	8023	13019.25	32227.75
infcU	Infection Cumulative Units For Any Reason	39.1	39.35	0	147	6.75	17.25	28	38.75	109.2
descA	Destruction Cumulative Animals For Any Reason	9602.8	9993.59	107	37294	1454.75	4042.75	6530	11002	26670.4
descU	Destruction Cumulative Units For Any Reason	33.5	32.59	1	125	7.3	18	24	34	89.45

We can also query the raw data and learn more details about the results. You can access SQLite Explorer through the Admin Panel.



These are the main tables that hold the results, so our queries will connect to these tables.

- Results_DailyByProductionType
- Results_DailyByZoneandProductionType
- Results_DailyByZone
- Results_Daily Controls



Navigation Tab	Table name in database (database name is the same as scenario name)
Production Type	Results_DailyByProductionType – All variables
Exposures	Results_DailyByProductionType – Exposure variables only
Infections	Results_DailyByProductionType – Infection variables only
Detections	Results_DailyByProductionType – Detection variables only
Vaccinations	Results_DailyByProductionType – Vaccination variables only
Destruction	Results_DailyByProductionType – Destruction variables only
Exams	Results_DailyByProductionType – Exam variables only
Lab Tests	Results_DailyByProductionType – Lab Test variables only
Tracing	Results_DailyByProductionType – Tracing variables only
Zone + Production Type	Results_DailyByZoneandProductionType
Zones	Results_DailyByZone
Control Activity	Results_DailyControls

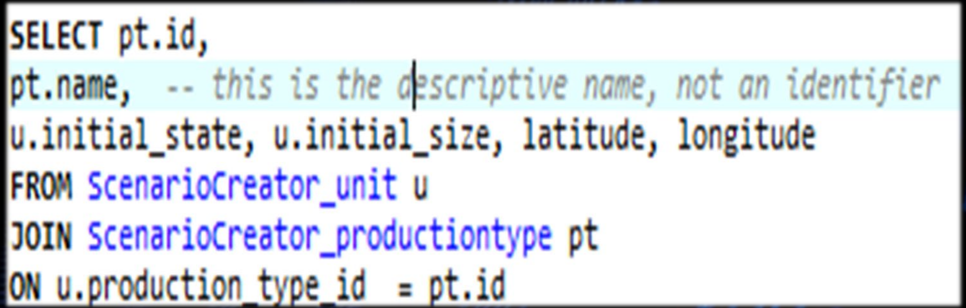
Additional Helpful Tables

Databases store information in a way that is most efficient and without redundancy. Sometimes efficiency creates an output that is difficult to understand. For example, Production Types are stored as numeric identifiers on the Results tables. As a user, you would not know that ID even existed. By connecting the table with the Production Type names in a query, it is easier to understand the data results.

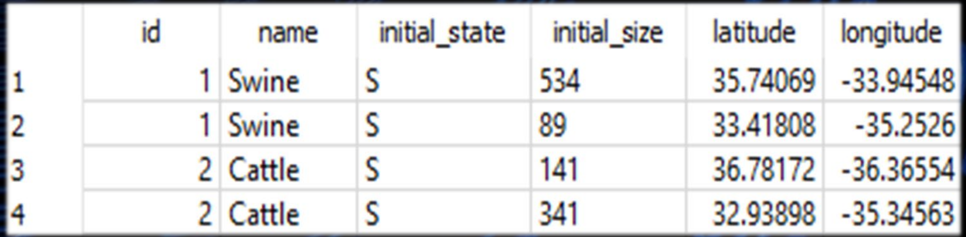
The queries in the Example Database Queries show how to make this connection.

The following tables are helpful when a Production Type name or a Zone name is needed.

- ScenarioCreator_ProductionType
- ScenarioCreator_Zone



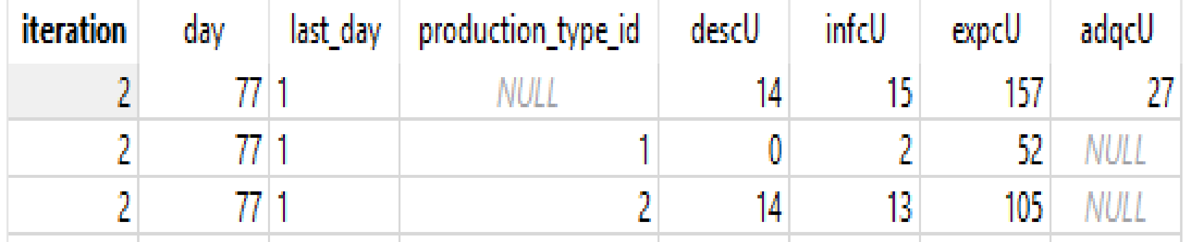
```
SELECT pt.id,
pt.name,  -- this is the descriptive name, not an identifier
u.initial_state, u.initial_size, latitude, longitude
FROM ScenarioCreator_unit u
JOIN ScenarioCreator_productiontype pt
ON u.production_type_id  = pt.id
```



	id	name	initial_state	initial_size	latitude	longitude
1	1	Swine	S	534	35.74069	-33.94548
2	1	Swine	S	89	33.41808	-35.2526
3	2	Cattle	S	141	36.78172	-36.36554
4	2	Cattle	S	341	32.93898	-35.34563

A Helpful Hint

The production_type_id field for the first record is blank (or null) because that record shows values for all production types combined. The example queries take advantage of this by using a *Where Clause* to return only the combined record.



iteration	day	last_day	production_type_id	descU	infcU	expcU	adqcU
2	77	1	NULL	14	15	157	27
2	77	1	1	0	2	52	NULL
2	77	1	2	14	13	105	NULL

WHERE 1=1
AND production_type_id is null

The Where 1=1 clause is a logical true. This makes it easy to add additional clauses without having to rewrite. Simply add another AND clause if needed.

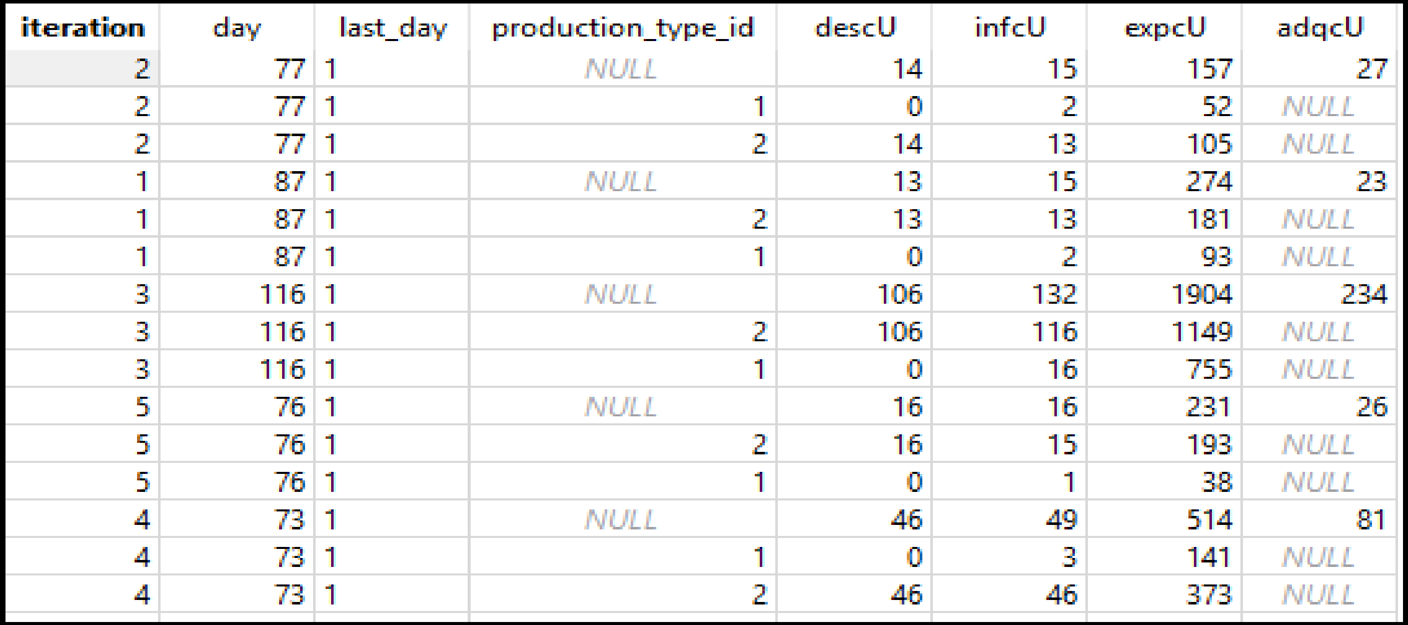
Another Helpful Hint

Databases do not store data in an order that is logical to you. Instead, they store it in the order that it was created. Use

```
    Order By iteration and day
```

in your query to create a logical order.

In this image, the actual order iterations completed was 2, 1, 3, 5 then 4.

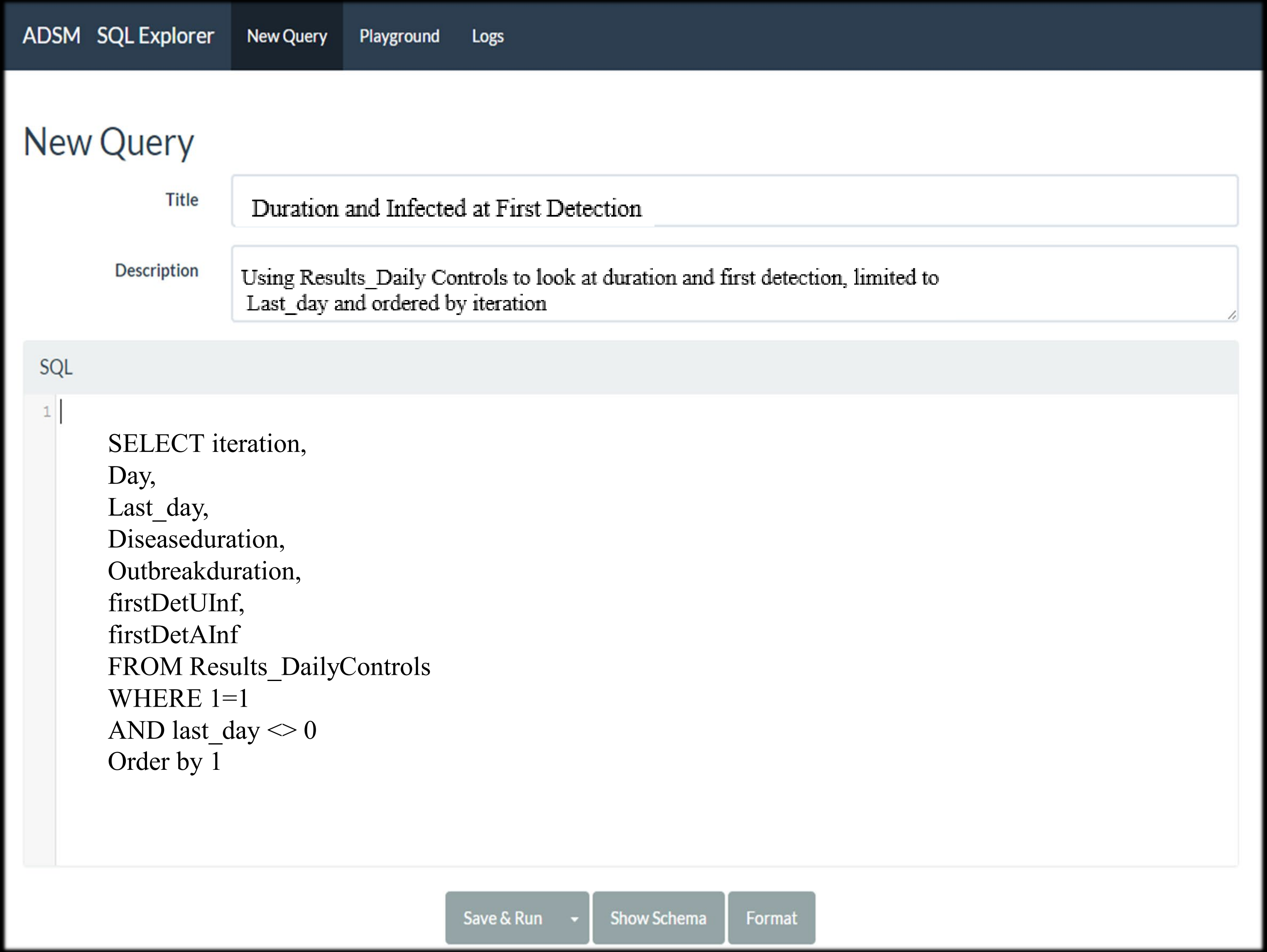


iteration	day	last_day	production_type_id	descU	infcU	expcU	adqcU
2	77	1	*NULL*	14	15	157	27
2	77	1	1	0	2	52	*NULL*
2	77	1	2	14	13	105	*NULL*
1	87	1	*NULL*	13	15	274	23
1	87	1	2	13	13	181	*NULL*
1	87	1	1	0	2	93	*NULL*
3	116	1	*NULL*	106	132	1904	234
3	116	1	2	106	116	1149	*NULL*
3	116	1	1	0	16	755	*NULL*
5	76	1	*NULL*	16	16	231	26
5	76	1	2	16	15	193	*NULL*
5	76	1	1	0	1	38	*NULL*
4	73	1	*NULL*	46	49	514	81
4	73	1	1	0	3	141	*NULL*
4	73	1	2	46	46	373	*NULL*

Raw Data for Duration and Infected at First Detection query

We will start at a high level to look at these results.

You can cut and paste this query into your SQL Explorer window if you would like hands-on experience.



New Query

Title: Duration and Infected at First Detection

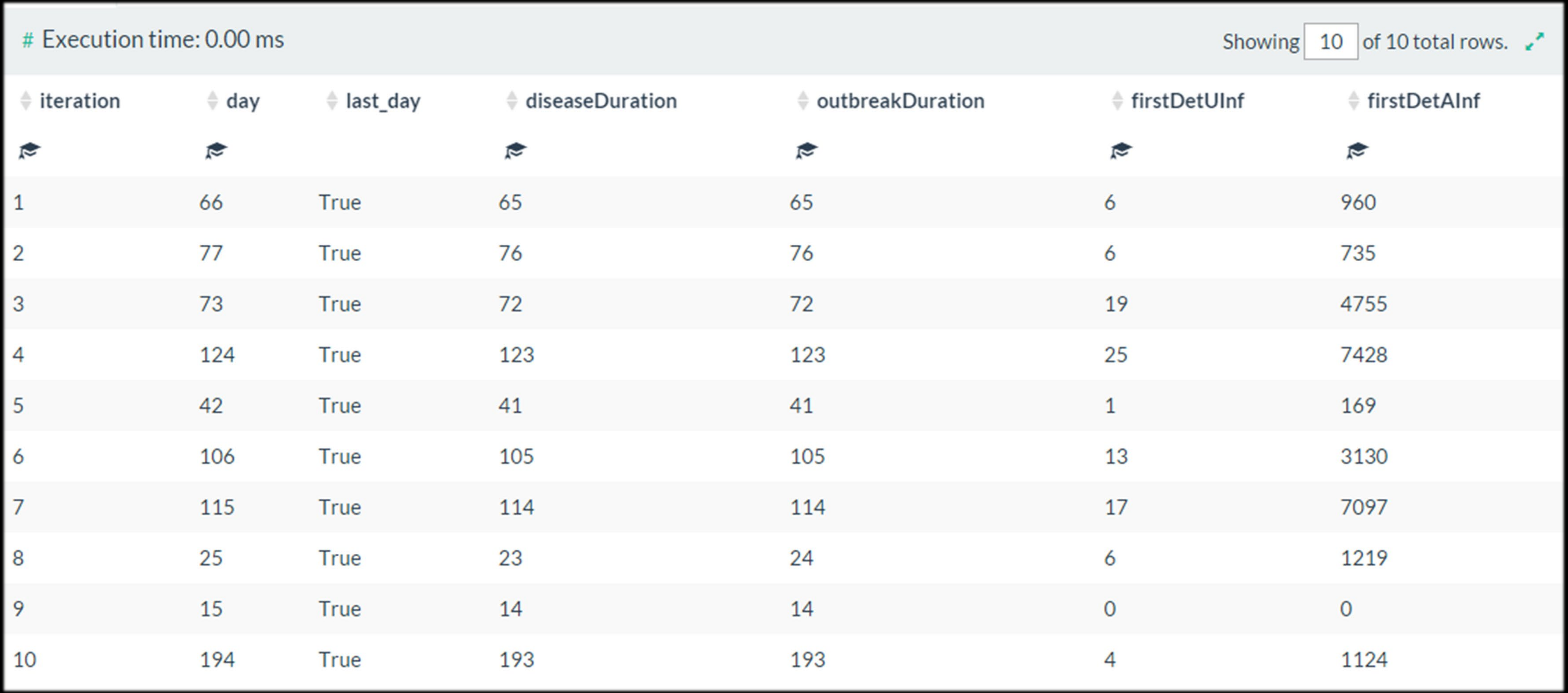
Description: Using Results_Daily Controls to look at duration and first detection, limited to Last_day and ordered by iteration

SQL

```
SELECT iteration,
Day,
Last_day,
Diseaseduration,
Outbreakduration,
firstDetUInf,
firstDetAInf
FROM Results_DailyControls
WHERE 1=1
AND last_day <> 0
Order by 1
```

Raw Data for Duration and Infected at First Detection results

Here are the results from the previous query.



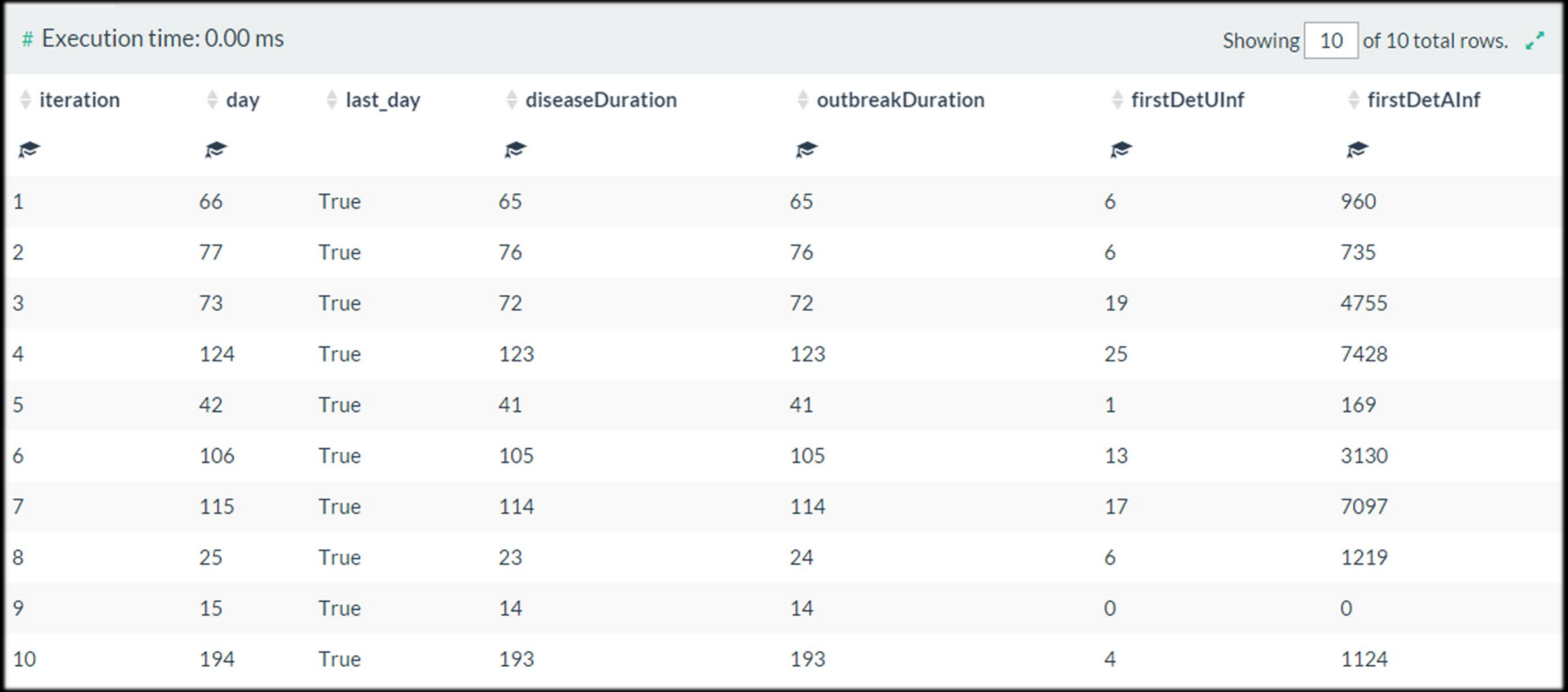
Execution time: 0.00 ms

Showing 10 of 10 total rows.

iteration	day	last_day	diseaseDuration	outbreakDuration	firstDetUInf	firstDetAInf
1	66	True	65	65	6	960
2	77	True	76	76	6	735
3	73	True	72	72	19	4755
4	124	True	123	123	25	7428
5	42	True	41	41	1	169
6	106	True	105	105	13	3130
7	115	True	114	114	17	7097
8	25	True	23	24	6	1219
9	15	True	14	14	0	0
10	194	True	193	193	4	1124

Raw Data for Duration and Infected at First Detection

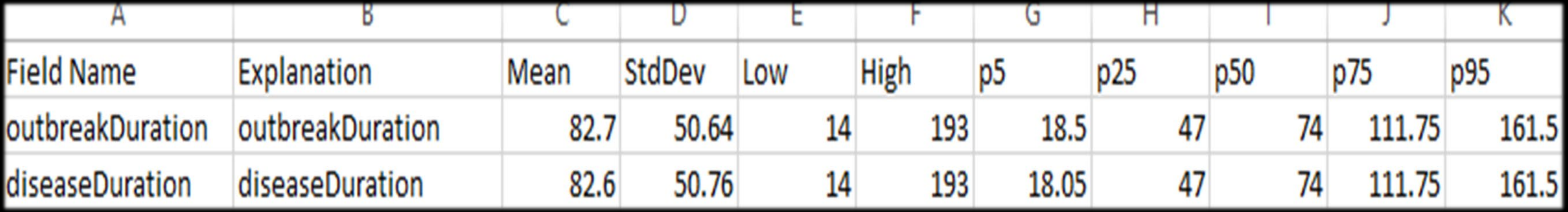
What can be learned from this result set? Since this is the first look at the data, it is still early in the investigation.



Execution time: 0.00 ms

Showing 10 of 10 total rows.

iteration	day	last_day	diseaseDuration	outbreakDuration	firstDetUInf	firstDetAInf
1	66	True	65	65	6	960
2	77	True	76	76	6	735
3	73	True	72	72	19	4755
4	124	True	123	123	25	7428
5	42	True	41	41	1	169
6	106	True	105	105	13	3130
7	115	True	114	114	17	7097
8	25	True	23	24	6	1219
9	15	True	14	14	0	0
10	194	True	193	193	4	1124



A	B	C	D	E	F	G	H	I	J	K
Field Name	Explanation	Mean	StdDev	Low	High	p5	p25	p50	p75	p95
outbreakDuration	outbreakDuration	82.7	50.64	14	193	18.5	47	74	111.75	161.5
diseaseDuration	diseaseDuration	82.6	50.76	14	193	18.05	47	74	111.75	161.5

There were a range of outcomes.

The fewer units infected at first detection (firstDetUInf), the shorter the outbreak seems to be…
BUT,
The count of animals (firstDetAInf) also matters as in the case of iteration 10.

Iteration 10 had four units with many animals infected at first detection.

The Summary file agrees with the raw data for minimum and maximum values.

Duration and Infected at First Detection

Many things could influence the duration, including both the spread of the disease and the control measures taken in response to the disease. While duration is a high-level indicator of what the model is doing, it may not be the best place begin evaluating what is happening.

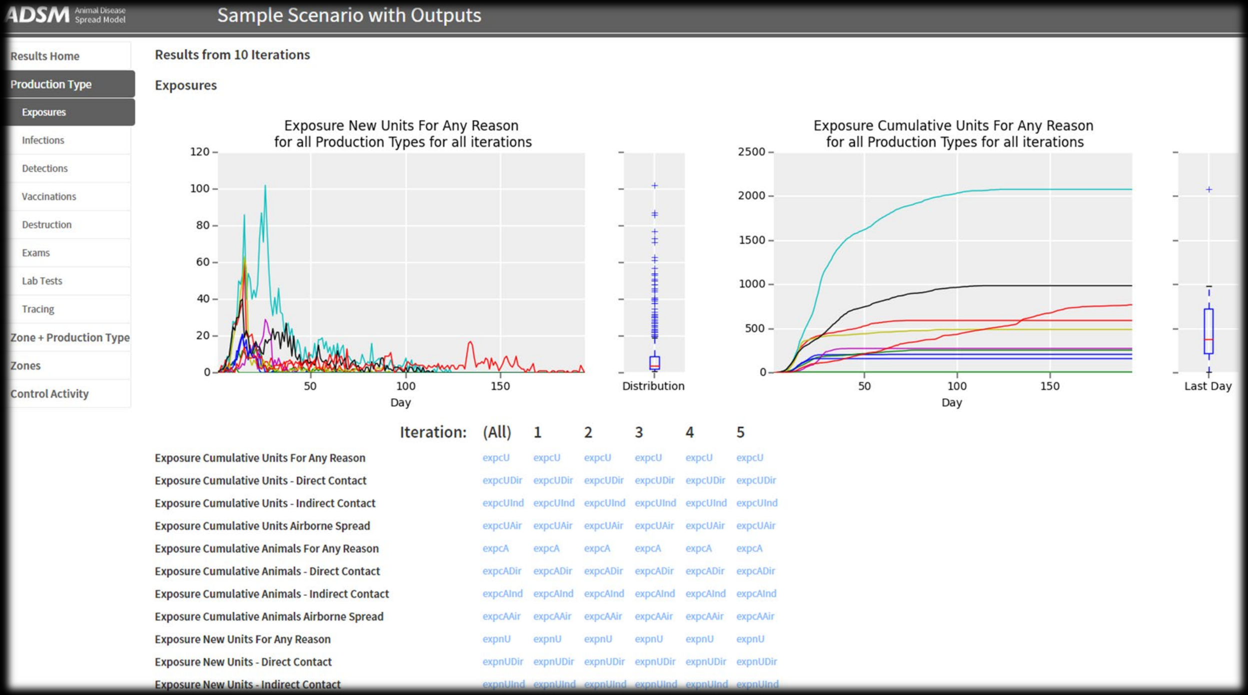
The data also returned two duration variables, *Disease duration* and *Outbreak Duration*. The difference between disease duration (diseaseDuration) and outbreak duration (outbreakDuration) is this:

- Disease duration is the number of days that any unit was in an infected state.
- Outbreak duration is the number of days that any unit was in an infected state, plus any additional days needed to complete the control measures that were applied.

Let’s move on to look at more details in the results, starting with count of exposure, count of exposures that are adequate to cause disease, and count of infections that happen because of those exposures.

Understanding Exposures - **10** Iterations

The visualization shows the summary of exposures throughout the outbreak. Exposures are not always adequate to cause infection. Even when the exposure is adequate, it doesn’t cause disease if the recipient unit is not susceptible to disease due to immunity.



Results from 10 Iterations

Exposures

Iteration:	(All)	1	2	3	4	5
Exposure Cumulative Units For Any Reason	expcU	expcU	expcU	expcU	expcU	expcU
Exposure Cumulative Units - Direct Contact	expcUDir	expcUDir	expcUDir	expcUDir	expcUDir	expcUDir
Exposure Cumulative Units - Indirect Contact	expcUInd	expcUInd	expcUInd	expcUInd	expcUInd	expcUInd
Exposure Cumulative Units Airborne Spread	expcUAir	expcUAir	expcUAir	expcUAir	expcUAir	expcUAir
Exposure Cumulative Animals For Any Reason	expcA	expcA	expcA	expcA	expcA	expcA
Exposure Cumulative Animals - Direct Contact	expcADir	expcADir	expcADir	expcADir	expcADir	expcADir
Exposure Cumulative Animals - Indirect Contact	expcAInd	expcAInd	expcAInd	expcAInd	expcAInd	expcAInd
Exposure Cumulative Animals Airborne Spread	expcAAir	expcAAir	expcAAir	expcAAir	expcAAir	expcAAir
Exposure New Units For Any Reason	expnU	expnU	expnU	expnU	expnU	expnU
Exposure New Units - Direct Contact	expnUDir	expnUDir	expnUDir	expnUDir	expnUDir	expnUDir
Exposure New Units - Indirect Contact	expnUInd	expnUInd	expnUInd	expnUInd	expnUInd	expnUInd

What situations could make a unit not susceptible to disease when the exposure was adequate?

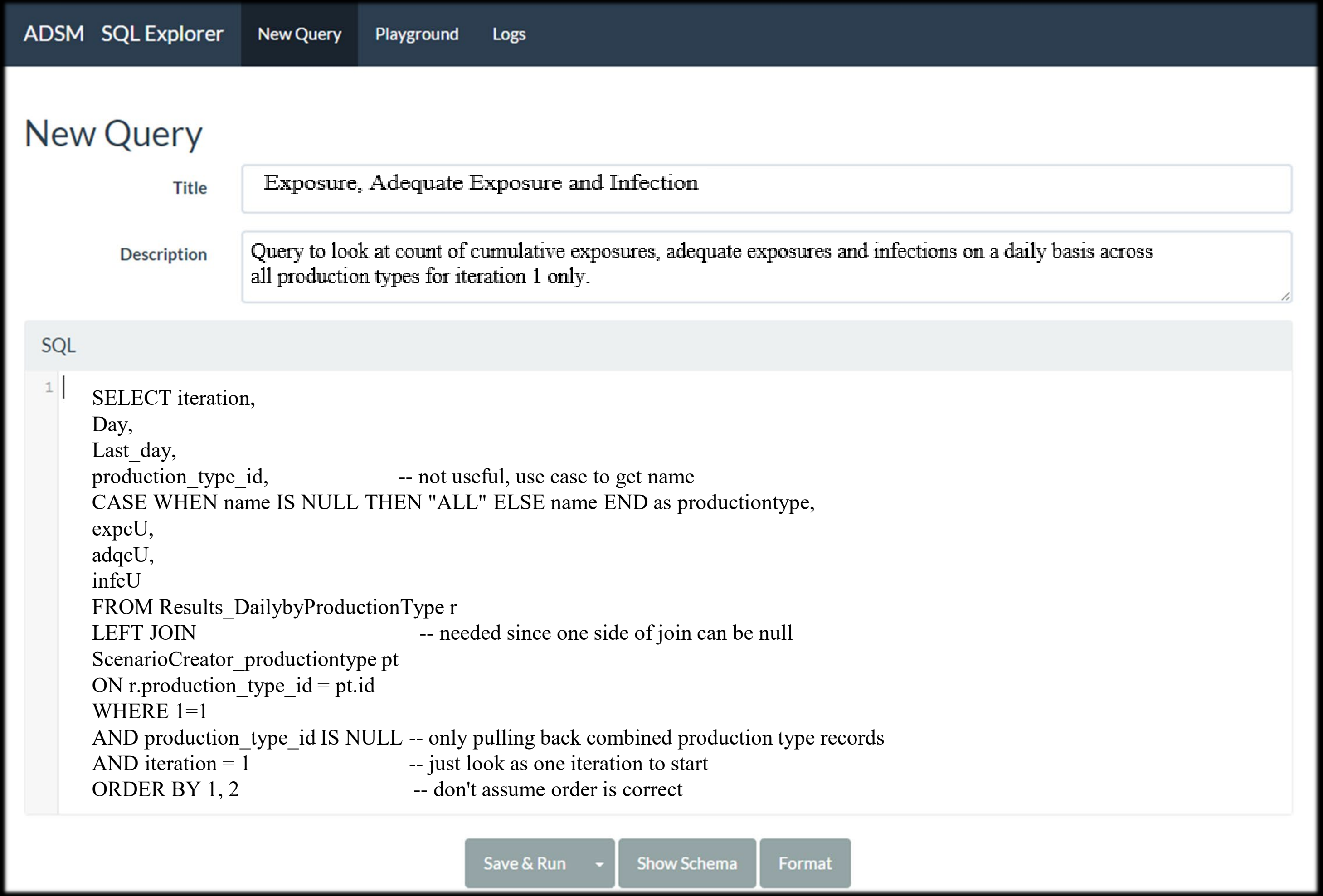
- If the unit was previously exposed and is now in an active disease state, adequate exposure will not cause an infection.
- If the unit is in an immune state, due to either vaccine immunity or natural immunity, adequate exposure will not cause an infection.
- If the unit is in a susceptible state, there is still a probability that the adequate exposure will not result in disease transmission. The Infection Probability parameter controls infection probability.

Therefore, exposure (expcU), adequate exposure (adqcU) and infected (infcU) may all have different values in the raw data.

Mariposa Ranch Watusi

Raw Data for Exposure, Adequate Exposure, and Infection

Copy and paste this query into your SQL window if you want hands-on experience. Remember to use the Sample Scenario with Outputs, or any scenario that has been run.



New Query

Title: Exposure, Adequate Exposure and Infection

Description: Query to look at count of cumulative exposures, adequate exposures and infections on a daily basis across all production types for iteration 1 only.

SQL

```
SELECT iteration,
Day,
Last_day,
production_type_id,                    -- not useful, use case to get name
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
expcU,
adqcU,
infcU
FROM Results_DailybyProductionType r
LEFT JOIN                                  -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NULL -- only pulling back combined production type records
AND iteration = 1                       -- just look as one iteration to start
ORDER BY 1, 2                           -- don't assume order is correct
```

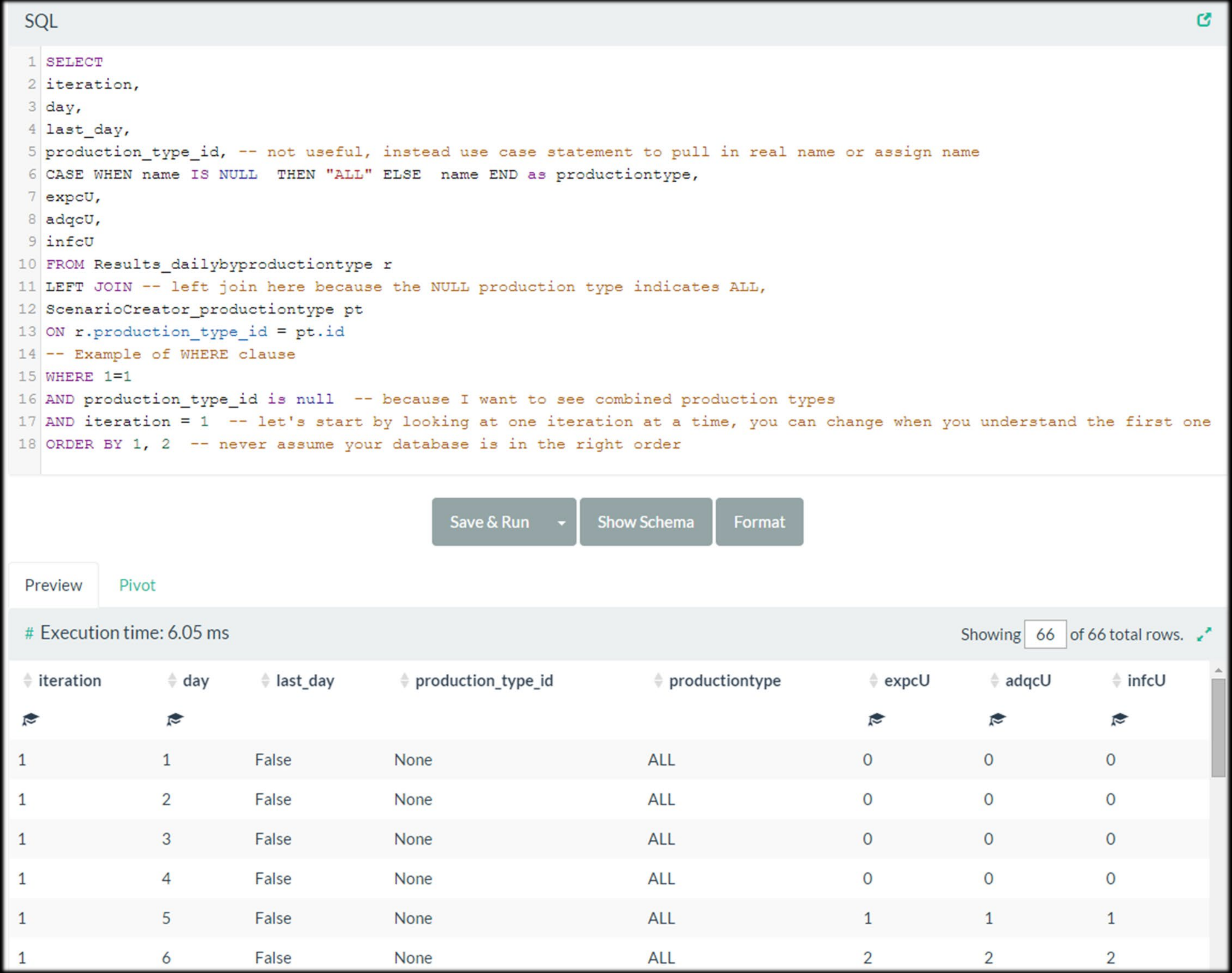
Raw Data for Exposure, Adequate Exposure, and Infection

The query requested results only from Iteration 1, starting on day 1 and counting forward. On day 5, an exposure happens. The exposure is adequate, and it causes an infection.

On day 6, another exposure happens; it is adequate and also causes an infection.

The variables in this query are the cumulative variables; they are a sum of the total as the days progress.

In the query window, it is possible to scroll down and view each day of the outbreak.



```
SELECT
iteration,
day,
last_day,
production_type_id, -- not useful, instead use case statement to pull in real name or assign name
CASE WHEN name IS NULL  THEN "ALL" ELSE  name END as productiontype,
expcU,
adqcU,
infcU
FROM Results_dailybyproductiontype r
LEFT JOIN -- left join here because the NULL production type indicates ALL,
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
-- Example of WHERE clause
WHERE 1=1
AND production_type_id is null  -- because I want to see combined production types
AND iteration = 1  -- let's start by looking at one iteration at a time, you can change when you understand the first one
ORDER BY 1, 2  -- never assume your database is in the right order
```

Execution time: 6.05 ms

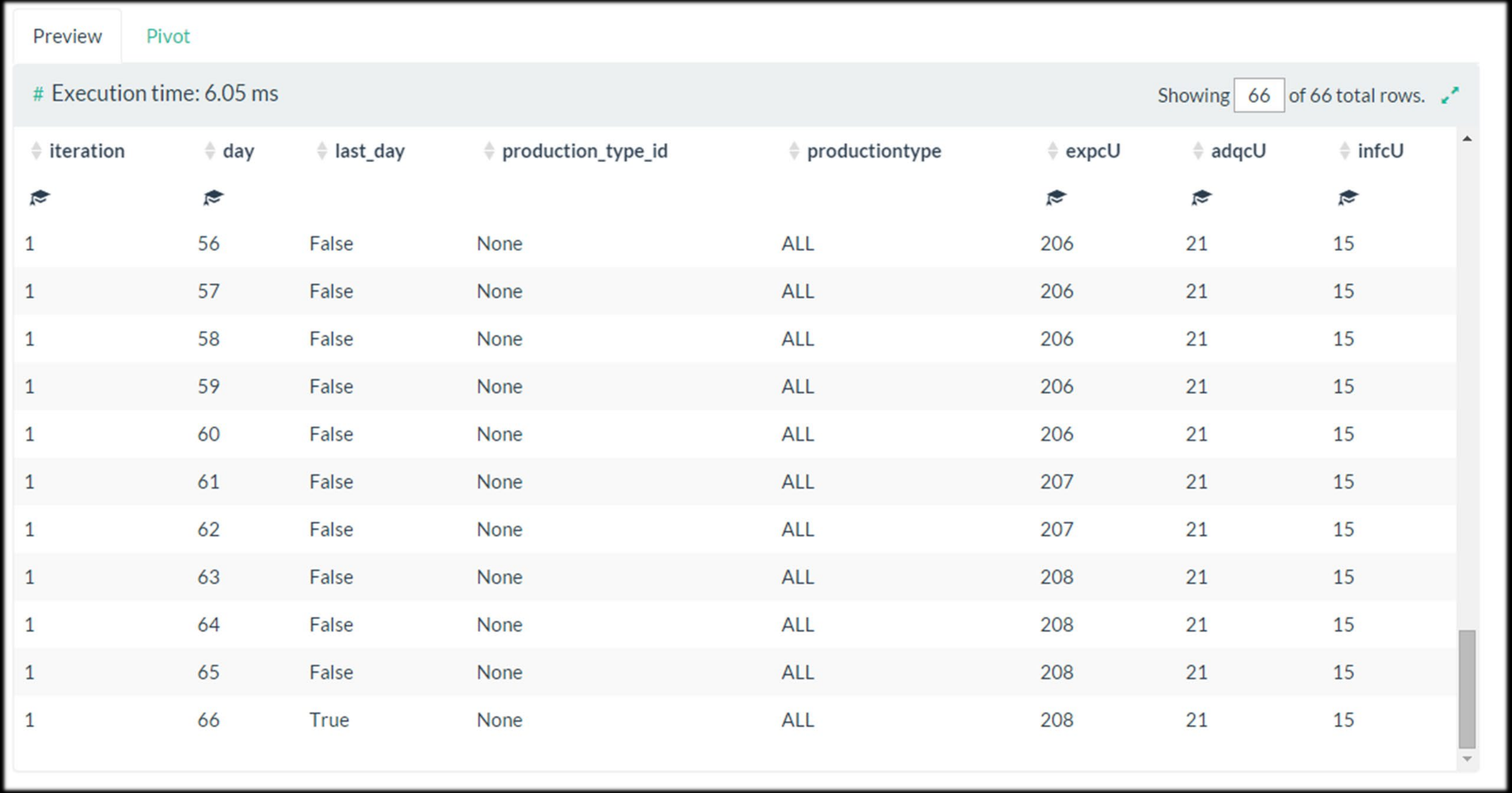
Showing 66 of 66 total rows.

iteration	day	last_day	production_type_id	productiontype	expcU	adqcU	infcU
1	1	False	None	ALL	0	0	0
1	2	False	None	ALL	0	0	0
1	3	False	None	ALL	0	0	0
1	4	False	None	ALL	0	0	0
1	5	False	None	ALL	1	1	1
1	6	False	None	ALL	2	2	2

Raw Data for Exposure, Adequate Exposure, and Infection

In the query window, it is possible to scroll down and see all 66 days that happened in iteration 1.

By the end of iteration 1, there were 208 total exposures, 21 of those were adequate, and 15 of the exposures caused disease.



Execution time: 6.05 ms

Showing 66 of 66 total rows.

iteration	day	last_day	production_type_id	productiontype	expcU	adqcU	infcU
1	56	False	None	ALL	206	21	15
1	57	False	None	ALL	206	21	15
1	58	False	None	ALL	206	21	15
1	59	False	None	ALL	206	21	15
1	60	False	None	ALL	206	21	15
1	61	False	None	ALL	207	21	15
1	62	False	None	ALL	207	21	15
1	63	False	None	ALL	208	21	15
1	64	False	None	ALL	208	21	15
1	65	False	None	ALL	208	21	15
1	66	True	None	ALL	208	21	15

Other Ways to Look at Exposure

The results set seems clear, but we can look at the exposures in other ways to understand more.

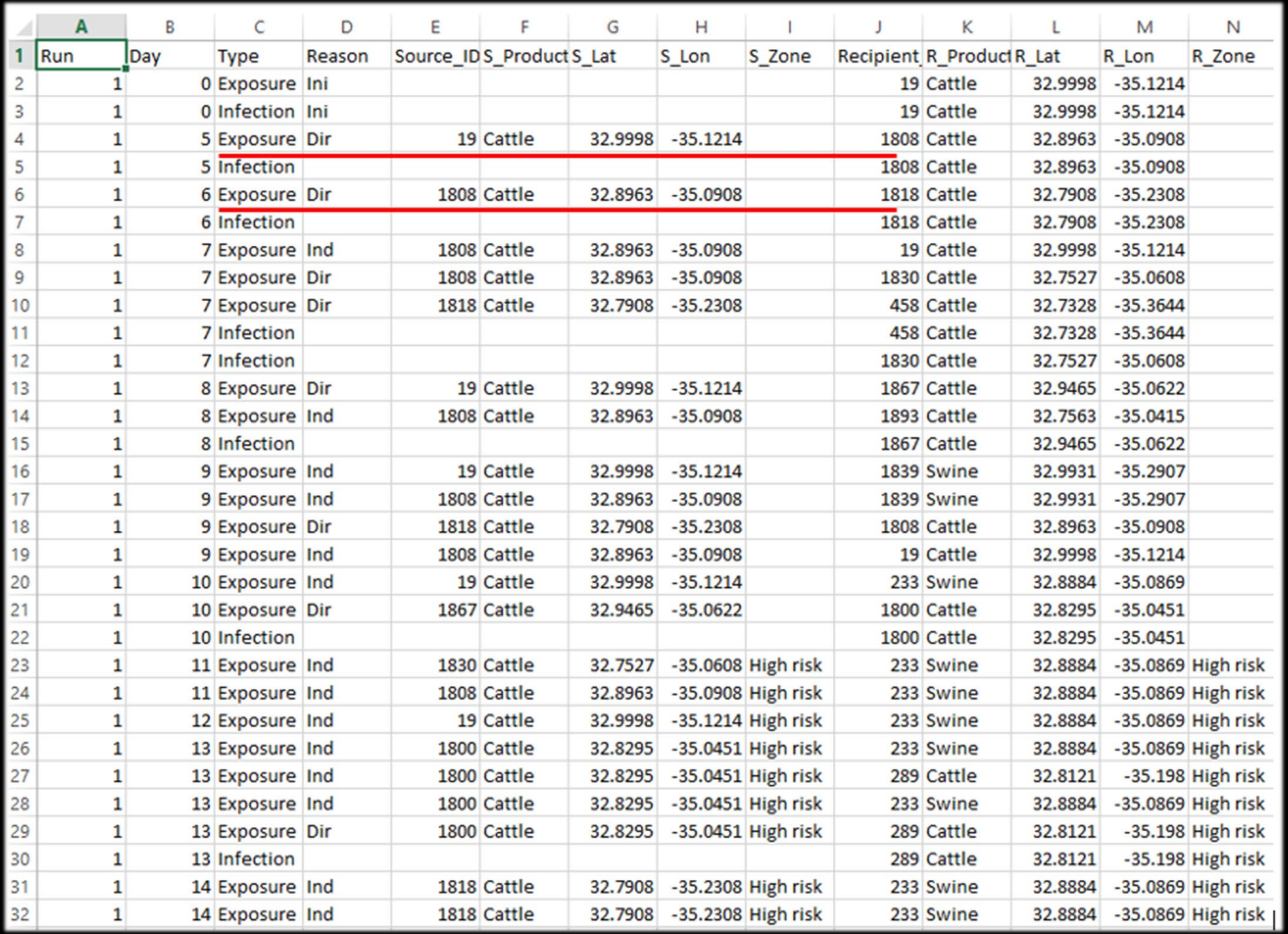
Using the Supplemental Output File Daily Exposures gives more details. This is daily_exposures_1, which matches iteration 1.

The reason code "Ini" on day 0 refers to the initial infection of the index herd, Unit 19, is that this was specified by the user.

On day 5, Unit 19 had direct contact with Unit 1808, causing infection.

On day 6, Unit 1808 had direct contact with Unit 1818, causing infection. The data will continue if exposures and infections happen in the simulation.

This is the network of disease spread.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Run	Day	Type	Reason	Source_ID	S_Product	S_Lat	S_Lon	S_Zone	Recipient	R_Product	R_Lat	R_Lon	R_Zone
2	1	0	Exposure	Ini						19	Cattle	32.9998	-35.1214	
3	1	0	Infection	Ini						19	Cattle	32.9998	-35.1214	
4	1	5	Exposure	Dir	19	Cattle	32.9998	-35.1214		1808	Cattle	32.8963	-35.0908	
5	1	5	Infection							1808	Cattle	32.8963	-35.0908	
6	1	6	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1818	Cattle	32.7908	-35.2308	
7	1	6	Infection							1818	Cattle	32.7908	-35.2308	
8	1	7	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
9	1	7	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1830	Cattle	32.7527	-35.0608	
10	1	7	Exposure	Dir	1818	Cattle	32.7908	-35.2308		458	Cattle	32.7328	-35.3644	
11	1	7	Infection							458	Cattle	32.7328	-35.3644	
12	1	7	Infection							1830	Cattle	32.7527	-35.0608	
13	1	8	Exposure	Dir	19	Cattle	32.9998	-35.1214		1867	Cattle	32.9465	-35.0622	
14	1	8	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1893	Cattle	32.7563	-35.0415	
15	1	8	Infection							1867	Cattle	32.9465	-35.0622	
16	1	9	Exposure	Ind	19	Cattle	32.9998	-35.1214		1839	Swine	32.9931	-35.2907	
17	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1839	Swine	32.9931	-35.2907	
18	1	9	Exposure	Dir	1818	Cattle	32.7908	-35.2308		1808	Cattle	32.8963	-35.0908	
19	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
20	1	10	Exposure	Ind	19	Cattle	32.9998	-35.1214		233	Swine	32.8884	-35.0869	
21	1	10	Exposure	Dir	1867	Cattle	32.9465	-35.0622		1800	Cattle	32.8295	-35.0451	
22	1	10	Infection							1800	Cattle	32.8295	-35.0451	
23	1	11	Exposure	Ind	1830	Cattle	32.7527	-35.0608	High risk	233	Swine	32.8884	-35.0869	High risk
24	1	11	Exposure	Ind	1808	Cattle	32.8963	-35.0908	High risk	233	Swine	32.8884	-35.0869	High risk
25	1	12	Exposure	Ind	19	Cattle	32.9998	-35.1214	High risk	233	Swine	32.8884	-35.0869	High risk
26	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
27	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
28	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
29	1	13	Exposure	Dir	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
30	1	13	Infection							289	Cattle	32.8121	-35.198	High risk
31	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk
32	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk

A clarification on the Daily Exposures file -
Where "infection" is noted, the meaning is actually adequate exposure.

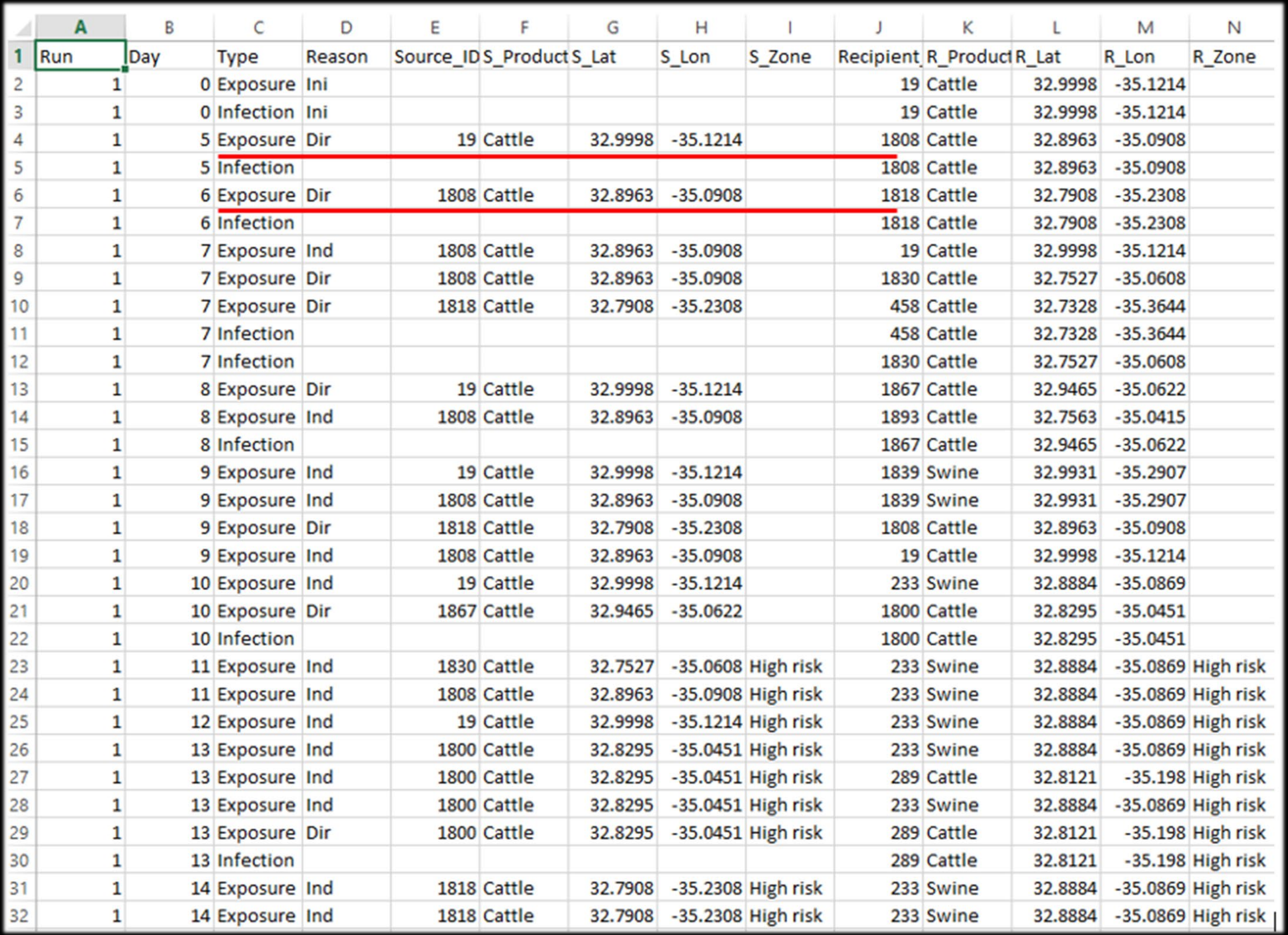
Learning More from Daily_Exposures

Since we have a nice view of this data, there are a few more things to point out.

Day 9 has many exposures and no infections. Why not? Perhaps the exposure was not adequate. Also, Unit 1808 and Unit 1818 are already infected, so those units won’t get infected again.

The exposure count on Day 9 doesn’t match the query (shown on page 44). Why are there more exposures in the query? The Supplemental Output File is not going to show Airborne Spread unless it is adequate to cause disease. *Airborne Spread creates a massive number of exposures and it would make huge output files.* Instead, the next step will be looking at spread by contact method and that will show the details.

Another hint from this file is that zone names do not appear until Day 11. That is a clue that detection didn’t happen until Day 10 to trigger zone formation. There are ways you can double-check detection in other variables.



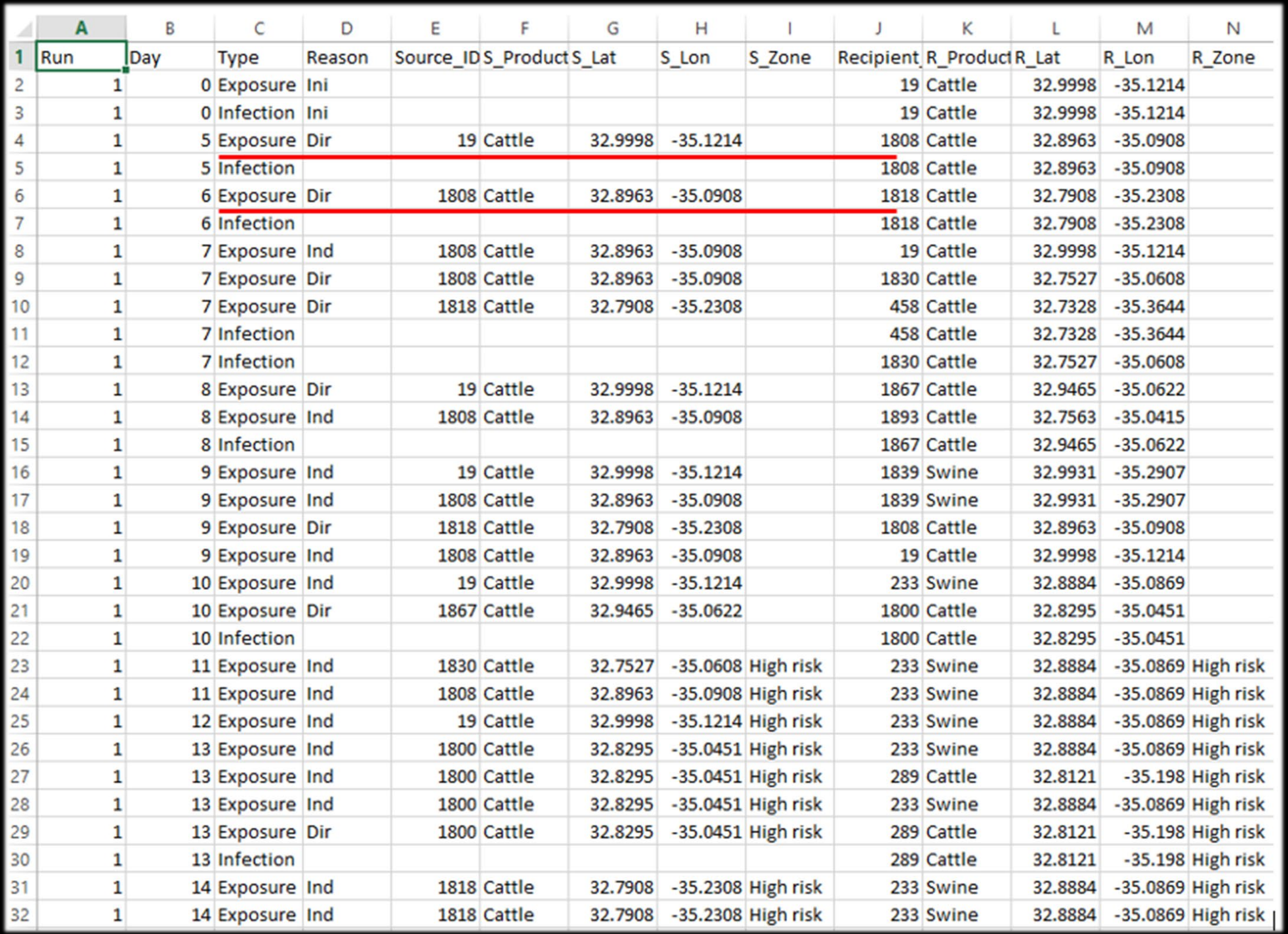
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Run	Day	Type	Reason	Source_ID	S_Product	S_Lat	S_Lon	S_Zone	Recipient	R_Product	R_Lat	R_Lon	R_Zone
2	1	0	Exposure	Ini						19	Cattle	32.9998	-35.1214	
3	1	0	Infection	Ini						19	Cattle	32.9998	-35.1214	
4	1	5	Exposure	Dir	19	Cattle	32.9998	-35.1214		1808	Cattle	32.8963	-35.0908	
5	1	5	Infection							1808	Cattle	32.8963	-35.0908	
6	1	6	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1818	Cattle	32.7908	-35.2308	
7	1	6	Infection							1818	Cattle	32.7908	-35.2308	
8	1	7	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
9	1	7	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1830	Cattle	32.7527	-35.0608	
10	1	7	Exposure	Dir	1818	Cattle	32.7908	-35.2308		458	Cattle	32.7328	-35.3644	
11	1	7	Infection							458	Cattle	32.7328	-35.3644	
12	1	7	Infection							1830	Cattle	32.7527	-35.0608	
13	1	8	Exposure	Dir	19	Cattle	32.9998	-35.1214		1867	Cattle	32.9465	-35.0622	
14	1	8	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1893	Cattle	32.7563	-35.0415	
15	1	8	Infection							1867	Cattle	32.9465	-35.0622	
16	1	9	Exposure	Ind	19	Cattle	32.9998	-35.1214		1839	Swine	32.9931	-35.2907	
17	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1839	Swine	32.9931	-35.2907	
18	1	9	Exposure	Dir	1818	Cattle	32.7908	-35.2308		1808	Cattle	32.8963	-35.0908	
19	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
20	1	10	Exposure	Ind	19	Cattle	32.9998	-35.1214		233	Swine	32.8884	-35.0869	
21	1	10	Exposure	Dir	1867	Cattle	32.9465	-35.0622		1800	Cattle	32.8295	-35.0451	
22	1	10	Infection							1800	Cattle	32.8295	-35.0451	
23	1	11	Exposure	Ind	1830	Cattle	32.7527	-35.0608	High risk	233	Swine	32.8884	-35.0869	High risk
24	1	11	Exposure	Ind	1808	Cattle	32.8963	-35.0908	High risk	233	Swine	32.8884	-35.0869	High risk
25	1	12	Exposure	Ind	19	Cattle	32.9998	-35.1214	High risk	233	Swine	32.8884	-35.0869	High risk
26	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
27	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
28	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
29	1	13	Exposure	Dir	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
30	1	13	Infection							289	Cattle	32.8121	-35.198	High risk
31	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk
32	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk

A Final Note on Daily_Exposures

The Sample Scenario is very simple. In a more complex scenario, there is a possibility for more complex interactions.

It is possible for two different source units to have an exposure with the same destination unit on the same day.

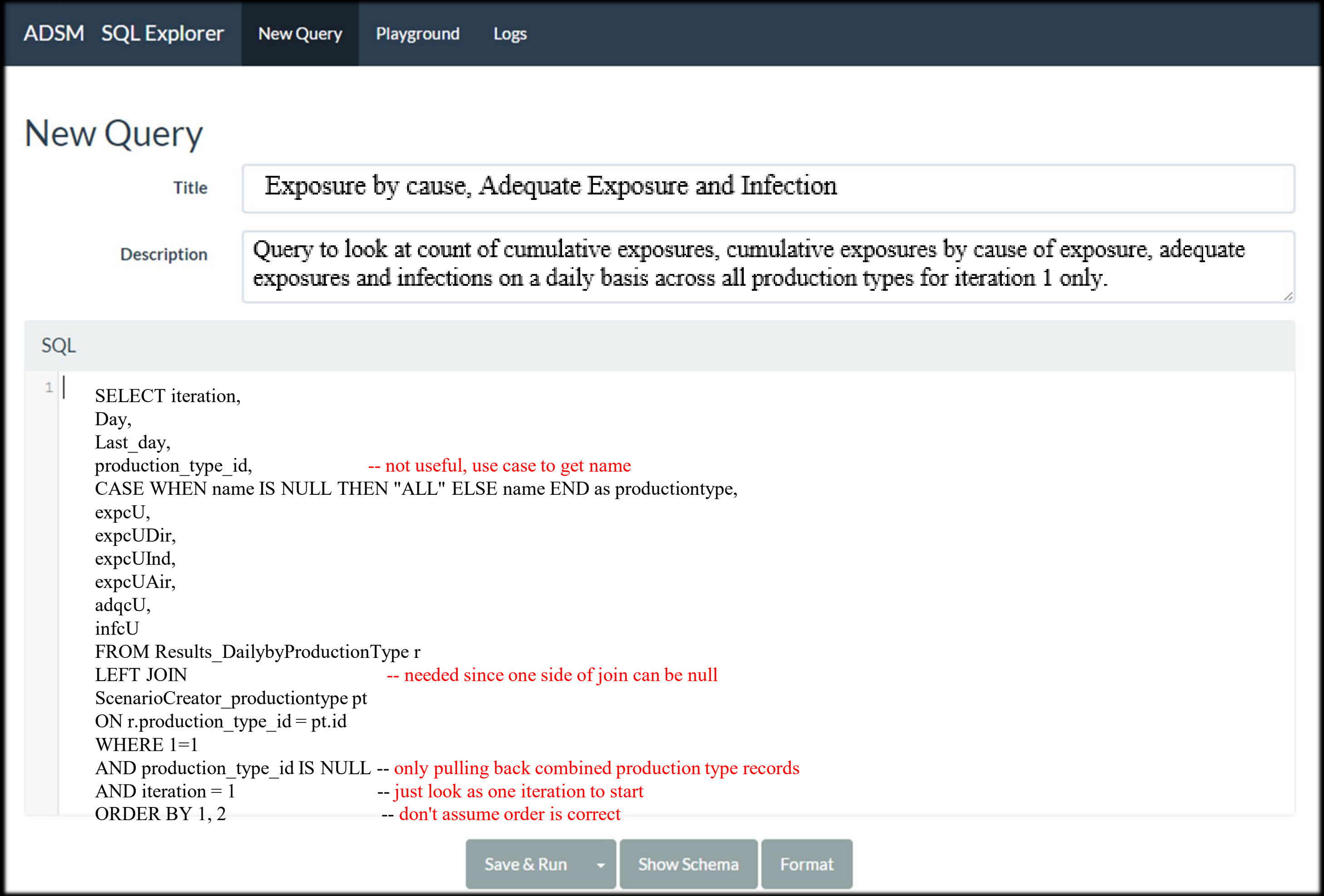
In the simulation engine, a decision will be made to generate an adequate exposure. However, the output would not clarify which source caused the infection. The adequate infection record has null values related to the source unit as a result of this possibility.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Run	Day	Type	Reason	Source_ID	S_Product	S_Lat	S_Lon	S_Zone	Recipient	R_Product	R_Lat	R_Lon	R_Zone
2	1	0	Exposure	Ini						19	Cattle	32.9998	-35.1214	
3	1	0	Infection	Ini						19	Cattle	32.9998	-35.1214	
4	1	5	Exposure	Dir	19	Cattle	32.9998	-35.1214		1808	Cattle	32.8963	-35.0908	
5	1	5	Infection							1808	Cattle	32.8963	-35.0908	
6	1	6	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1818	Cattle	32.7908	-35.2308	
7	1	6	Infection							1818	Cattle	32.7908	-35.2308	
8	1	7	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
9	1	7	Exposure	Dir	1808	Cattle	32.8963	-35.0908		1830	Cattle	32.7527	-35.0608	
10	1	7	Exposure	Dir	1818	Cattle	32.7908	-35.2308		458	Cattle	32.7328	-35.3644	
11	1	7	Infection							458	Cattle	32.7328	-35.3644	
12	1	7	Infection							1830	Cattle	32.7527	-35.0608	
13	1	8	Exposure	Dir	19	Cattle	32.9998	-35.1214		1867	Cattle	32.9465	-35.0622	
14	1	8	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1893	Cattle	32.7563	-35.0415	
15	1	8	Infection							1867	Cattle	32.9465	-35.0622	
16	1	9	Exposure	Ind	19	Cattle	32.9998	-35.1214		1839	Swine	32.9931	-35.2907	
17	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		1839	Swine	32.9931	-35.2907	
18	1	9	Exposure	Dir	1818	Cattle	32.7908	-35.2308		1808	Cattle	32.8963	-35.0908	
19	1	9	Exposure	Ind	1808	Cattle	32.8963	-35.0908		19	Cattle	32.9998	-35.1214	
20	1	10	Exposure	Ind	19	Cattle	32.9998	-35.1214		233	Swine	32.8884	-35.0869	
21	1	10	Exposure	Dir	1867	Cattle	32.9465	-35.0622		1800	Cattle	32.8295	-35.0451	
22	1	10	Infection							1800	Cattle	32.8295	-35.0451	
23	1	11	Exposure	Ind	1830	Cattle	32.7527	-35.0608	High risk	233	Swine	32.8884	-35.0869	High risk
24	1	11	Exposure	Ind	1808	Cattle	32.8963	-35.0908	High risk	233	Swine	32.8884	-35.0869	High risk
25	1	12	Exposure	Ind	19	Cattle	32.9998	-35.1214	High risk	233	Swine	32.8884	-35.0869	High risk
26	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
27	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
28	1	13	Exposure	Ind	1800	Cattle	32.8295	-35.0451	High risk	233	Swine	32.8884	-35.0869	High risk
29	1	13	Exposure	Dir	1800	Cattle	32.8295	-35.0451	High risk	289	Cattle	32.8121	-35.198	High risk
30	1	13	Infection							289	Cattle	32.8121	-35.198	High risk
31	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk
32	1	14	Exposure	Ind	1818	Cattle	32.7908	-35.2308	High risk	233	Swine	32.8884	-35.0869	High risk

Details for Routes of Exposure

Copy and paste this query into your SQL window if you want hands-on experience. Remember to use the Sample Scenario with Outputs, or any scenario that has been run.



New Query

Title: Exposure by cause, Adequate Exposure and Infection

Description: Query to look at count of cumulative exposures, cumulative exposures by cause of exposure, adequate exposures and infections on a daily basis across all production types for iteration 1 only.

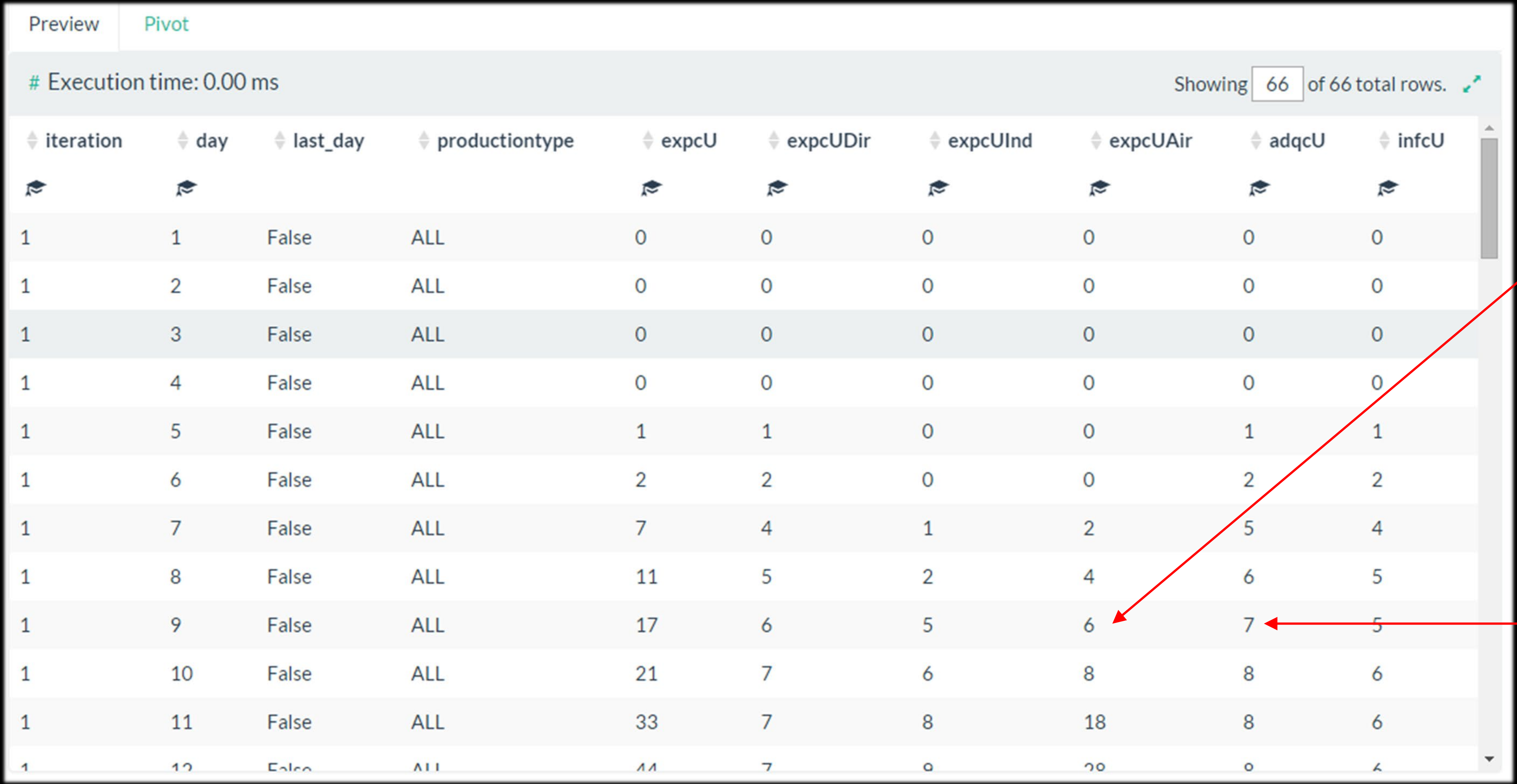
SQL

```
SELECT iteration,
Day,
Last_day,
production_type_id,                    -- not useful, use case to get name
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
expcU,
expcUDir,
expcUInd,
expcUAir,
adqcU,
infcU
FROM Results_DailybyProductionType r
LEFT JOIN                              -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NULL -- only pulling back combined production type records
AND iteration = 1              -- just look as one iteration to start
ORDER BY 1, 2                  -- don't assume order is correct
```

Note that Production_Type_id was dropped out. Having a field with no value doesn't tell us much once we understand why it is blank.

Raw Data for Exposure with Cause, Adequate and Infection Methods of Spread

The results from the previous page query look like this. You can determine which of your contact methods are causing the most spread.



Preview Pivot

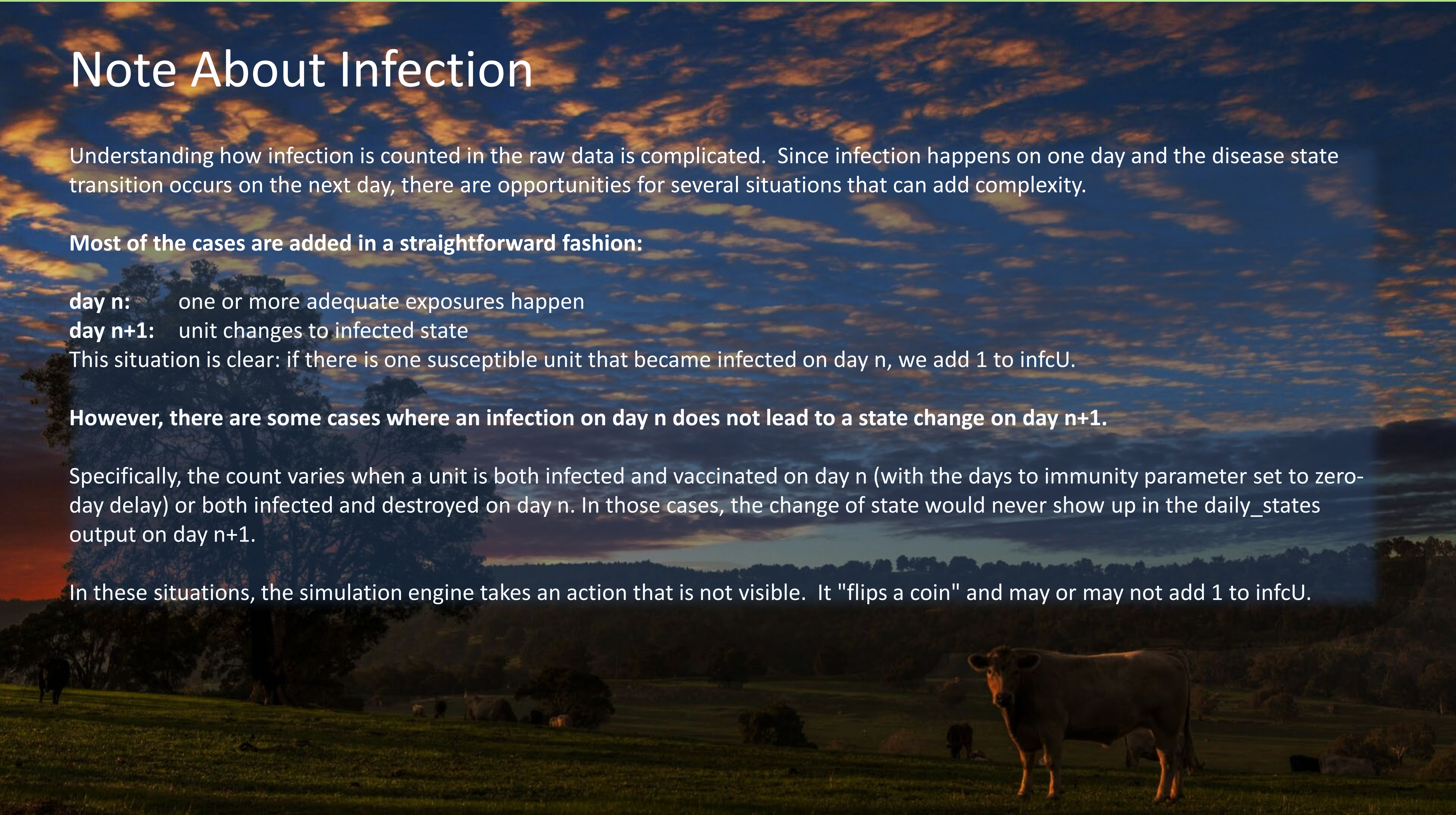
Execution time: 0.00 ms

Showing 66 of 66 total rows.

iteration	day	last_day	productiontype	expcU	expcUDir	expcUInd	expcUAir	adqcU	infcU
1	1	False	ALL	0	0	0	0	0	0
1	2	False	ALL	0	0	0	0	0	0
1	3	False	ALL	0	0	0	0	0	0
1	4	False	ALL	0	0	0	0	0	0
1	5	False	ALL	1	1	0	0	1	1
1	6	False	ALL	2	2	0	0	2	2
1	7	False	ALL	7	4	1	2	5	4
1	8	False	ALL	11	5	2	4	6	5
1	9	False	ALL	17	6	5	6	7	5
1	10	False	ALL	21	7	6	8	8	6
1	11	False	ALL	33	7	8	18	8	6
1	12	False	ALL	44	7	9	28	8	6

Airborne is now included, and the total count is clearer.

Between days 8 and 9, 6 exposures happened, but only one of those exposures was adequate. Also, no more infections happen, so the exposure must have been to the Unit that was already infected.



Note About Infection

Understanding how infection is counted in the raw data is complicated. Since infection happens on one day and the disease state transition occurs on the next day, there are opportunities for several situations that can add complexity.

Most of the cases are added in a straightforward fashion:

day n: one or more adequate exposures happen
day n+1: unit changes to infected state
This situation is clear: if there is one susceptible unit that became infected on day n, we add 1 to infcU.

However, there are some cases where an infection on day n does not lead to a state change on day n+1.

Specifically, the count varies when a unit is both infected and vaccinated on day n (with the days to immunity parameter set to zero-day delay) or both infected and destroyed on day n. In those cases, the change of state would never show up in the daily_states output on day n+1.

In these situations, the simulation engine takes an action that is not visible. It "flips a coin" and may or may not add 1 to infcU.

Wait a minute! Something is missing

When you created parameters, you decided:

- the production types that can be contacted by other production types
- How often the production types contact each other
- The methods by which the production types come into contact

There must be more details, right?

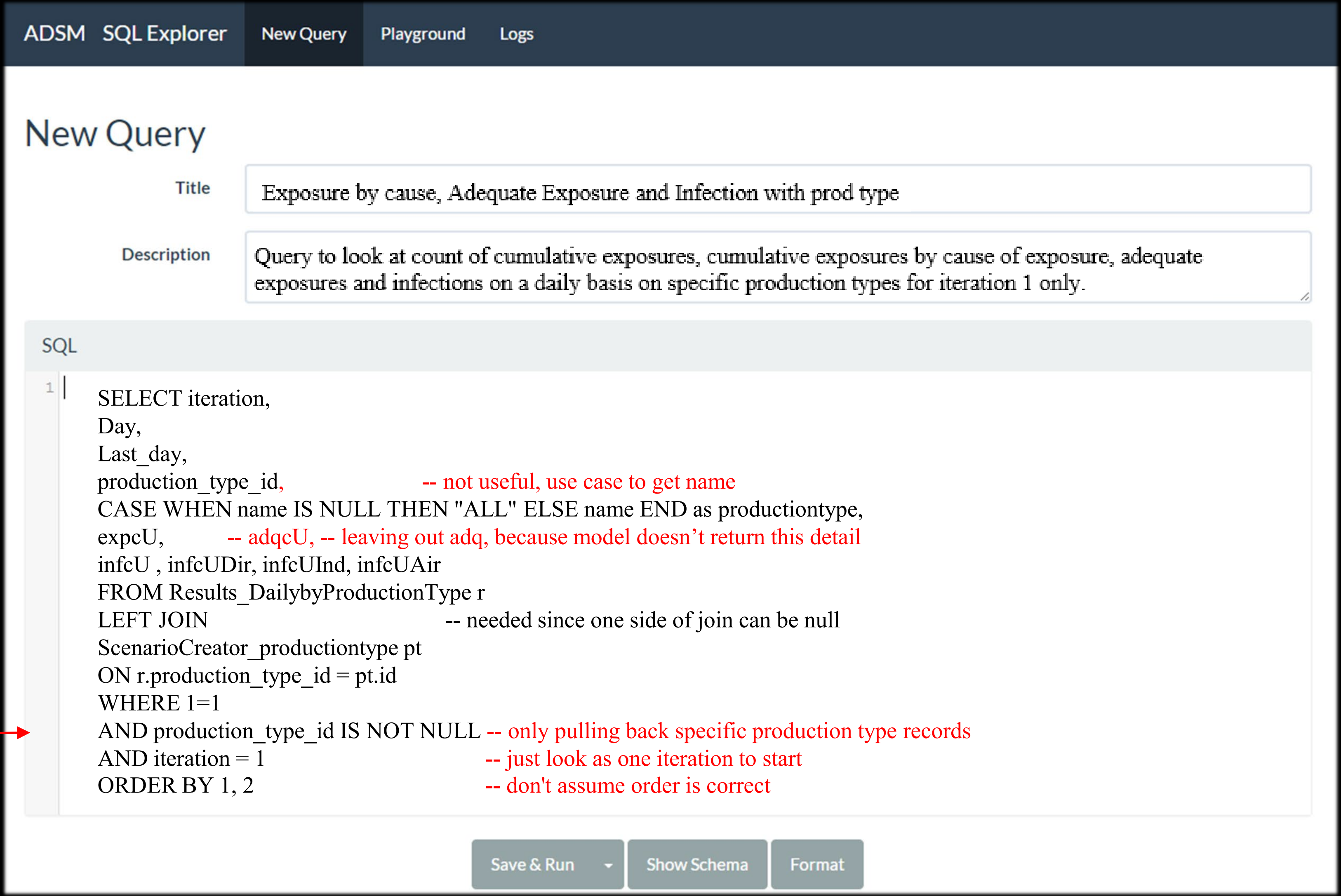
The first three queries were designed to be preliminary steps to review the data, by collapsing the records so that only the combined production type record is showing. The next steps break down the results and show more details about production types.

Danielle Lynn Moonshine Ranch

Query for Exposure, Adequate Exposure, and Infection Methods of Spread by Production Type

Copy and paste this query into your SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.

Earlier, we dropped Production_Type_id, and now we need it back.



New Query

Title: Exposure by cause, Adequate Exposure and Infection with prod type

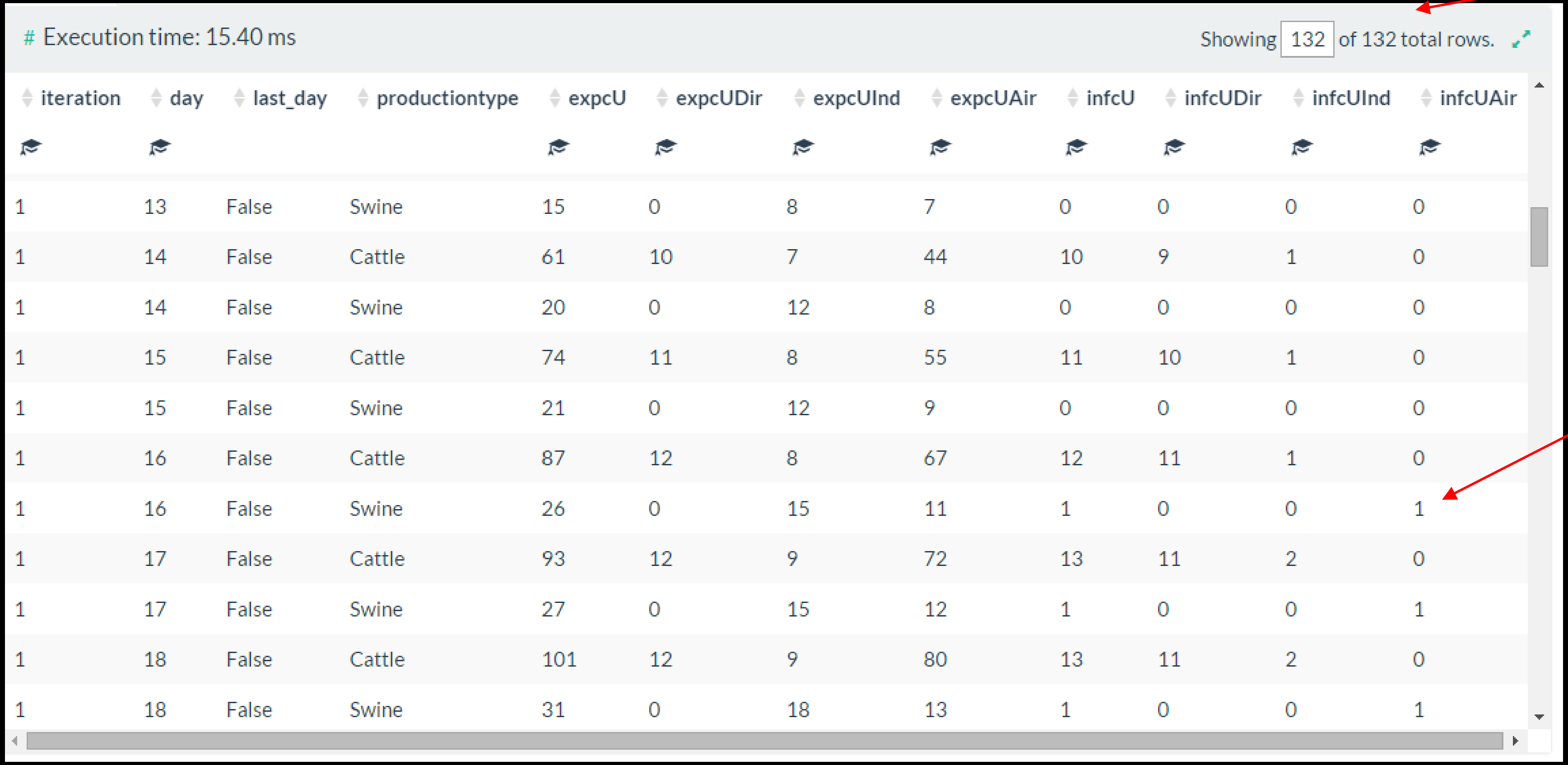
Description: Query to look at count of cumulative exposures, cumulative exposures by cause of exposure, adequate exposures and infections on a daily basis on specific production types for iteration 1 only.

SQL

```
SELECT iteration,
Day,
Last_day,
production_type_id,                    -- not useful, use case to get name
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
expcU,          -- adqcU, -- leaving out adq, because model doesn’t return this detail
infcU , infcUDir, infcUInd, infcUAir
FROM Results_DailybyProductionType r
LEFT JOIN                                   -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NOT NULL -- only pulling back specific production type records
AND iteration = 1                         -- just look as one iteration to start
ORDER BY 1, 2                             -- don't assume order is correct
```

Raw Data for Exposure, Adequate Exposure, and Infection Methods of Spread by Production Type

This is the dataset from the previous page query. You can determine which of your contact methods are causing the most spread, and in which production types that spread is occurring.



Execution time: 15.40 ms

Showing 132 of 132 total rows.

iteration	day	last_day	productiontype	expcU	expcUDir	expcUInd	expcUAir	infcU	infcUDir	infcUInd	infcUAir
1	13	False	Swine	15	0	8	7	0	0	0	0
1	14	False	Cattle	61	10	7	44	10	9	1	0
1	14	False	Swine	20	0	12	8	0	0	0	0
1	15	False	Cattle	74	11	8	55	11	10	1	0
1	15	False	Swine	21	0	12	9	0	0	0	0
1	16	False	Cattle	87	12	8	67	12	11	1	0
1	16	False	Swine	26	0	15	11	1	0	0	1
1	17	False	Cattle	93	12	9	72	13	11	2	0
1	17	False	Swine	27	0	15	12	1	0	0	1
1	18	False	Cattle	101	12	9	80	13	11	2	0
1	18	False	Swine	31	0	18	13	1	0	0	1

Notice the row count doubled, because there are two production types.

Disease spread in this iteration occurs mainly in cattle, until Day 16 when it spreads to swine by airborne exposure.

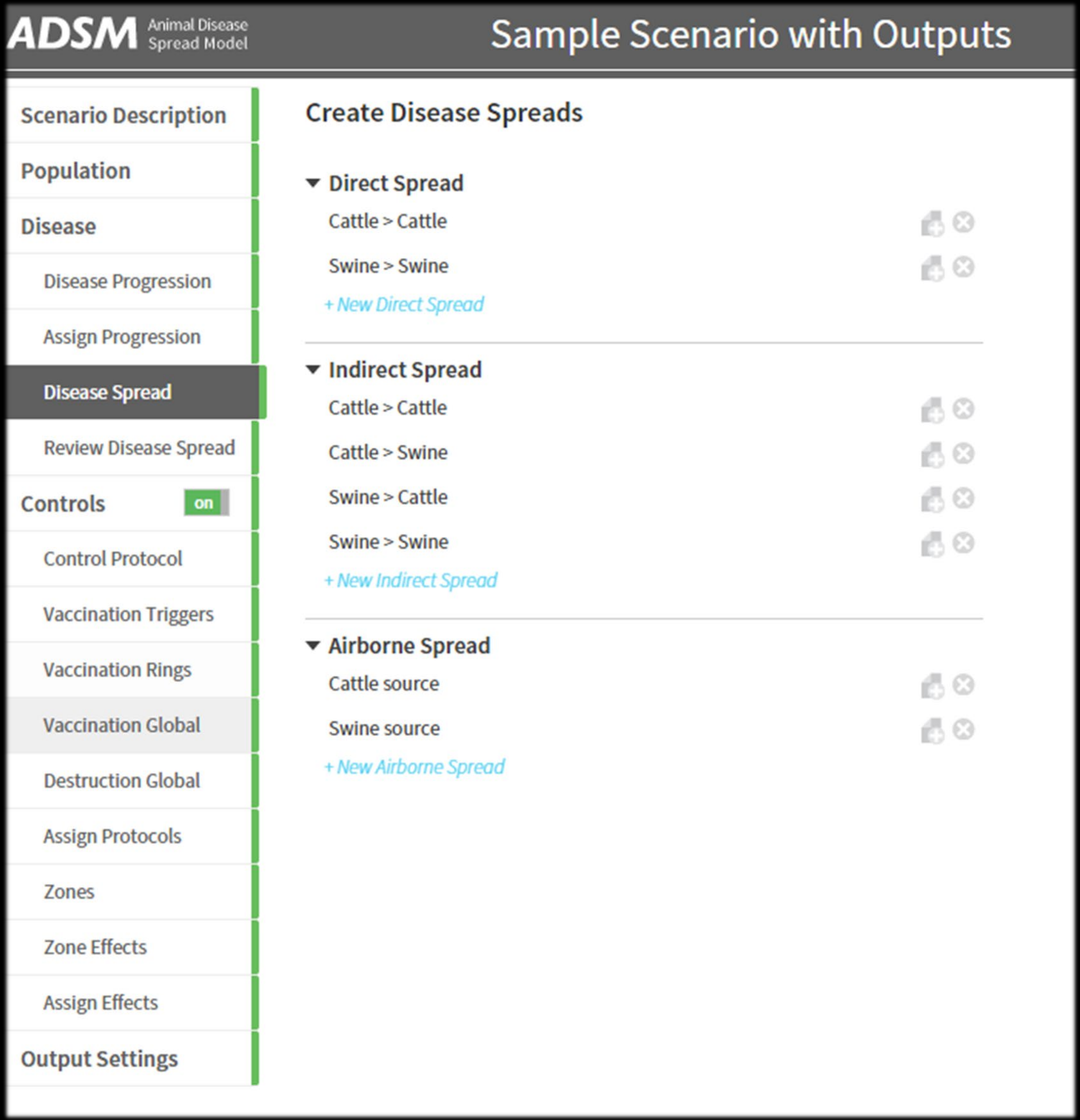
The Parameters Explain the Story

In ADSM, all the parameters are in the individual tabs associated with each type of spread.

It is possible to open each one of these and research every parameter block individually.

There is no reason to open every one of these blocks when we have access to the data behind the application. The correct query will get us an answer with less hassle. The query is a little more complicated. It stacks results from direct spread and indirect spread together.

You've got this. You are a query professional at this point!



ADSM Animal Disease Spread Model

Sample Scenario with Outputs

Create Disease Spreads

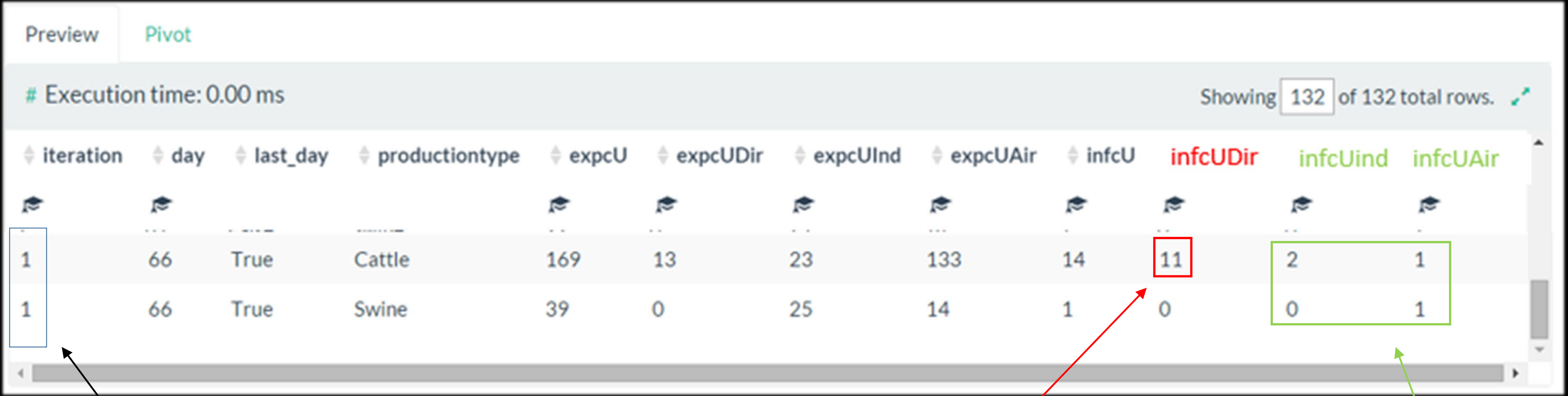
Direct Spread
- Cattle > Cattle
- Swine > Swine
- + New Direct Spread

Indirect Spread
- Cattle > Cattle
- Cattle > Swine
- Swine > Cattle
- Swine > Swine
- + New Indirect Spread

Airborne Spread
- Cattle source
- Swine source
- + New Airborne Spread

Evaluation of Spread

These tools provide a way to look at how spread is occurring, and which production types are being affected. *Do these results make sense based on the Sample Scenario parameter inputs?* We will check parameters next.



Execution time: 0.00 ms

Showing 132 of 132 total rows.

iteration	day	last_day	productiontype	expcU	expcUDir	expcUInd	expcUAir	infcU	infcUDir	infcUind	infcUAir
1	66	True	Cattle	169	13	23	133	14	11	2	1
1	66	True	Swine	39	0	25	14	1	0	0	1

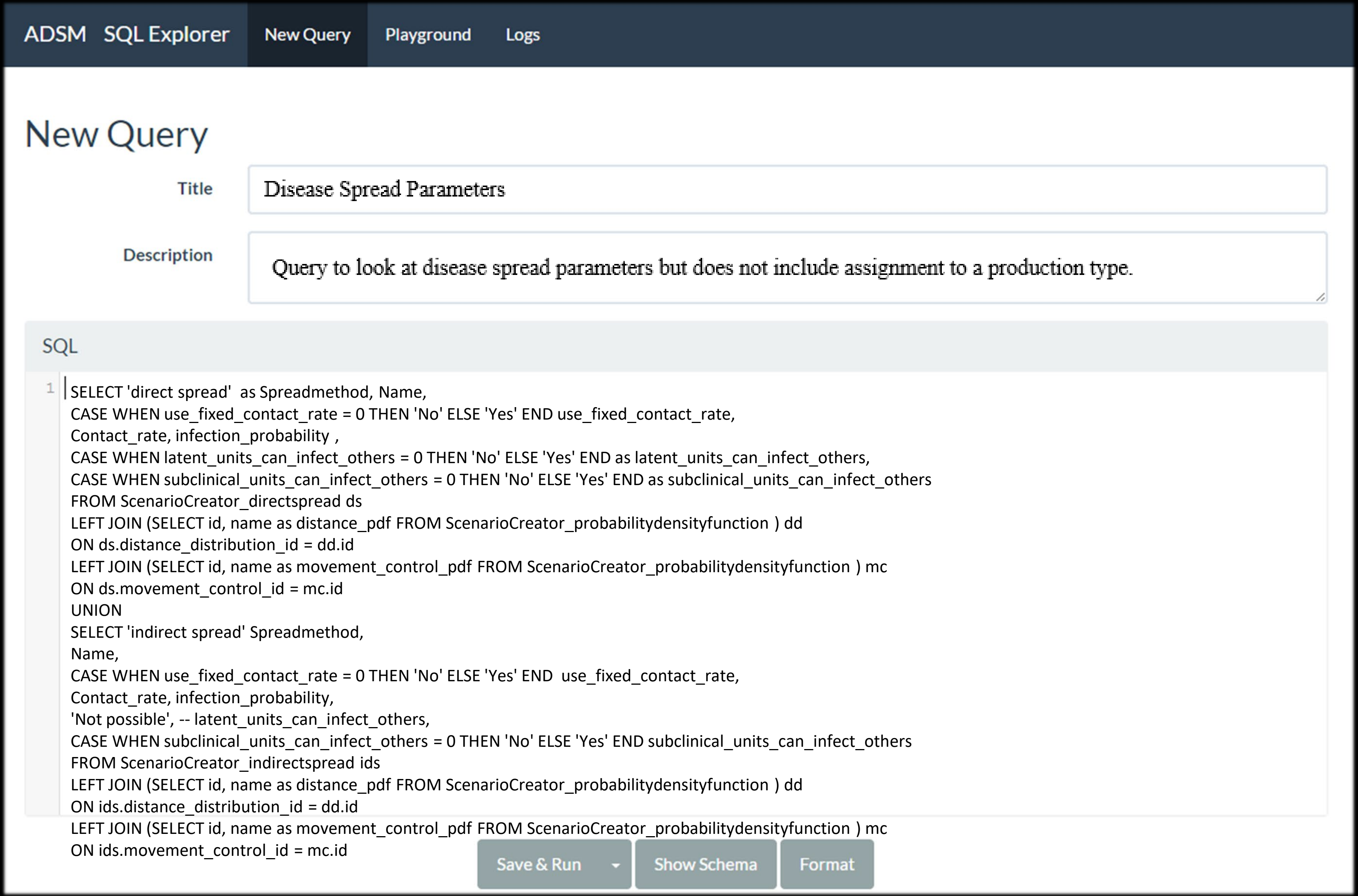
The last day of the outbreak is a good place to evaluate this question

Most of the infection was caused by direct contact from Cattle to Cattle

A small amount was caused by the other methods of contact

Query for Direct and Indirect Disease Spread Parameters

Copy and paste this query into your SQL window if you want hands-on experience. You can use this query on any database, as it is not looking at results.



New Query

Title: Disease Spread Parameters

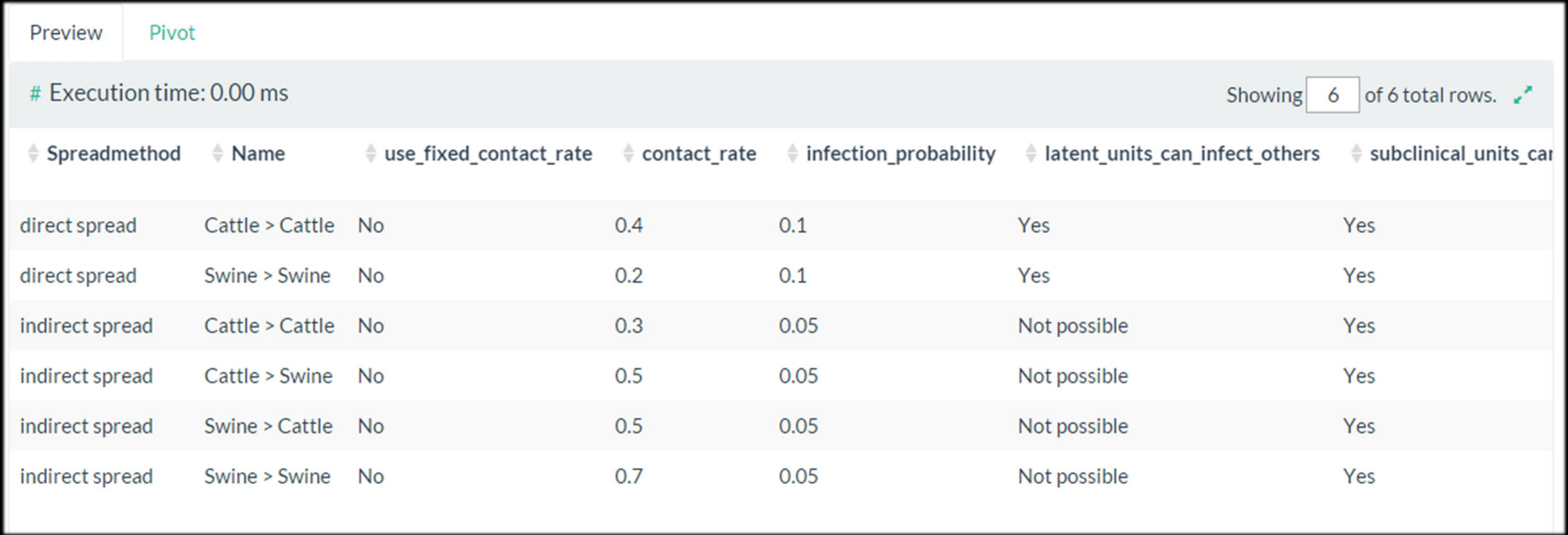
Description: Query to look at disease spread parameters but does not include assignment to a production type.

SQL

```
SELECT 'direct spread'  as Spreadmethod, Name,
CASE WHEN use_fixed_contact_rate = 0 THEN 'No' ELSE 'Yes' END use_fixed_contact_rate,
Contact_rate, infection_probability ,
CASE WHEN latent_units_can_infect_others = 0 THEN 'No' ELSE 'Yes' END as latent_units_can_infect_others,
CASE WHEN subclinical_units_can_infect_others = 0 THEN 'No' ELSE 'Yes' END as subclinical_units_can_infect_others
FROM ScenarioCreator_directspread ds
LEFT JOIN (SELECT id, name as distance_pdf FROM ScenarioCreator_probabilitydensityfunction ) dd
ON ds.distance_distribution_id = dd.id
LEFT JOIN (SELECT id, name as movement_control_pdf FROM ScenarioCreator_probabilitydensityfunction ) mc
ON ds.movement_control_id = mc.id
UNION
SELECT 'indirect spread' Spreadmethod,
Name,
CASE WHEN use_fixed_contact_rate = 0 THEN 'No' ELSE 'Yes' END  use_fixed_contact_rate,
Contact_rate, infection_probability,
'Not possible', -- latent_units_can_infect_others,
CASE WHEN subclinical_units_can_infect_others = 0 THEN 'No' ELSE 'Yes' END subclinical_units_can_infect_others
FROM ScenarioCreator_indirectspread ids
LEFT JOIN (SELECT id, name as distance_pdf FROM ScenarioCreator_probabilitydensityfunction ) dd
ON ids.distance_distribution_id = dd.id
LEFT JOIN (SELECT id, name as movement_control_pdf FROM ScenarioCreator_probabilitydensityfunction ) mc
ON ids.movement_control_id = mc.id
```

Raw Data for Parameters for Direct and Indirect Spread

This is the dataset from the previous page query. You can determine which of your contact methods were parameterized to cause the most spread, and in which production types.



Execution time: 0.00 ms

Showing 6 of 6 total rows.

Spreadmethod	Name	use_fixed_contact_rate	contact_rate	infection_probability	latent_units_can_infect_others	subclinical_units_car
direct spread	Cattle > Cattle	No	0.4	0.1	Yes	Yes
direct spread	Swine > Swine	No	0.2	0.1	Yes	Yes
indirect spread	Cattle > Cattle	No	0.3	0.05	Not possible	Yes
indirect spread	Cattle > Swine	No	0.5	0.05	Not possible	Yes
indirect spread	Swine > Cattle	No	0.5	0.05	Not possible	Yes
indirect spread	Swine > Swine	No	0.7	0.05	Not possible	Yes

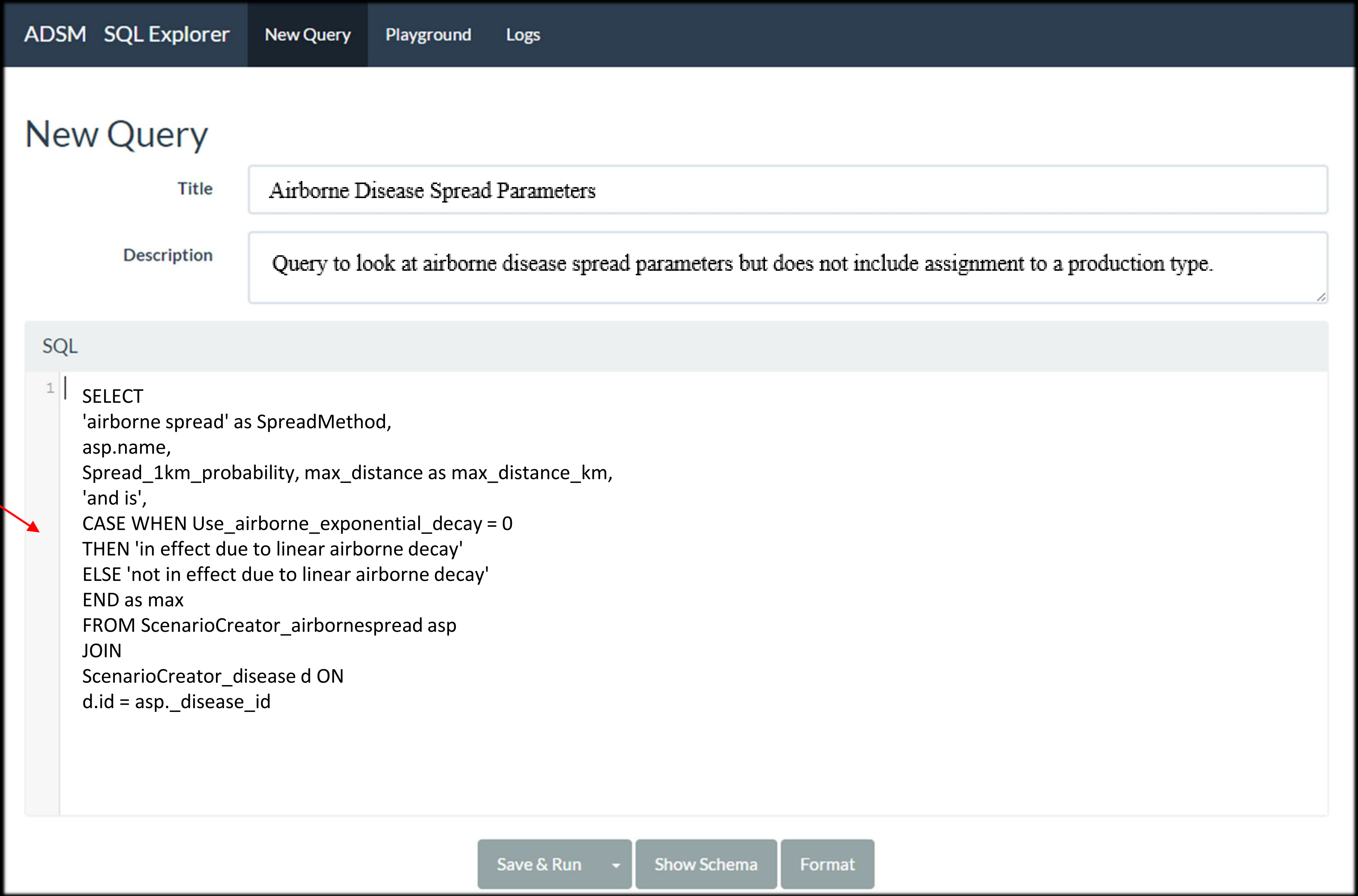
Now that we can see the parameters, it does make sense that Cattle > Cattle Direct Spread caused the most infections; the contact rate multiplied by the infection probability is highest for that route of spread.

Using a meaningful naming convention on the spread methods helps make this example clear. Name is user-defined.

Query for Airborne Disease Spread Parameters

Copy and paste this query into your SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.

Here is where you can note the effect of turning on the airborne exponential decay parameter.



New Query

Title: Airborne Disease Spread Parameters

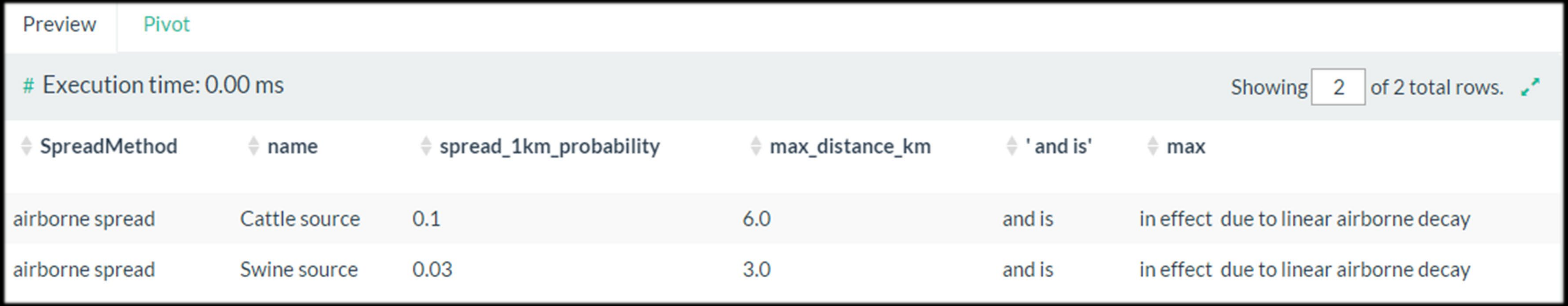
Description: Query to look at airborne disease spread parameters but does not include assignment to a production type.

SQL

```
SELECT
'airborne spread' as SpreadMethod,
asp.name,
Spread_1km_probability, max_distance as max_distance_km,
'and is',
CASE WHEN Use_airborne_exponential_decay = 0
THEN 'in effect due to linear airborne decay'
ELSE 'not in effect due to linear airborne decay'
END as max
FROM ScenarioCreator_airbornespread asp
JOIN
ScenarioCreator_disease d ON
d.id = asp._disease_id
```

Raw Data for Parameters for Airborne Spread

This is the dataset from the previous page query. You can determine how airborne spread was parameterized.



Execution time: 0.00 ms

Showing 2 of 2 total rows.

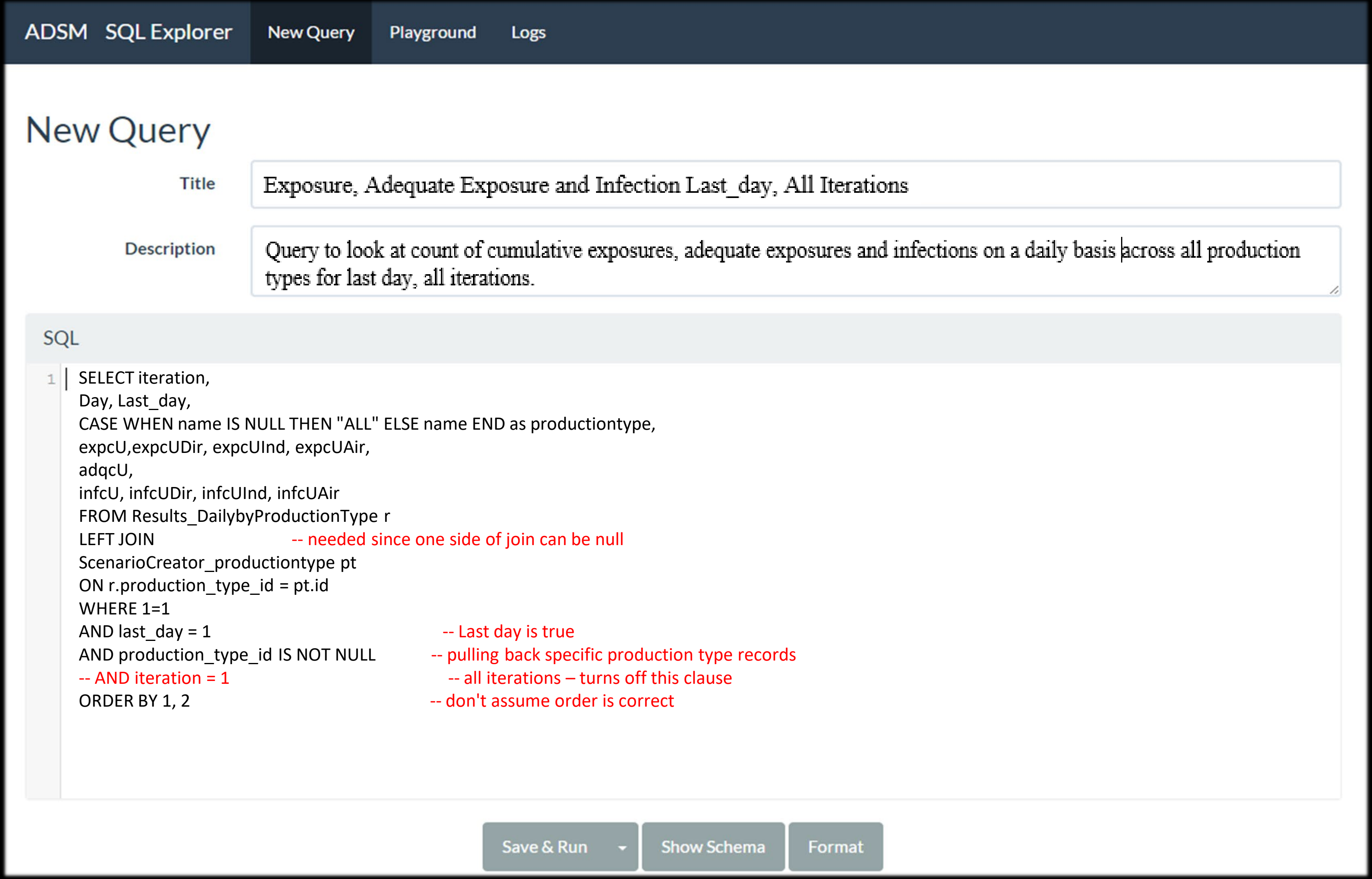
SpreadMethod	name	spread_1km_probability	max_distance_km	' and is'	max
airborne spread	Cattle source	0.1	6.0	and is	in effect due to linear airborne decay
airborne spread	Swine source	0.03	3.0	and is	in effect due to linear airborne decay

From these parameters we would expect that cattle, as compared to swine, are more likely to contribute to airborne spread of disease to any susceptible production type and that 6 km is the maximum distance that airborne spread can occur between an infectious and susceptible premises.

Query for Exposure, Adequate Exposure and Infection Methods of Spread by Production Type for Last Day All Iterations

After walking through the steps for looking at one iteration, let’s expand and look at the last day only but look across all 10 iterations

Copy and paste this query into your SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.



New Query

Title: Exposure, Adequate Exposure and Infection Last_day, All Iterations

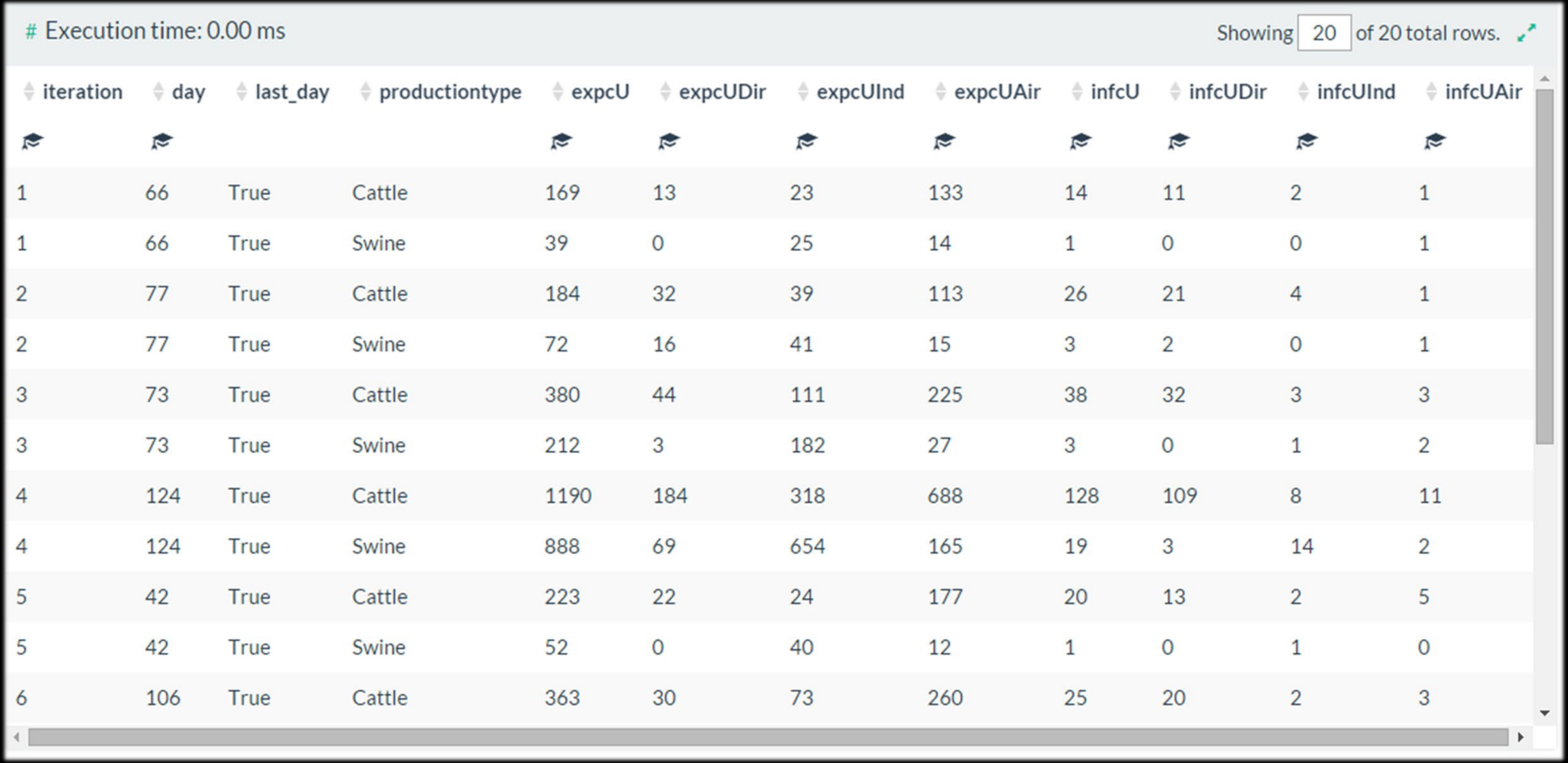
Description: Query to look at count of cumulative exposures, adequate exposures and infections on a daily basis across all production types for last day, all iterations.

SQL

```
SELECT iteration,
Day, Last_day,
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
expcU,expcUDir, expcUInd, expcUAir,
adqcU,
infcU, infcUDir, infcUInd, infcUAir
FROM Results_DailybyProductionType r
LEFT JOIN                    -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND last_day = 1                             -- Last day is true
AND production_type_id IS NOT NULL          -- pulling back specific production type records
-- AND iteration = 1                           -- all iterations – turns off this clause
ORDER BY 1, 2                               -- don't assume order is correct
```

Raw Data for **10** Iterations Airborne

This is the dataset from the previous page query. Note that last_day now = True. There are a range of outcomes, as expected with the stochastic nature of the simulation. Recall here that the query output is looking at the recipients of the contact. *Does the evaluation hold true when looking at more iterations?*

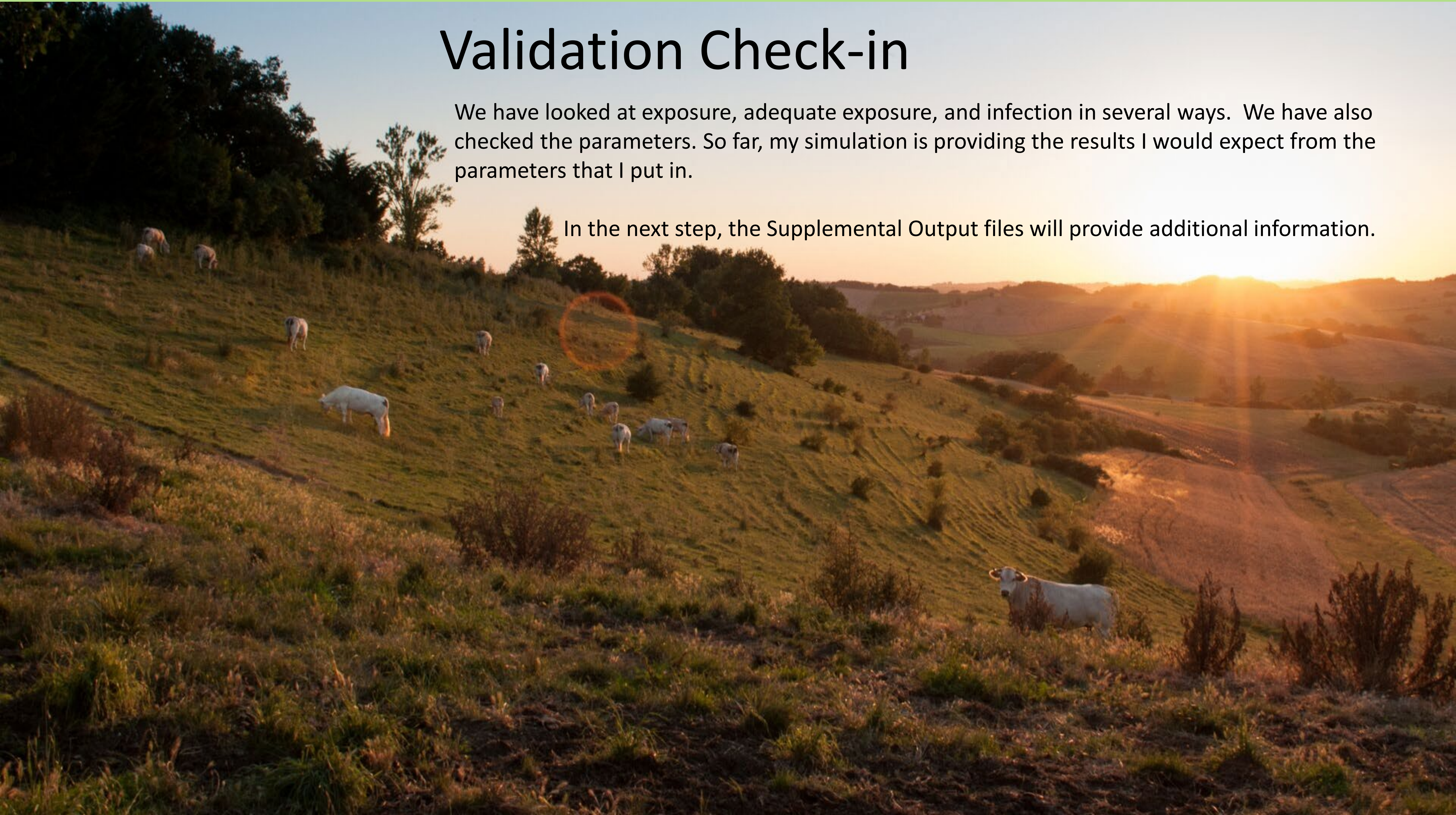


Execution time: 0.00 ms

Showing 20 of 20 total rows.

iteration	day	last_day	productiontype	expcU	expcUDir	expcUInd	expcUAir	infcU	infcUDir	infcUInd	infcUAir
1	66	True	Cattle	169	13	23	133	14	11	2	1
1	66	True	Swine	39	0	25	14	1	0	0	1
2	77	True	Cattle	184	32	39	113	26	21	4	1
2	77	True	Swine	72	16	41	15	3	2	0	1
3	73	True	Cattle	380	44	111	225	38	32	3	3
3	73	True	Swine	212	3	182	27	3	0	1	2
4	124	True	Cattle	1190	184	318	688	128	109	8	11
4	124	True	Swine	888	69	654	165	19	3	14	2
5	42	True	Cattle	223	22	24	177	20	13	2	5
5	42	True	Swine	52	0	40	12	1	0	1	0
6	106	True	Cattle	363	30	73	260	25	20	2	3

This query shows that more cattle units than swine units are exposed and infected by airborne spread. To get an idea of which production types are the source of airborne contacts, see the daily exposures output file.



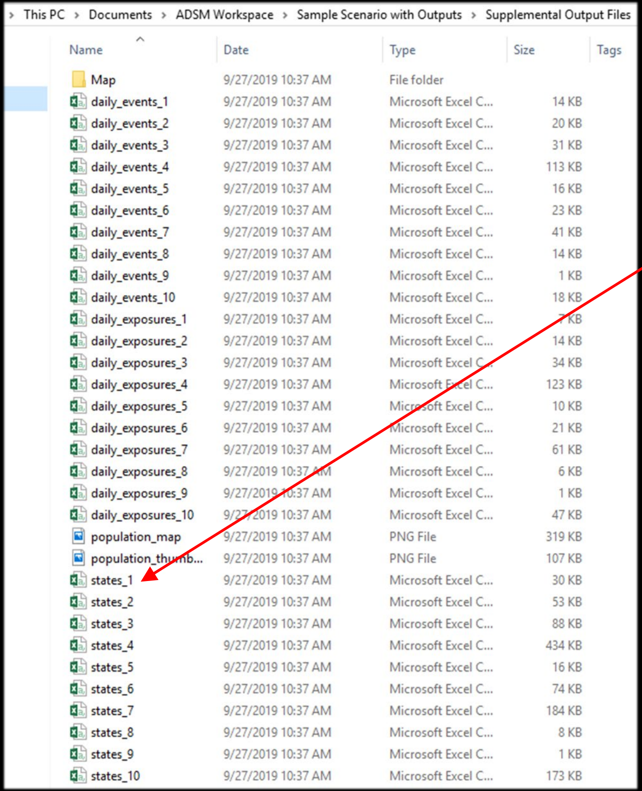
Validation Check-in

We have looked at exposure, adequate exposure, and infection in several ways. We have also checked the parameters. So far, my simulation is providing the results I would expect from the parameters that I put in.

In the next step, the Supplemental Output files will provide additional information.

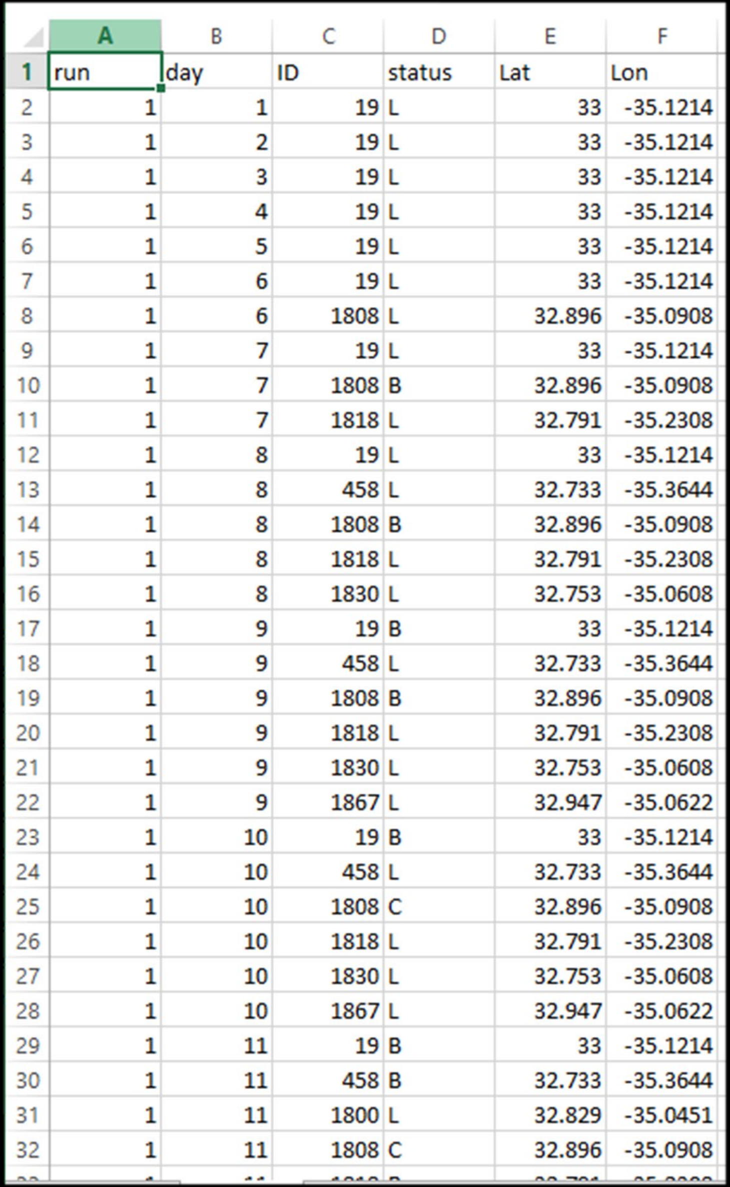
Supplemental Output Files – **Daily States**

Since we have been looking at the routes of infection, let's look at the Supplemental Output File with the daily disease state. In this case, we will look at states_1.csv to stay with the iteration 1 example.



This PC › Documents › ADSM Workspace › Sample Scenario with Outputs › Supplemental Output Files

Name	Date	Type	Size	Tags
Map	9/27/2019 10:37 AM	File folder		
daily_events_1	9/27/2019 10:37 AM	Microsoft Excel C...	14 KB	
daily_events_2	9/27/2019 10:37 AM	Microsoft Excel C...	20 KB	
daily_events_3	9/27/2019 10:37 AM	Microsoft Excel C...	31 KB	
daily_events_4	9/27/2019 10:37 AM	Microsoft Excel C...	113 KB	
daily_events_5	9/27/2019 10:37 AM	Microsoft Excel C...	16 KB	
daily_events_6	9/27/2019 10:37 AM	Microsoft Excel C...	23 KB	
daily_events_7	9/27/2019 10:37 AM	Microsoft Excel C...	41 KB	
daily_events_8	9/27/2019 10:37 AM	Microsoft Excel C...	14 KB	
daily_events_9	9/27/2019 10:37 AM	Microsoft Excel C...	1 KB	
daily_events_10	9/27/2019 10:37 AM	Microsoft Excel C...	18 KB	
daily_exposures_1	9/27/2019 10:37 AM	Microsoft Excel C...	7 KB	
daily_exposures_2	9/27/2019 10:37 AM	Microsoft Excel C...	14 KB	
daily_exposures_3	9/27/2019 10:37 AM	Microsoft Excel C...	34 KB	
daily_exposures_4	9/27/2019 10:37 AM	Microsoft Excel C...	123 KB	
daily_exposures_5	9/27/2019 10:37 AM	Microsoft Excel C...	10 KB	
daily_exposures_6	9/27/2019 10:37 AM	Microsoft Excel C...	21 KB	
daily_exposures_7	9/27/2019 10:37 AM	Microsoft Excel C...	61 KB	
daily_exposures_8	9/27/2019 10:37 AM	Microsoft Excel C...	6 KB	
daily_exposures_9	9/27/2019 10:37 AM	Microsoft Excel C...	1 KB	
daily_exposures_10	9/27/2019 10:37 AM	Microsoft Excel C...	47 KB	
population_map	9/27/2019 10:37 AM	PNG File	319 KB	
population_thumb...	9/27/2019 10:37 AM	PNG File	107 KB	
states_1	9/27/2019 10:37 AM	Microsoft Excel C...	30 KB	
states_2	9/27/2019 10:37 AM	Microsoft Excel C...	53 KB	
states_3	9/27/2019 10:37 AM	Microsoft Excel C...	88 KB	
states_4	9/27/2019 10:37 AM	Microsoft Excel C...	434 KB	
states_5	9/27/2019 10:37 AM	Microsoft Excel C...	16 KB	
states_6	9/27/2019 10:37 AM	Microsoft Excel C...	74 KB	
states_7	9/27/2019 10:37 AM	Microsoft Excel C...	184 KB	
states_8	9/27/2019 10:37 AM	Microsoft Excel C...	8 KB	
states_9	9/27/2019 10:37 AM	Microsoft Excel C...	1 KB	
states_10	9/27/2019 10:37 AM	Microsoft Excel C...	173 KB	



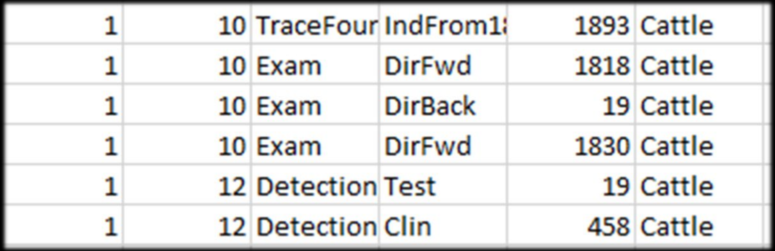
	A	B	C	D	E	F
1	run	day	ID	status	Lat	Lon
2	1	1	19	L	33	-35.1214
3	1	2	19	L	33	-35.1214
4	1	3	19	L	33	-35.1214
5	1	4	19	L	33	-35.1214
6	1	5	19	L	33	-35.1214
7	1	6	19	L	33	-35.1214
8	1	6	1808	L	32.896	-35.0908
9	1	7	19	L	33	-35.1214
10	1	7	1808	B	32.896	-35.0908
11	1	7	1818	L	32.791	-35.2308
12	1	8	19	L	33	-35.1214
13	1	8	458	L	32.733	-35.3644
14	1	8	1808	B	32.896	-35.0908
15	1	8	1818	L	32.791	-35.2308
16	1	8	1830	L	32.753	-35.0608
17	1	9	19	B	33	-35.1214
18	1	9	458	L	32.733	-35.3644
19	1	9	1808	B	32.896	-35.0908
20	1	9	1818	L	32.791	-35.2308
21	1	9	1830	L	32.753	-35.0608
22	1	9	1867	L	32.947	-35.0622
23	1	10	19	B	33	-35.1214
24	1	10	458	L	32.733	-35.3644
25	1	10	1808	C	32.896	-35.0908
26	1	10	1818	L	32.791	-35.2308
27	1	10	1830	L	32.753	-35.0608
28	1	10	1867	L	32.947	-35.0622
29	1	11	19	B	33	-35.1214
30	1	11	458	B	32.733	-35.3644
31	1	11	1800	L	32.829	-35.0451
32	1	11	1808	C	32.896	-35.0908

Supplemental Output Files – **Daily States**

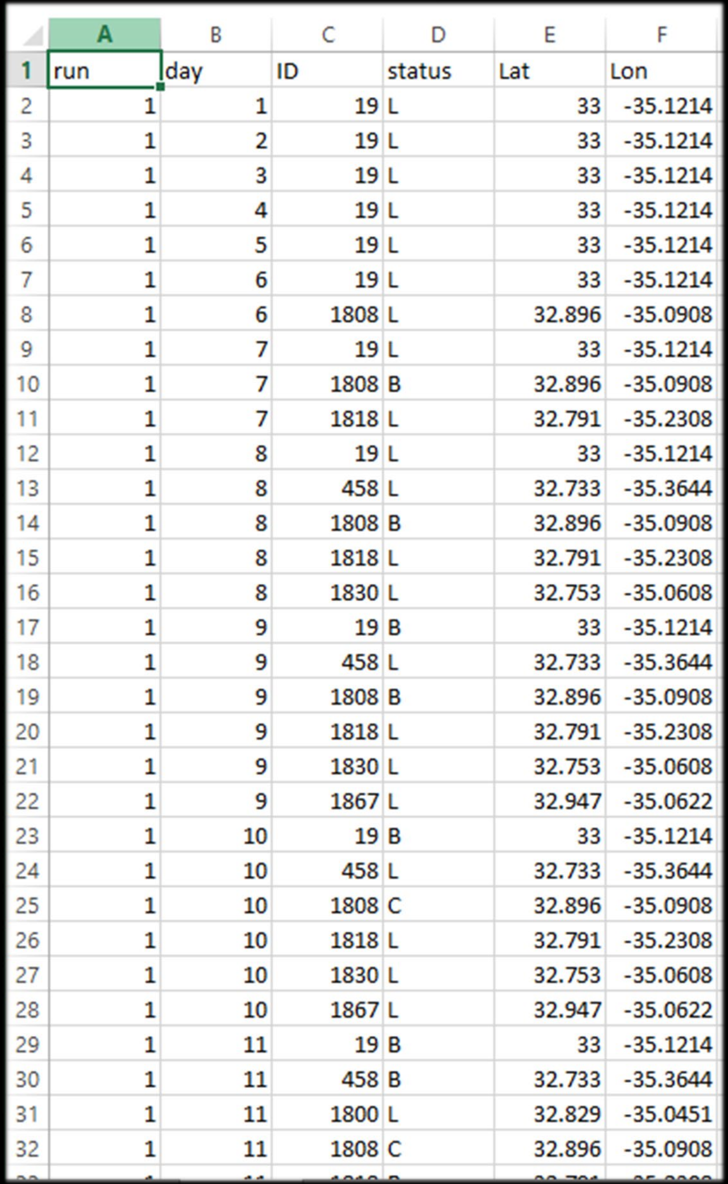
Unit 19 is the index herd. This is a good opportunity for a verification step. This view allows verification of the steps in the disease progression. The first thing I want to know is the production types of my units.

Quick Hint – The production type information is on the Population tab, but instead just open Daily_events_1.csv file, because most of these units trigger events almost immediately.

Image from Daily_Events_1 and all units are cattle.



1	10	TraceFour	IndFrom1	1893	Cattle
1	10	Exam	DirFwd	1818	Cattle
1	10	Exam	DirBack	19	Cattle
1	10	Exam	DirFwd	1830	Cattle
1	12	Detection	Test	19	Cattle
1	12	Detection	Clin	458	Cattle



	A	B	C	D	E	F
1	run	day	ID	status	Lat	Lon
2	1	1	19	L	33	-35.1214
3	1	2	19	L	33	-35.1214
4	1	3	19	L	33	-35.1214
5	1	4	19	L	33	-35.1214
6	1	5	19	L	33	-35.1214
7	1	6	19	L	33	-35.1214
8	1	6	1808	L	32.896	-35.0908
9	1	7	19	L	33	-35.1214
10	1	7	1808	B	32.896	-35.0908
11	1	7	1818	L	32.791	-35.2308
12	1	8	19	L	33	-35.1214
13	1	8	458	L	32.733	-35.3644
14	1	8	1808	B	32.896	-35.0908
15	1	8	1818	L	32.791	-35.2308
16	1	8	1830	L	32.753	-35.0608
17	1	9	19	B	33	-35.1214
18	1	9	458	L	32.733	-35.3644
19	1	9	1808	B	32.896	-35.0908
20	1	9	1818	L	32.791	-35.2308
21	1	9	1830	L	32.753	-35.0608
22	1	9	1867	L	32.947	-35.0622
23	1	10	19	B	33	-35.1214
24	1	10	458	L	32.733	-35.3644
25	1	10	1808	C	32.896	-35.0908
26	1	10	1818	L	32.791	-35.2308
27	1	10	1830	L	32.753	-35.0608
28	1	10	1867	L	32.947	-35.0622
29	1	11	19	B	33	-35.1214
30	1	11	458	B	32.733	-35.3644
31	1	11	1800	L	32.829	-35.0451
32	1	11	1808	C	32.896	-35.0908

Supplemental Output Files – **Daily States**

Unit 19 is L (Latent) 8 days. On the 9th day it changes to B (subclinical).

Unit 1808 is L (Latent) 1 day. On the 2nd day it becomes B (subclinical).

Unit 1818 is L (Latent) 4 days. On the 5th day it becomes B (subclinical).

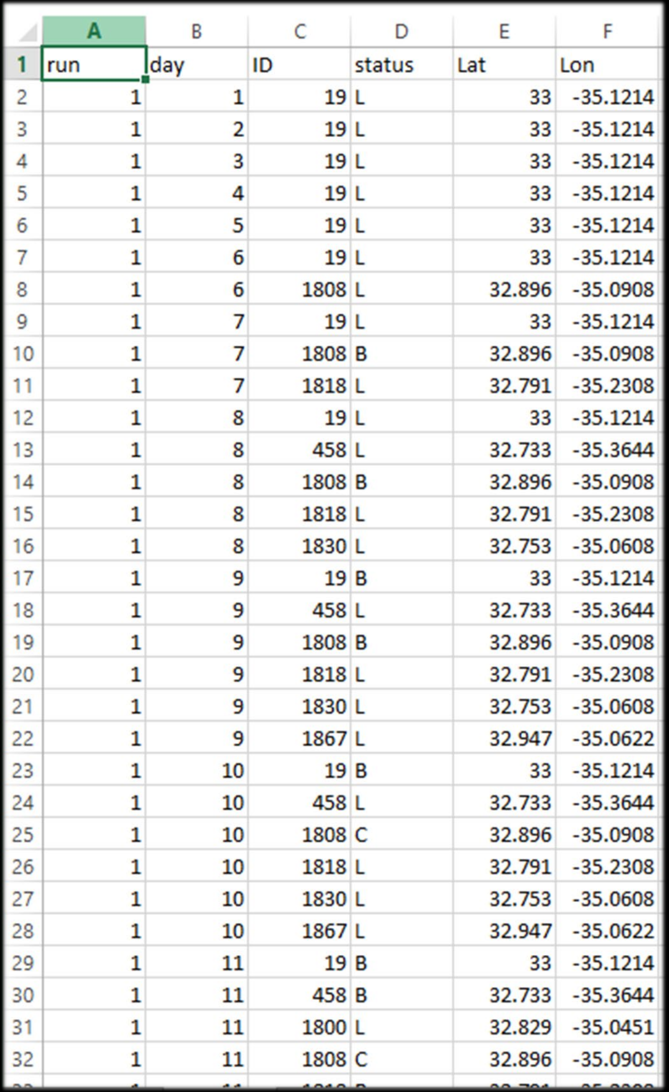
Unit 1830 is L (Latent) 3 days. On the 4th day it becomes B (subclinical).

Unit 458 is L (Latent) 3 days. On the 4th day it becomes B (subclinical).

The probability density function assigned to the latent stage in cattle is named Latent period – cattle and is Triangular, 0, 3, 9.

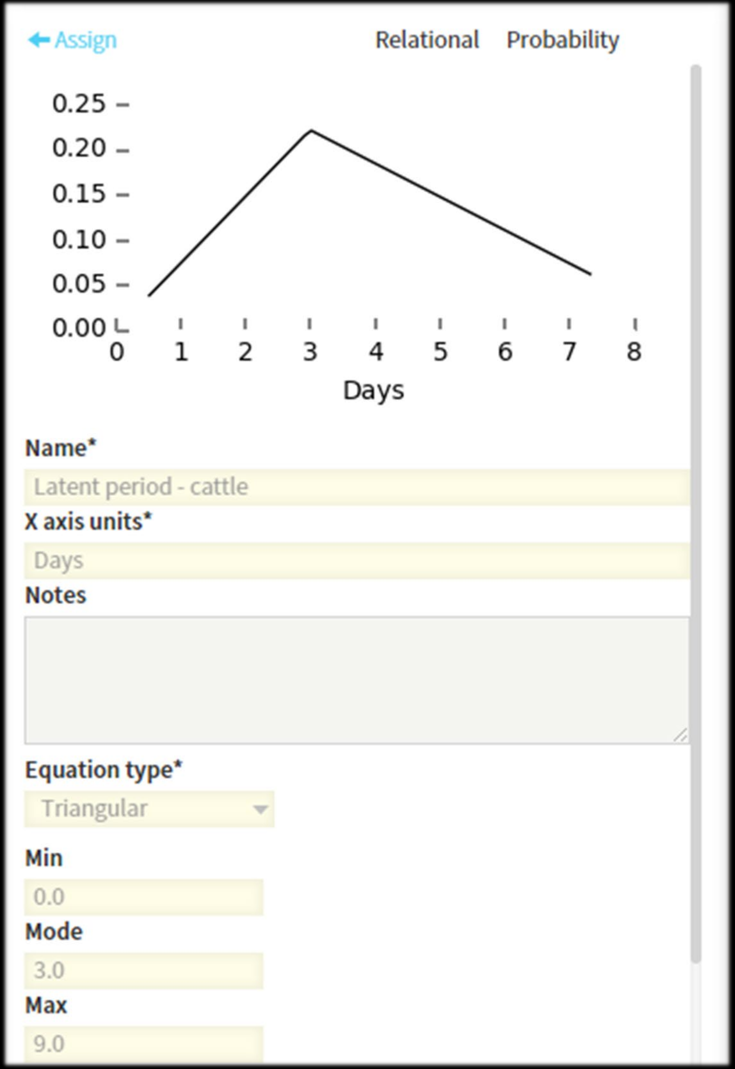
The values for the latent period days in cattle units (8, 1, 4, 3, 3) fall within the expected range of the probability density function (0 – 9 days) with most of the time lasting 3 days. This is a small example of making sure the model is doing what we expect.

states_1 file



	A	B	C	D	E	F
1	run	day	ID	status	Lat	Lon
2	1	1	19	L	33	-35.1214
3	1	2	19	L	33	-35.1214
4	1	3	19	L	33	-35.1214
5	1	4	19	L	33	-35.1214
6	1	5	19	L	33	-35.1214
7	1	6	19	L	33	-35.1214
8	1	6	1808	L	32.896	-35.0908
9	1	7	19	L	33	-35.1214
10	1	7	1808	B	32.896	-35.0908
11	1	7	1818	L	32.791	-35.2308
12	1	8	19	L	33	-35.1214
13	1	8	458	L	32.733	-35.3644
14	1	8	1808	B	32.896	-35.0908
15	1	8	1818	L	32.791	-35.2308
16	1	8	1830	L	32.753	-35.0608
17	1	9	19	B	33	-35.1214
18	1	9	458	L	32.733	-35.3644
19	1	9	1808	B	32.896	-35.0908
20	1	9	1818	L	32.791	-35.2308
21	1	9	1830	L	32.753	-35.0608
22	1	9	1867	L	32.947	-35.0622
23	1	10	19	B	33	-35.1214
24	1	10	458	L	32.733	-35.3644
25	1	10	1808	C	32.896	-35.0908
26	1	10	1818	L	32.791	-35.2308
27	1	10	1830	L	32.753	-35.0608
28	1	10	1867	L	32.947	-35.0622
29	1	11	19	B	33	-35.1214
30	1	11	458	B	32.733	-35.3644
31	1	11	1800	L	32.829	-35.0451
32	1	11	1808	C	32.896	-35.0908

probability density function



Name*
Latent period - cattle

X axis units*
Days

Notes

Equation type*
Triangular

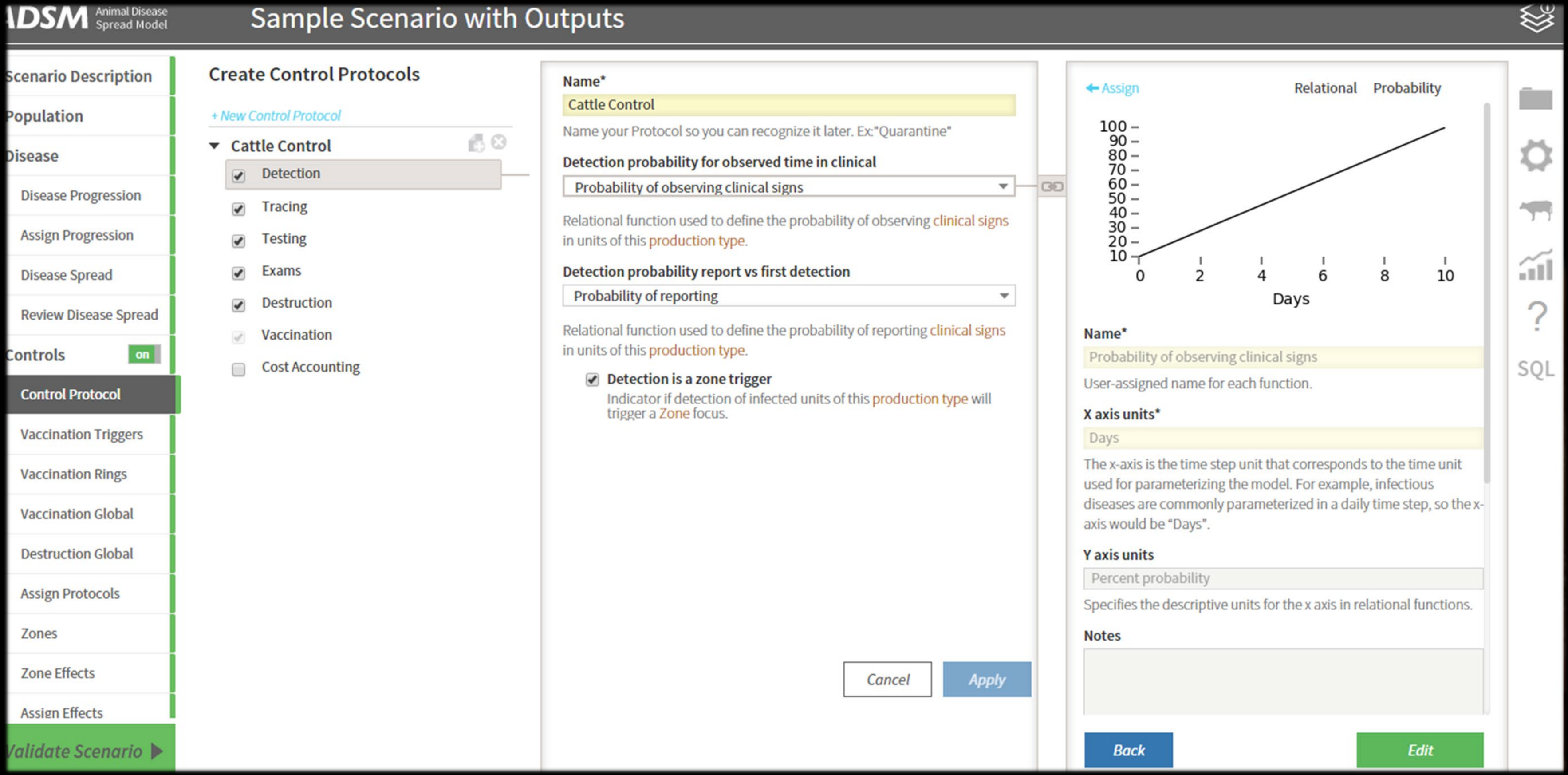
Min
0.0

Mode
3.0

Max
9.0

Controls

Now that we have a better understanding of how disease is spreading, let's look at how the control measures are behaving.



Create Control Protocols

+ New Control Protocol

Cattle Control

☑ Detection
☑ Tracing
☑ Testing
☑ Exams
☑ Destruction
☑ Vaccination
☐ Cost Accounting

Name*
Cattle Control
Name your Protocol so you can recognize it later. Ex:"Quarantine"

Detection probability for observed time in clinical
Probability of observing clinical signs
Relational function used to define the probability of observing clinical signs in units of this production type.

Detection probability report vs first detection
Probability of reporting
Relational function used to define the probability of reporting clinical signs in units of this production type.

☑ Detection is a zone trigger
Indicator if detection of infected units of this production type will trigger a Zone focus.

Cancel Apply

Name*
Probability of observing clinical signs
User-assigned name for each function.

X axis units*
Days
The x-axis is the time step unit that corresponds to the time unit used for parameterizing the model. For example, infectious diseases are commonly parameterized in a daily time step, so the x-axis would be "Days".

Y axis units
Percent probability
Specifies the descriptive units for the x axis in relational functions.

Notes

Back Edit

Just a reminder: If destruction is checked in main Control Protocol, then destruction will happen for detected units. The additional settings in destruction put in additional units, either because of a trace or because of pre-emptive destruction in a ring. Note that Control Protocols are assigned to one or more production types.

Assessing Detection

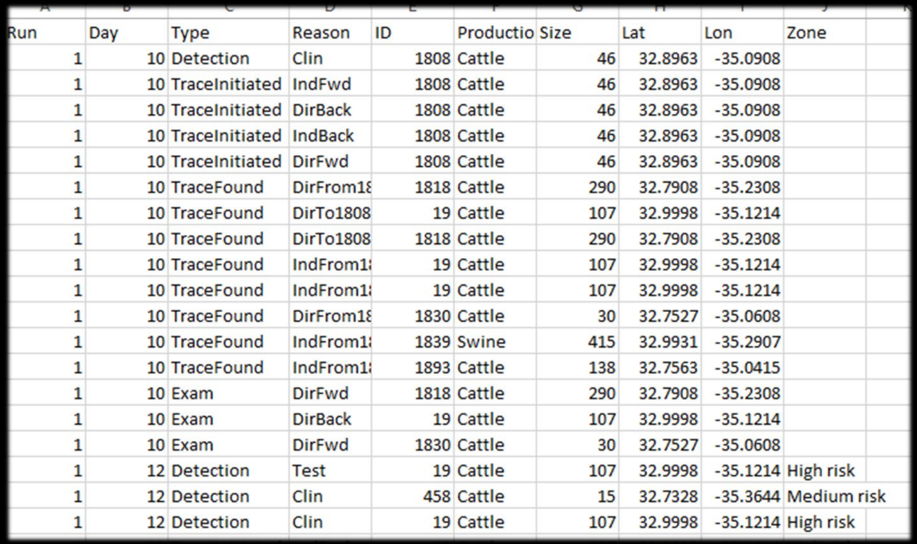
There are several ways we can explore detection.

At a high level, using the Results_DailyControls table, it is possible to simply determine with a y/n flag the day detection occurred with the field detOccurred.

```
SELECT iteration,
Day, DetOccurred
FROM Results_DailyControls
WHERE 1=1
AND last_day = 1
ORDER BY 1, 2
```

At a daily level, using the Results_DailybyProductionType table, there are multiple fields reporting on detection.

At the herd and daily level, using the Supplemental Output File Daily_events, you can see a detailed list of detection events.

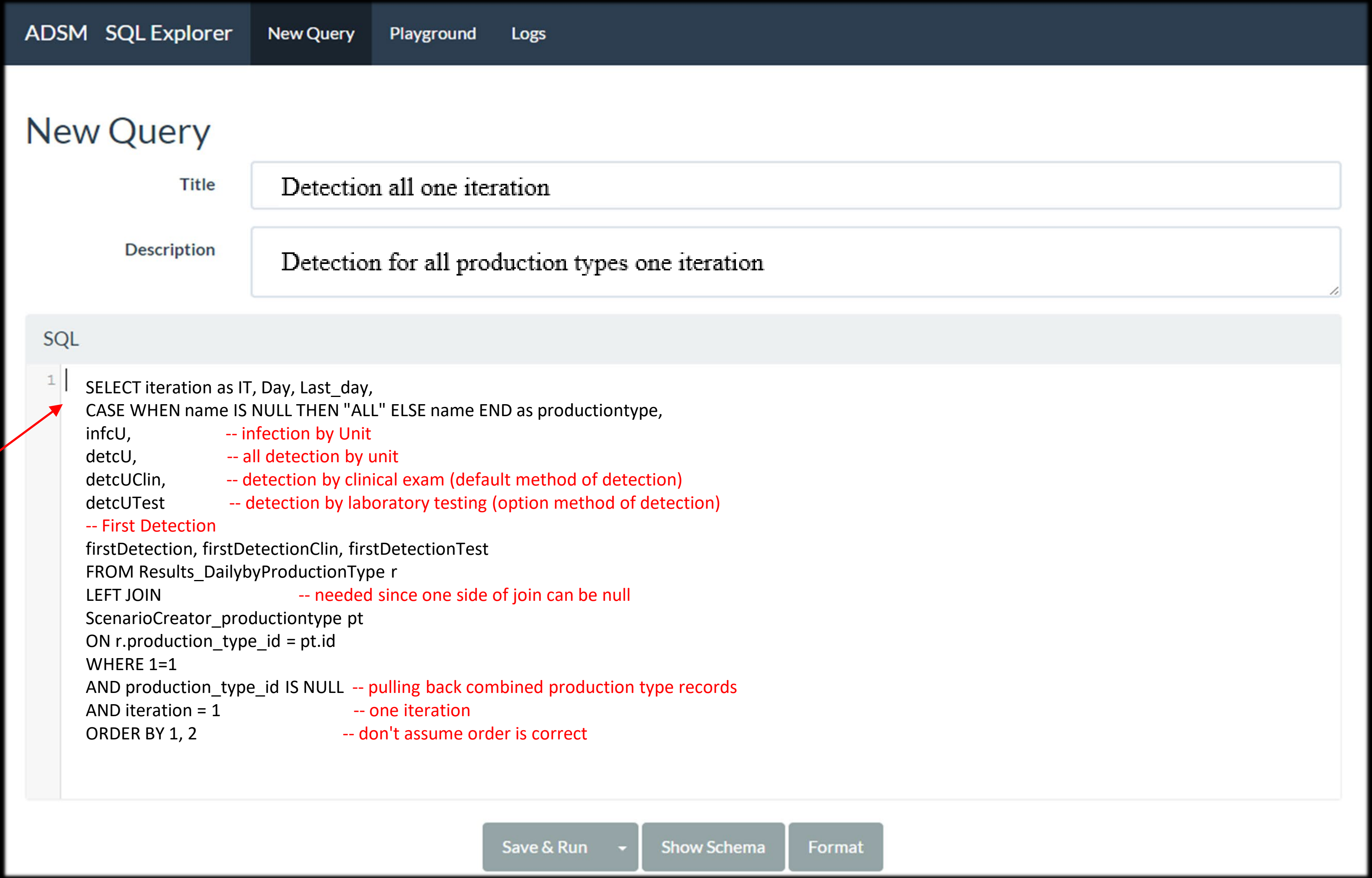


Run	Day	Type	Reason	ID	Productio	Size	Lat	Lon	Zone
1	10	Detection	Clin	1808	Cattle	46	32.8963	-35.0908	
1	10	TraceInitiated	IndFwd	1808	Cattle	46	32.8963	-35.0908	
1	10	TraceInitiated	DirBack	1808	Cattle	46	32.8963	-35.0908	
1	10	TraceInitiated	IndBack	1808	Cattle	46	32.8963	-35.0908	
1	10	TraceInitiated	DirFwd	1808	Cattle	46	32.8963	-35.0908	
1	10	TraceFound	DirFrom18	1818	Cattle	290	32.7908	-35.2308	
1	10	TraceFound	DirTo1808	19	Cattle	107	32.9998	-35.1214	
1	10	TraceFound	DirTo1808	1818	Cattle	290	32.7908	-35.2308	
1	10	TraceFound	IndFrom1	19	Cattle	107	32.9998	-35.1214	
1	10	TraceFound	IndFrom1	19	Cattle	107	32.9998	-35.1214	
1	10	TraceFound	DirFrom18	1830	Cattle	30	32.7527	-35.0608	
1	10	TraceFound	IndFrom1	1839	Swine	415	32.9931	-35.2907	
1	10	TraceFound	IndFrom1	1893	Cattle	138	32.7563	-35.0415	
1	10	Exam	DirFwd	1818	Cattle	290	32.7908	-35.2308	
1	10	Exam	DirBack	19	Cattle	107	32.9998	-35.1214	
1	10	Exam	DirFwd	1830	Cattle	30	32.7527	-35.0608	
1	12	Detection	Test	19	Cattle	107	32.9998	-35.1214	High risk
1	12	Detection	Clin	458	Cattle	15	32.7328	-35.3644	Medium risk
1	12	Detection	Clin	19	Cattle	107	32.9998	-35.1214	High risk

Query for Detection

Copy and paste this query into the SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.

There's another thing we did in the SQL code. Using the keyword *as,* the field named Iteration was renamed to IT. This is called an a*lias.* You can alias field names and table names. We automatically did it on table names to reduce the amount of code needed in the ON statement.



New Query

Title: Detection all one iteration

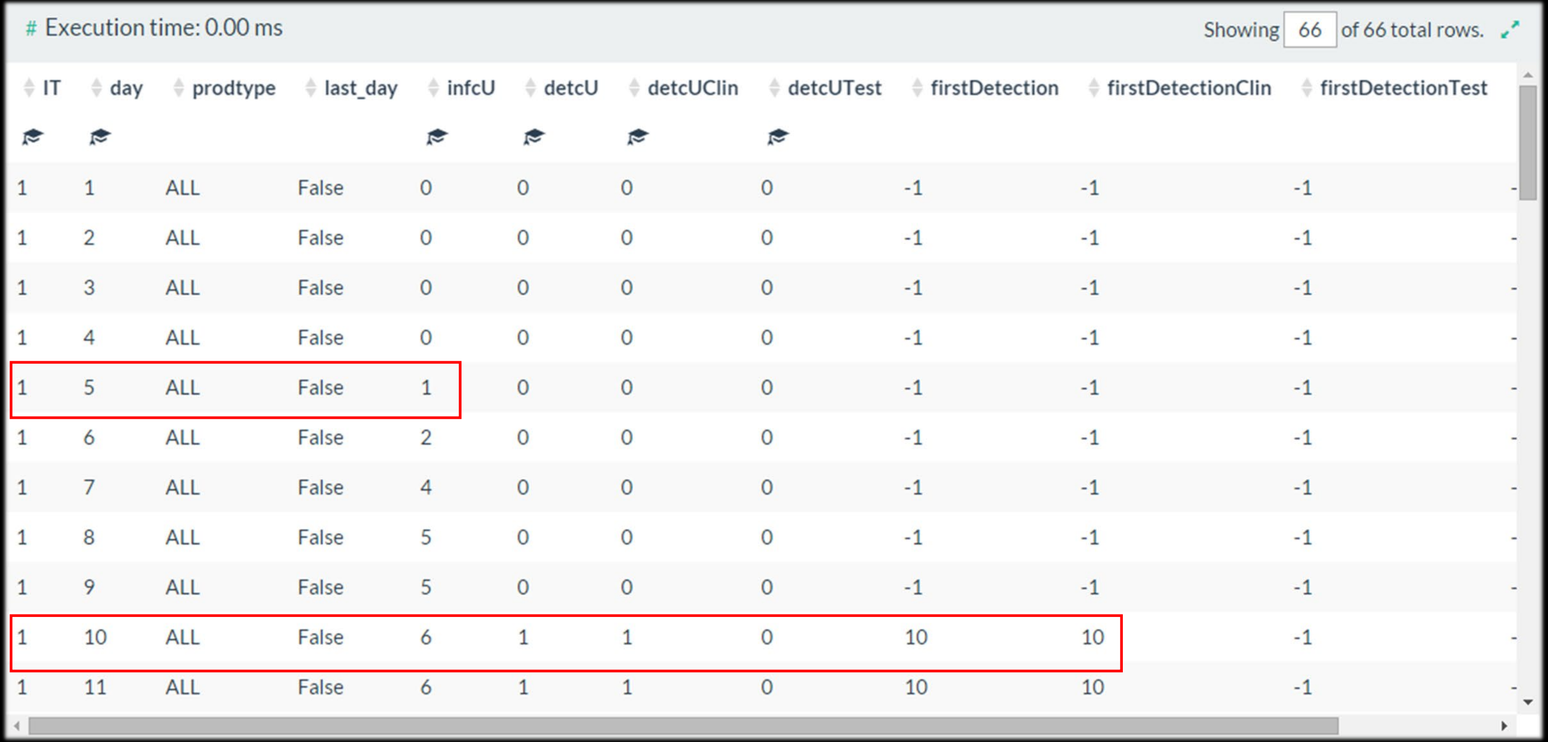
Description: Detection for all production types one iteration

SQL

```
SELECT iteration as IT, Day, Last_day,
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
infcU,                  -- infection by Unit
detcU,                  -- all detection by unit
detcUClin,              -- detection by clinical exam (default method of detection)
detcUTest               -- detection by laboratory testing (option method of detection)
-- First Detection
firstDetection, firstDetectionClin, firstDetectionTest
FROM Results_DailybyProductionType r
LEFT JOIN                           -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NULL  -- pulling back combined production type records
AND iteration = 1               -- one iteration
ORDER BY 1, 2                   -- don't assume order is correct
```

Detection Raw Data

Look at what happens in the raw data as the outbreak proceeds.



Execution time: 0.00 ms

Showing 66 of 66 total rows.

IT	day	prodtype	last_day	infcU	detcU	detcUClin	detcUTest	firstDetection	firstDetectionClin	firstDetectionTest
1	1	ALL	False	0	0	0	0	-1	-1	-1
1	2	ALL	False	0	0	0	0	-1	-1	-1
1	3	ALL	False	0	0	0	0	-1	-1	-1
1	4	ALL	False	0	0	0	0	-1	-1	-1
1	5	ALL	False	1	0	0	0	-1	-1	-1
1	6	ALL	False	2	0	0	0	-1	-1	-1
1	7	ALL	False	4	0	0	0	-1	-1	-1
1	8	ALL	False	5	0	0	0	-1	-1	-1
1	9	ALL	False	5	0	0	0	-1	-1	-1
1	10	ALL	False	6	1	1	0	10	10	-1
1	11	ALL	False	6	1	1	0	10	10	-1

Day 5 Infection starts to spread

Day 10 Detection happens

Note some of the fieldnames were shortened to fit everything into one view

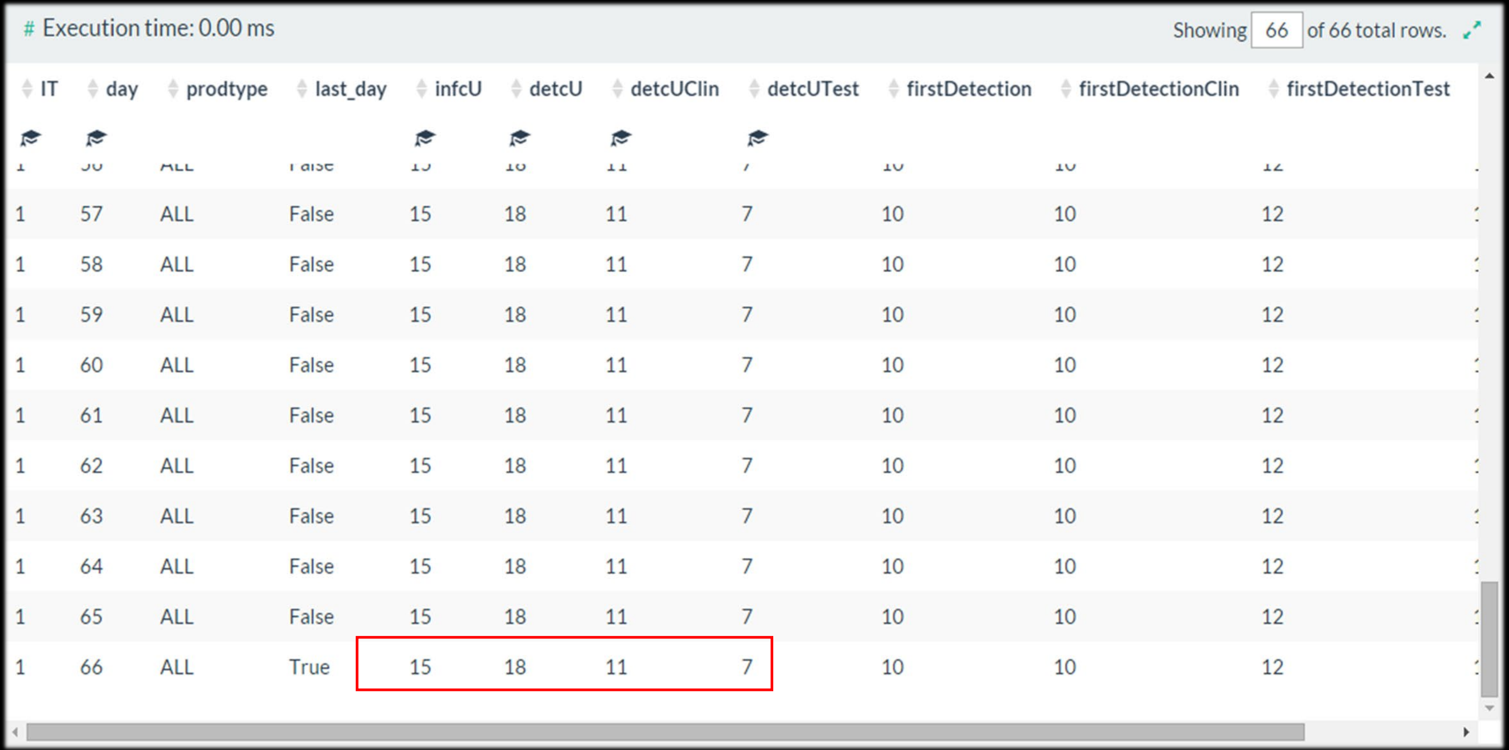
Day 10 First Detection is stamped onto the record

Detection Raw Data

By the last day, the raw data looks like this.

Something seems wrong with this. *How are there more detections than infections?*

After initial detection anywhere in the population, contact tracing may occur. Traced units may be examined for clinical signs and/or tested. Just as in real life, both of those processes could identify infection in the same unit. When this occurs, the model records both events as detections. This makes it appear that detections were over-counted.



Execution time: 0.00 ms

Showing 66 of 66 total rows.

IT	day	prodtype	last_day	infcU	detcU	detcUClin	detcUTest	firstDetection	firstDetectionClin	firstDetectionTest
1	56	ALL	False	15	18	11	7	10	10	12
1	57	ALL	False	15	18	11	7	10	10	12
1	58	ALL	False	15	18	11	7	10	10	12
1	59	ALL	False	15	18	11	7	10	10	12
1	60	ALL	False	15	18	11	7	10	10	12
1	61	ALL	False	15	18	11	7	10	10	12
1	62	ALL	False	15	18	11	7	10	10	12
1	63	ALL	False	15	18	11	7	10	10	12
1	64	ALL	False	15	18	11	7	10	10	12
1	65	ALL	False	15	18	11	7	10	10	12
1	66	ALL	True	15	18	11	7	10	10	12

Note some of the fieldnames were shortened to fit everything into one view

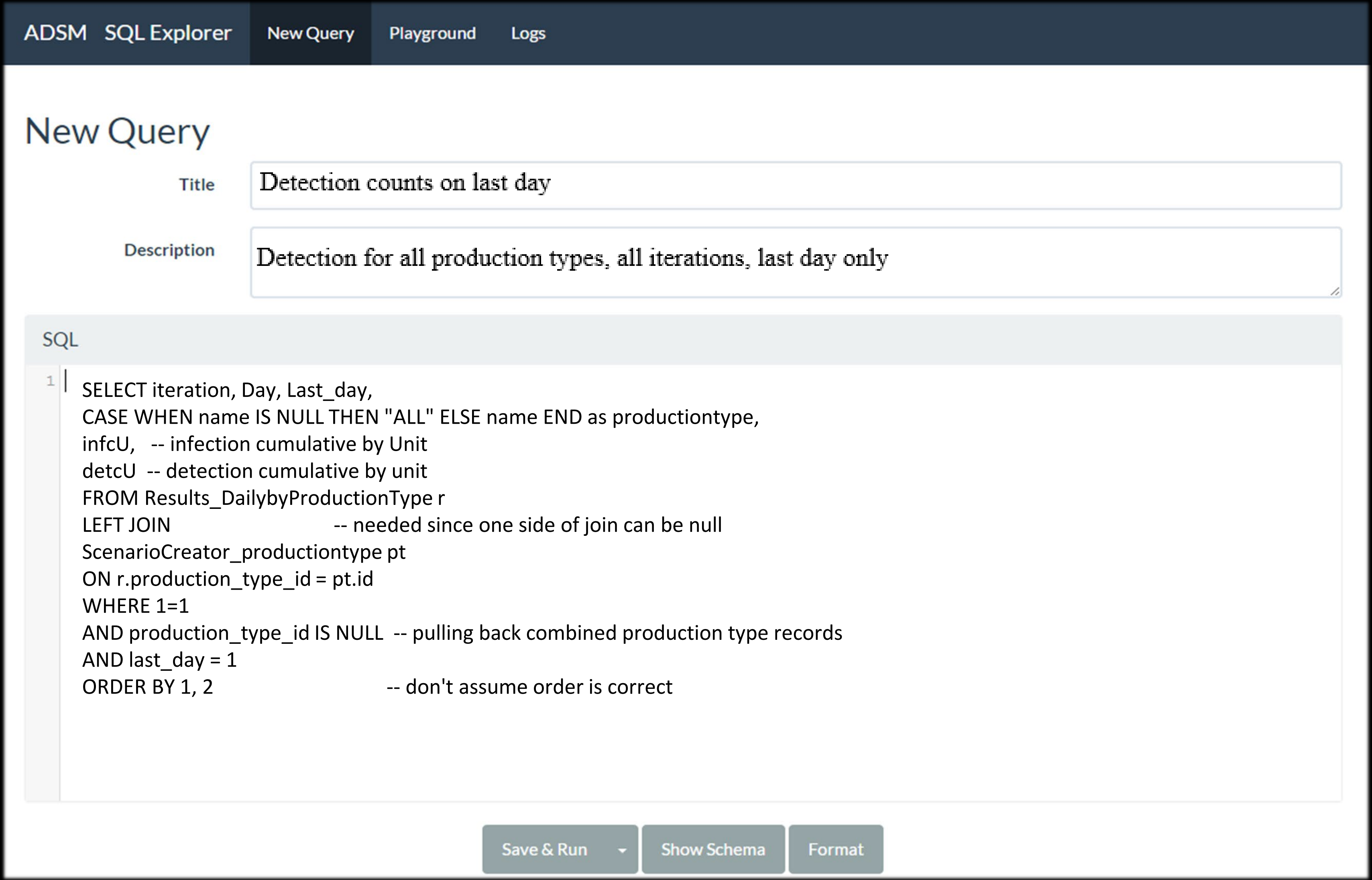
FirstDetection field is still showing the day of first detection.

Query for Detection on Last Day

Is infection always detected?

Looking at 10 iterations provides a variety of results to see the stochastic nature of the model. In iteration 1, all infections appeared to be detected, but if we look at other iterations there are different outcomes. In this query, results are limited to the last day.

Copy and paste this query into the SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.



New Query

Title: Detection counts on last day

Description: Detection for all production types, all iterations, last day only

SQL

```
SELECT iteration, Day, Last_day,
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
infcU,   -- infection cumulative by Unit
detcU  -- detection cumulative by unit
FROM Results_DailybyProductionType r
LEFT JOIN                              -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NULL  -- pulling back combined production type records
AND last_day = 1
ORDER BY 1, 2                              -- don't assume order is correct
```

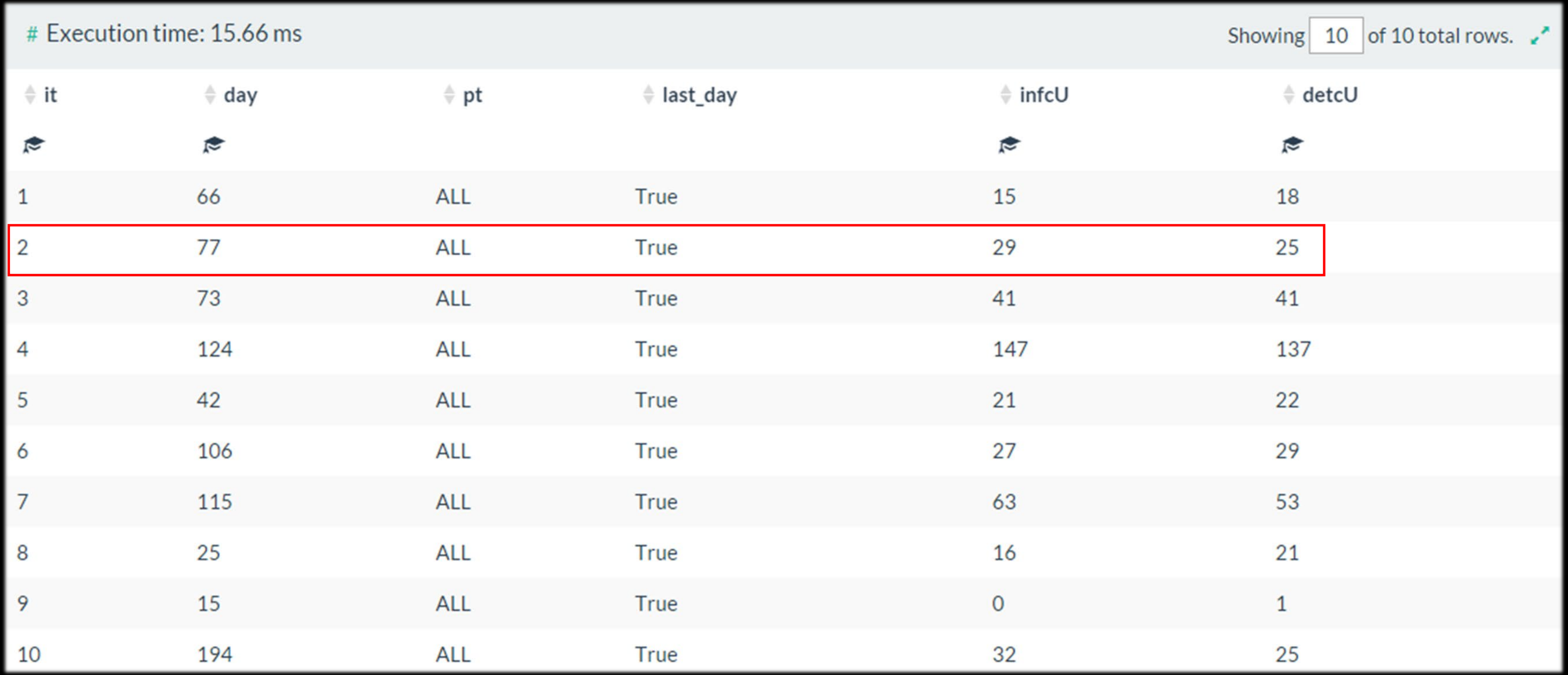
Detection Raw Data Last Day

There were several iterations that had fewer detections than infections.

Why did iteration 9 have 1 detection when there were 0 infections? The index unit was detected.

What happens to those units that are not detected? The Supplemental Output file states_2 will show the state.

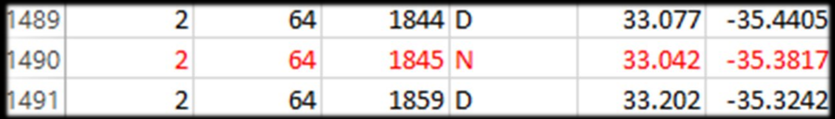
Iteration 2 is an example. In states_2.csv on Day 64, Unit 1845 changes to N (Natural Immune) as it is never detected.



Execution time: 15.66 ms

Showing 10 of 10 total rows.

it	day	pt	last_day	infcU	detcU
1	66	ALL	True	15	18
2	77	ALL	True	29	25
3	73	ALL	True	41	41
4	124	ALL	True	147	137
5	42	ALL	True	21	22
6	106	ALL	True	27	29
7	115	ALL	True	63	53
8	25	ALL	True	16	21
9	15	ALL	True	0	1
10	194	ALL	True	32	25

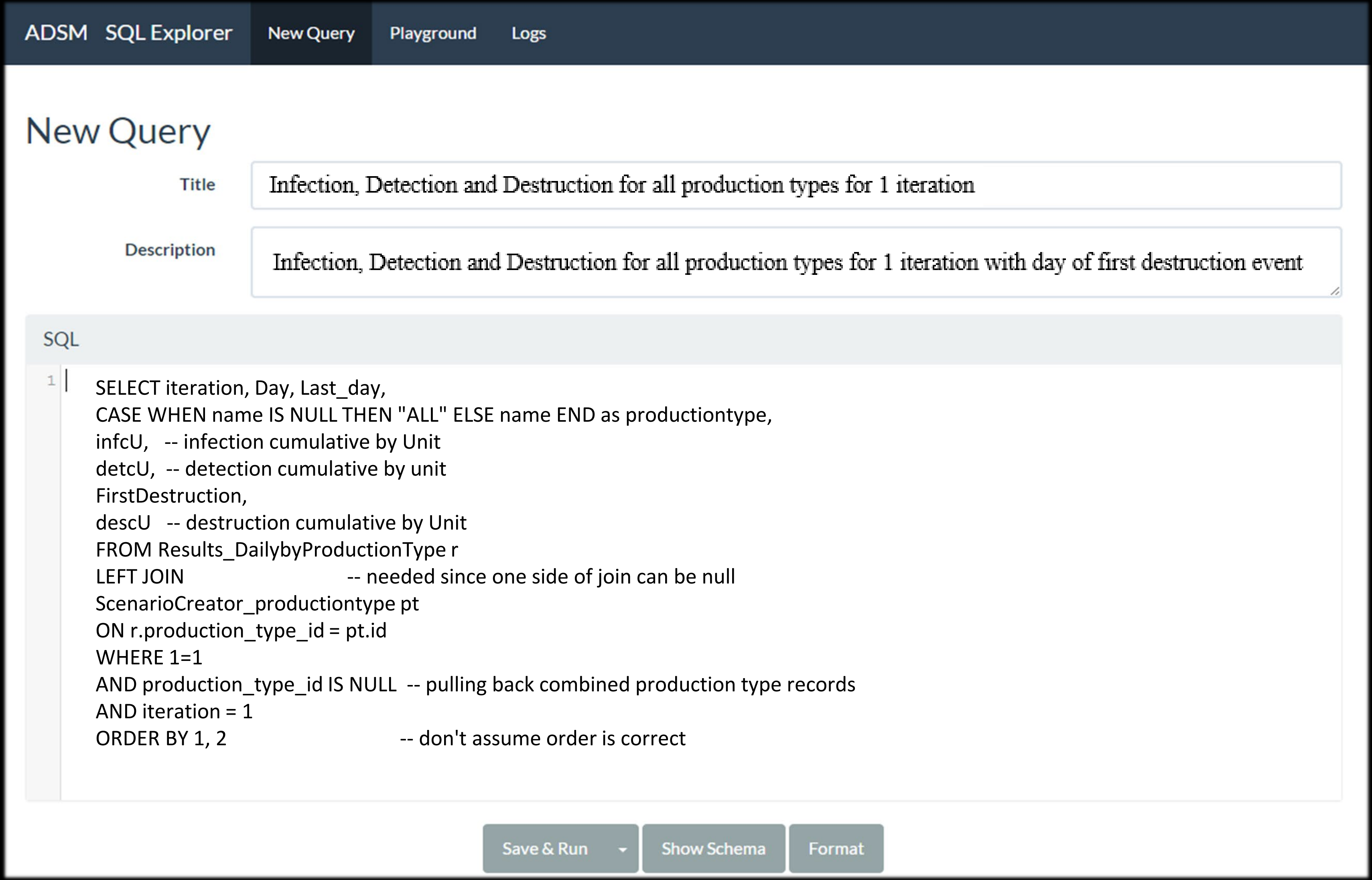


1489	2	64	1844	D	33.077	-35.4405
1490	2	64	1845	N	33.042	-35.3817
1491	2	64	1859	D	33.202	-35.3242

Query for Destruction as a Control Measure

Destruction is another common control measure used in animal disease outbreaks. An evaluation of depopulation’s effectiveness may also reveal something about the scenario.

Copy and paste this query into the SQL window if you want hands-on experience. Remember to use Sample Scenario with Outputs, or any scenario that has been run.



New Query

Title: Infection, Detection and Destruction for all production types for 1 iteration

Description: Infection, Detection and Destruction for all production types for 1 iteration with day of first destruction event

SQL

```
SELECT iteration, Day, Last_day,
CASE WHEN name IS NULL THEN "ALL" ELSE name END as productiontype,
infcU,   -- infection cumulative by Unit
detcU,  -- detection cumulative by unit
FirstDestruction,
descU   -- destruction cumulative by Unit
FROM Results_DailybyProductionType r
LEFT JOIN                              -- needed since one side of join can be null
ScenarioCreator_productiontype pt
ON r.production_type_id = pt.id
WHERE 1=1
AND production_type_id IS NULL  -- pulling back combined production type records
AND iteration = 1
ORDER BY 1, 2                              -- don't assume order is correct
```

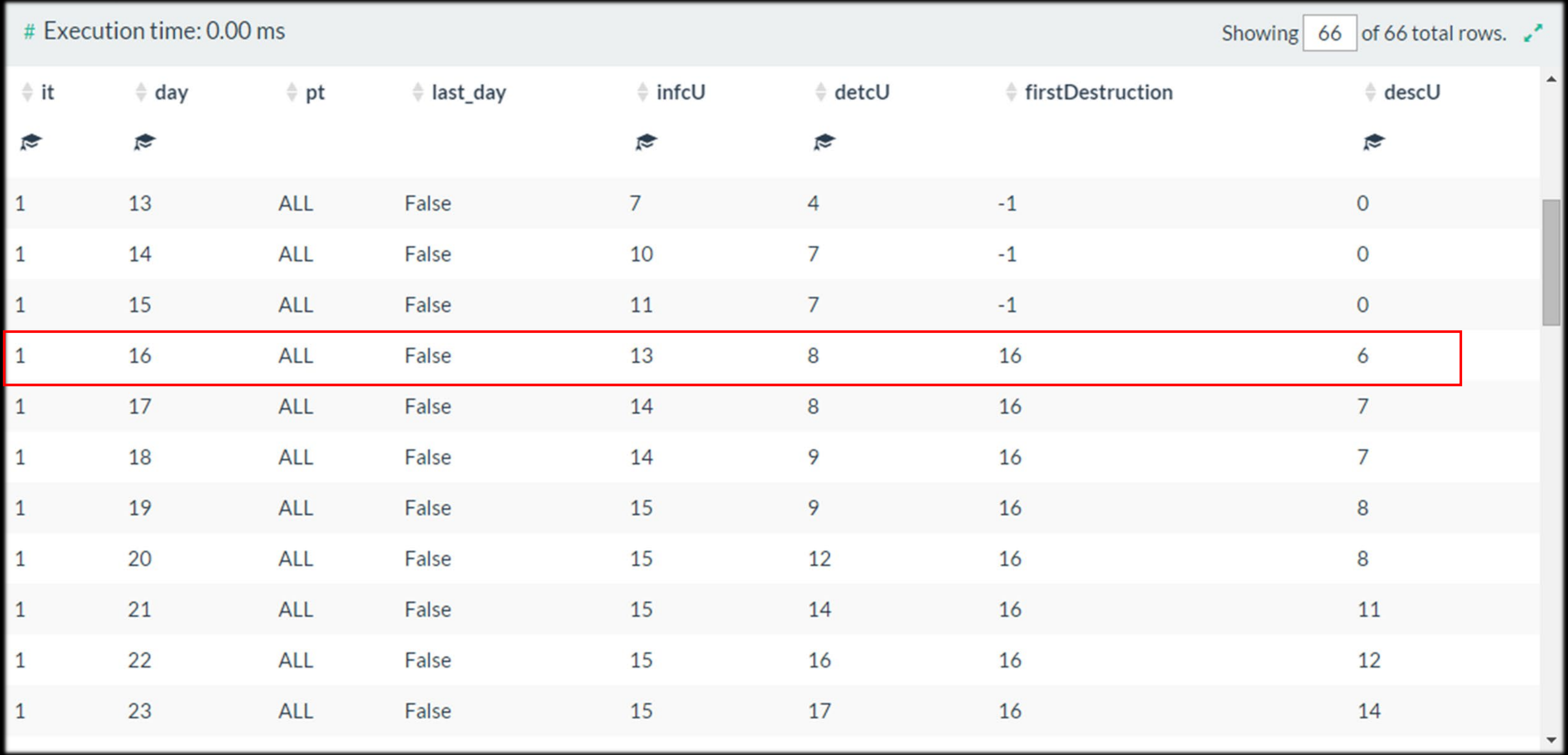
Raw Data for Destruction as a Control Measure

For Iteration 1
First detection happened on Day 10.

On Day 16, destruction starts. Recall that detection must happen before the model knows to destroy the unit. Once a detection has occurred, there are three main options:

1) Destroy the detected unit
2) Destroy a trace-in or out
3) Make a pre-emptive destruction ring

The Supplemental Output file Daily_events_1 shows exactly who was destroyed.

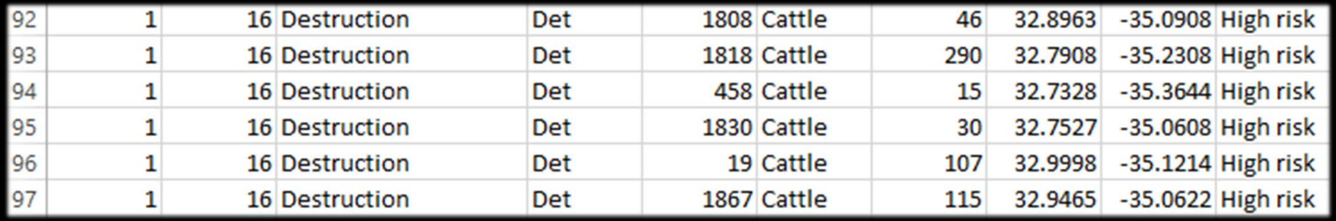


Execution time: 0.00 ms

Showing 66 of 66 total rows.

it	day	pt	last_day	infcU	detcU	firstDestruction	descU
1	13	ALL	False	7	4	-1	0
1	14	ALL	False	10	7	-1	0
1	15	ALL	False	11	7	-1	0
1	16	ALL	False	13	8	16	6
1	17	ALL	False	14	8	16	7
1	18	ALL	False	14	9	16	7
1	19	ALL	False	15	9	16	8
1	20	ALL	False	15	12	16	8
1	21	ALL	False	15	14	16	11
1	22	ALL	False	15	16	16	12
1	23	ALL	False	15	17	16	14

Note some of the fieldnames were shortened to fit everything into one view



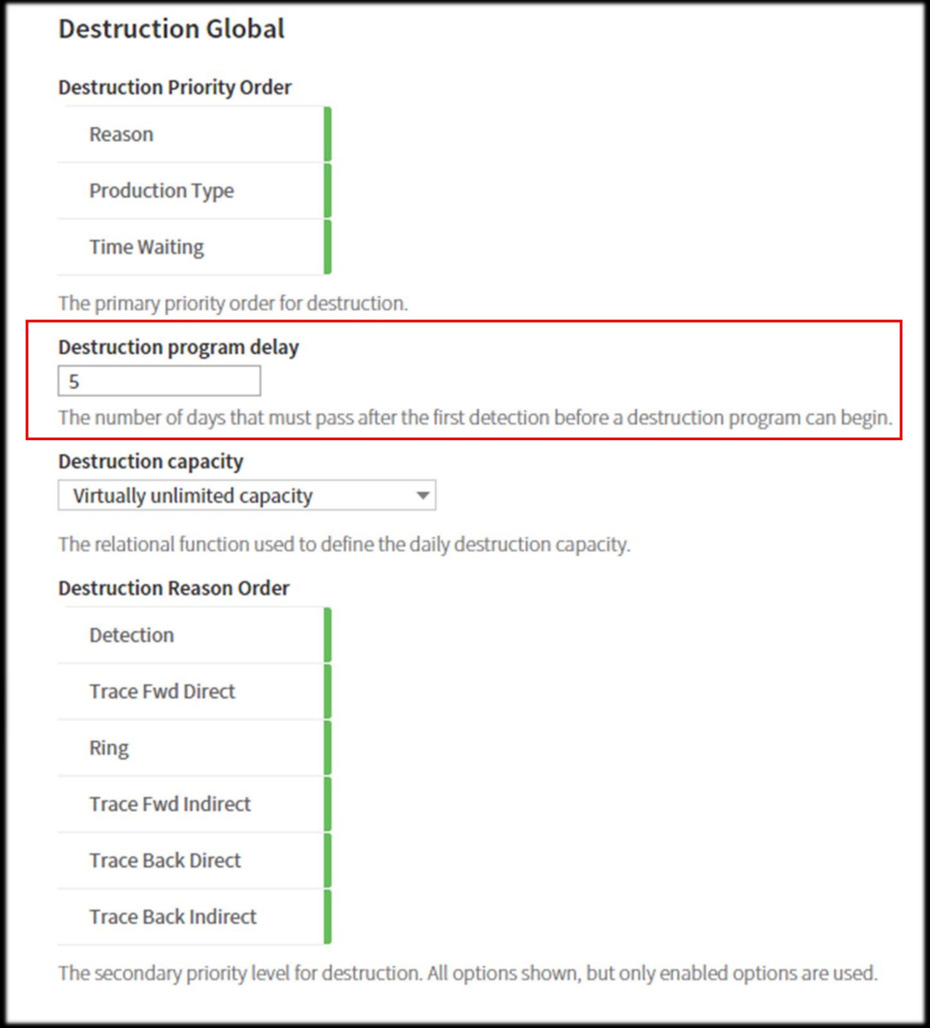
92	1	16	Destruction	Det	1808	Cattle	46	32.8963	-35.0908	High risk
93	1	16	Destruction	Det	1818	Cattle	290	32.7908	-35.2308	High risk
94	1	16	Destruction	Det	458	Cattle	15	32.7328	-35.3644	High risk
95	1	16	Destruction	Det	1830	Cattle	30	32.7527	-35.0608	High risk
96	1	16	Destruction	Det	19	Cattle	107	32.9998	-35.1214	High risk
97	1	16	Destruction	Det	1867	Cattle	115	32.9465	-35.0622	High risk

Destruction Delay Verification

This is another opportunity to verify that the parameters are guiding the model's action.

Recall detection didn't happen until Day 10.

On Day 16, destruction starts. Recall that detection must happen before the model knows to destroy the unit. The parameter ***Destruction Program Delay*** is set to 5 days. Therefore, a Day 10 detection with a Day 16 destruction makes sense in iteration 1.



Destruction Global

Destruction Priority Order

- Reason
- Production Type
- Time Waiting

The primary priority order for destruction.

Destruction program delay

5

The number of days that must pass after the first detection before a destruction program can begin.

Destruction capacity

Virtually unlimited capacity

The relational function used to define the daily destruction capacity.

Destruction Reason Order

- Detection
- Trace Fwd Direct
- Ring
- Trace Fwd Indirect
- Trace Back Direct
- Trace Back Indirect

The secondary priority level for destruction. All options shown, but only enabled options are used.

Summary of Evaluation Steps

1. At the beginning, we looked at duration and number of animals on infected premises at first detection
2. Then we ventured into Exposures
   - Exposure, Adequate Exposure, and Infection
   - Exposure, Adequate Exposure, and Infection by spread method
   - Exposure, Adequate, and Infection by production type
3. Spread parameters
4. Daily States
5. Detection
6. Destruction

Depending on the specifics of your scenario there may be other variables, like those related to vaccination, that you should explore.

The Data Dictionary can provide field level definitions. Use the ? Panel in the ADSM application to find the Data Dictionary.

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

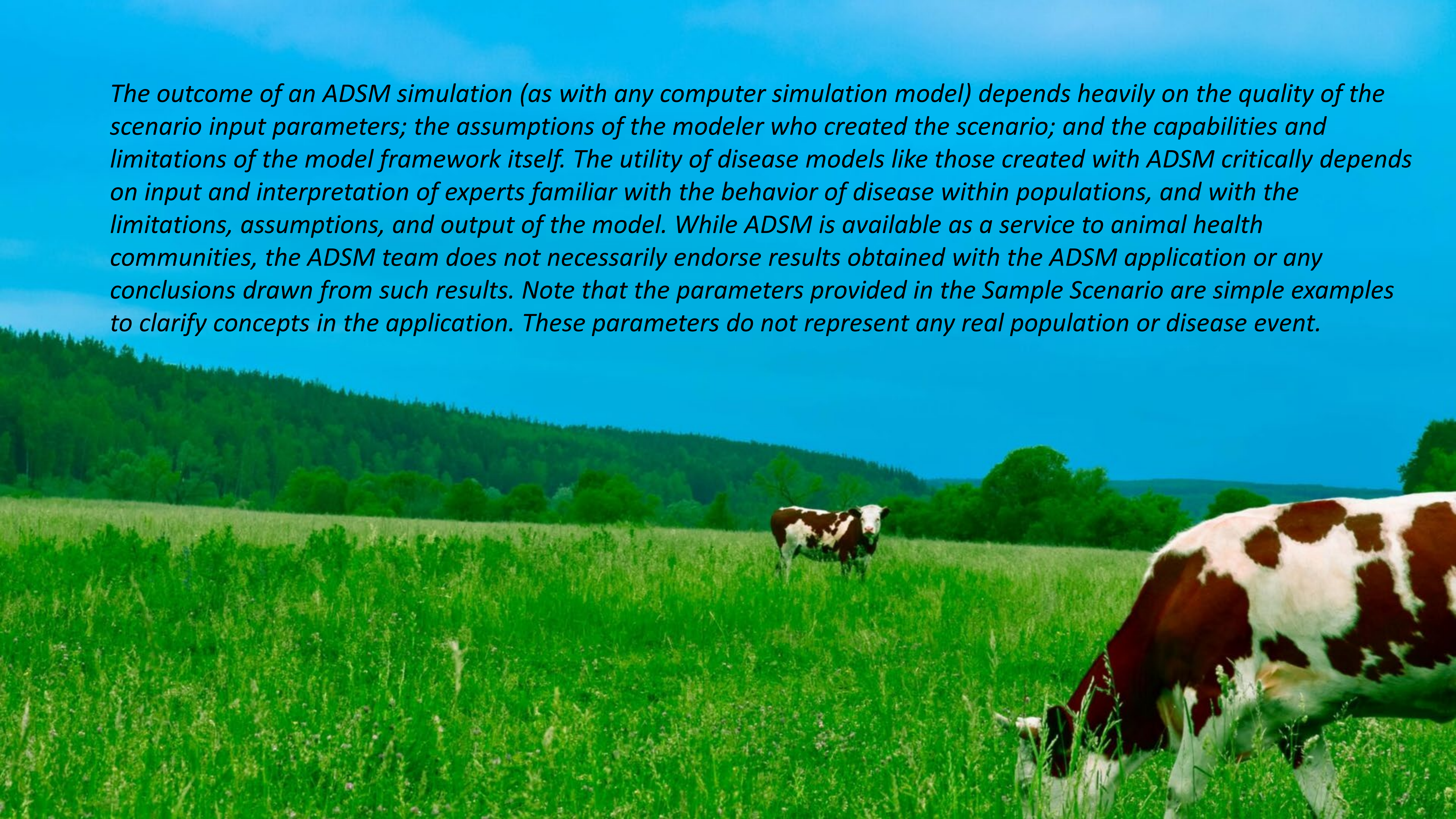
Try the sample scenario
https://github.com/NAVADMC/ADSM/wiki/A-Quick-Start-Guide:-Running-the-sample-scenario

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:

- 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



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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