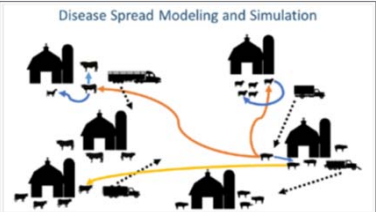
 United States Department of Agriculture

**Disease Spread Modeling and Simulation**

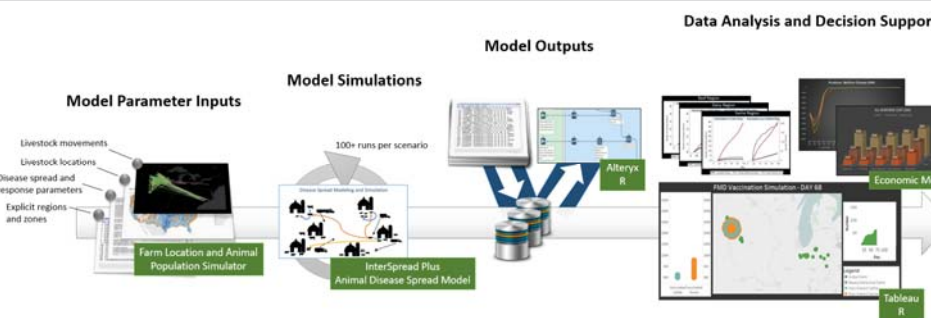


**DECISION SUPPORT FOR EMERGENCY PREPAREDNESS:  
THE USE OF COMPUTER MODELING AND VISUAL ANALYTICAL TOOLS TO EVALUATE CONTROL STRATEGIES**

LINDSEY HOLMSTROM  
VETERINARY EPIDEMIOLOGIST  
EPIDEMIOLOGIC AND ECONOMIC MODELING TEAM  
CEAH:VS:APHIS:USDA

JULY 8, 2018

Overview:  
Modeling and Visual Analytical Tools



**Model Parameter Inputs**

- Livestock movements
- Livestock locations
- Disease spread and response parameters
- Explicit regions and zones

**Model Simulations**

- Farm Location and Animal Population Simulator
- InterSpread Plus Animal Disease Spread Model
- 100+ runs per scenario

**Model Outputs**

- Alleryx R

**Data Analysis and Decision Support**

- Economic Model
- Tableau R

**The Epidemic and Economic Modeling Process**

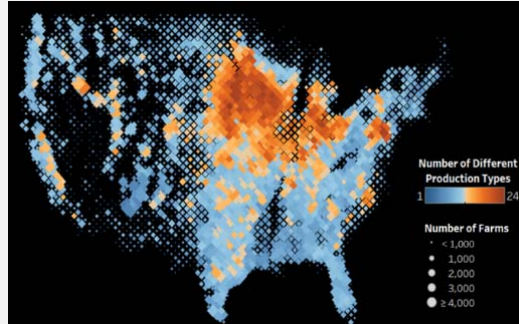
2

## National FAD Models in the U.S.

### Farm Location and Animal Population Simulator (FLAPS)

- Simulated farm locations based on empirical, county-level USDA NASS census data
- 44 Production Types:
  - Poultry (chickens, turkeys, specialty, backyard birds)
  - Commercial bison, beef/dairy cattle, goats, sheep, swine
- 2.2+ million farms

Geocoding of GIPSA data for livestock market placement



Mix of production types and animal/farm densities

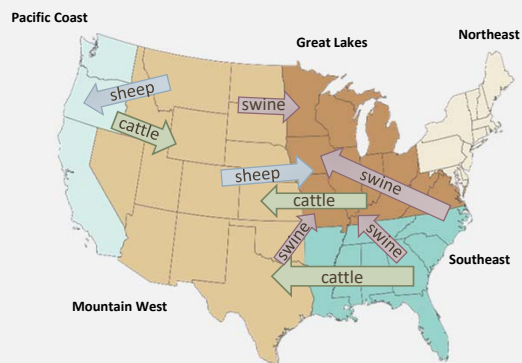
### Model Parameter Input Tools

3

## National FAD Models in the U.S.

### Movements of animals based on U.S. livestock industry movement patterns surveys

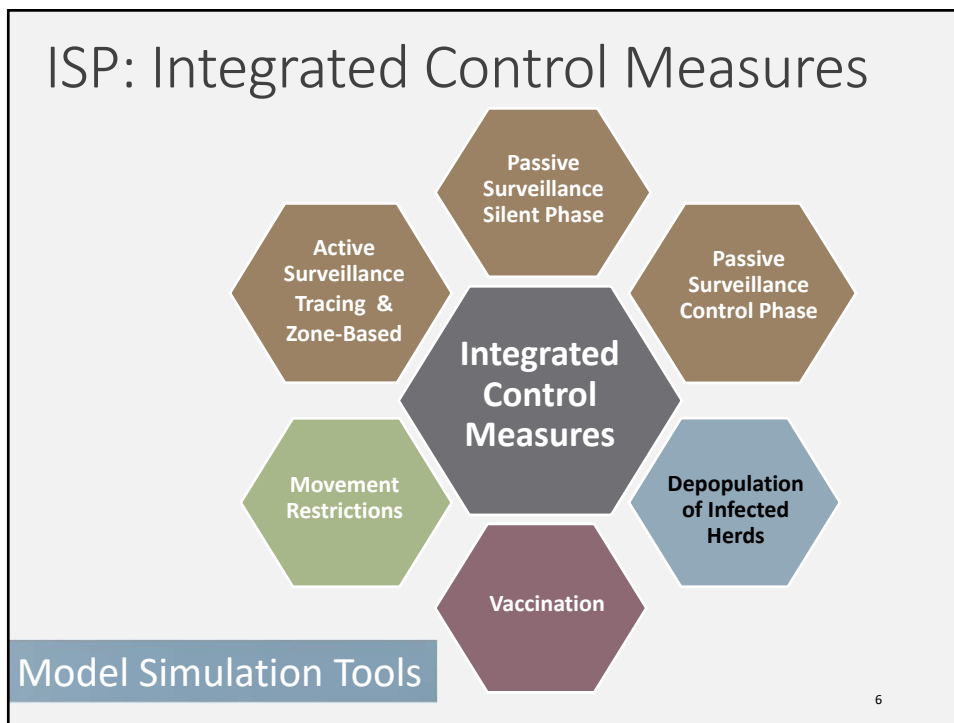
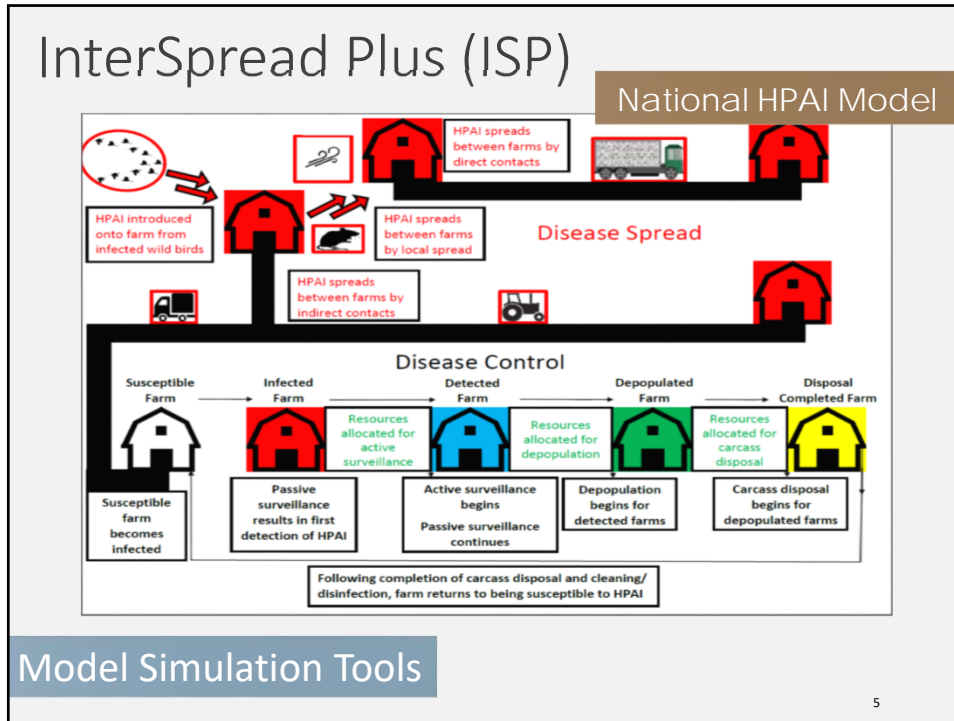
- Short and long distance movement of animals are represented in the model, based on known characteristics and patterns within the different livestock industries
- Regional differences in movements are accounted for within the model



Short and long distance movement of animals

### Model Parameter Input Tools

4



## Animal Disease Spread Model (ADSM)

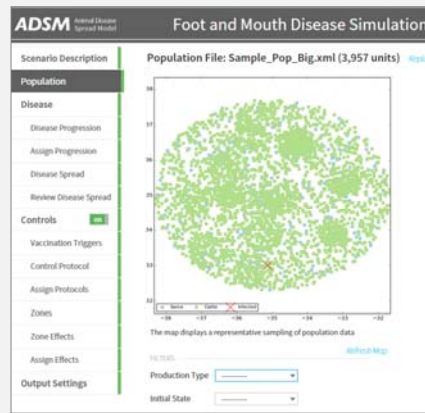
An enhancement of the North American Animal Disease Spread Model (NAADSM)

- Upgraded technology
- Redesigned, user-friendly interface

Freely available to the global animal health community

Uses:

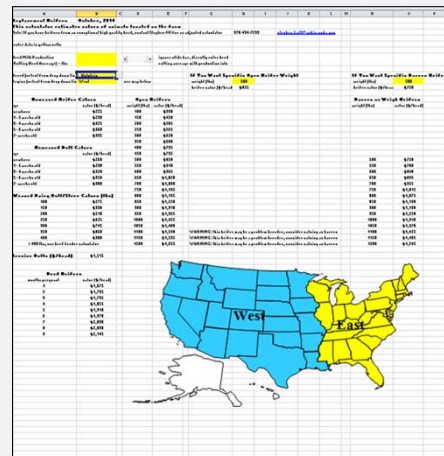
- Analyzing different control strategies and potential resource requirements
- Prioritizing response options
- Demonstrating the impact of a disease within a region
- Education and outreach



### Model Simulation Tools

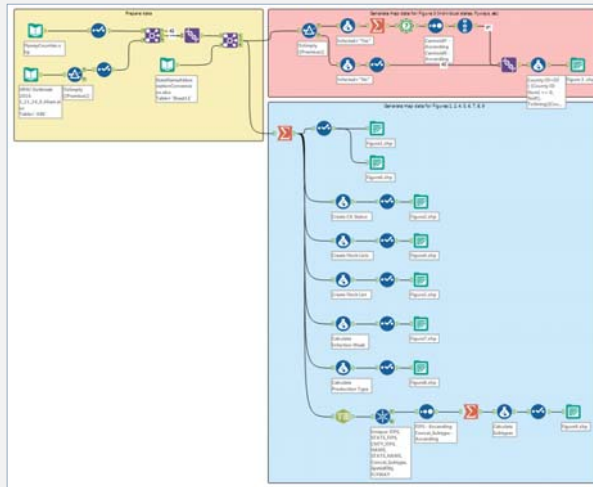
## Economic Modeling

- Animal Appraisal Value Calculator
- Budget Models
- Quarterly Livestock Sector Model



### Model Simulation Tools

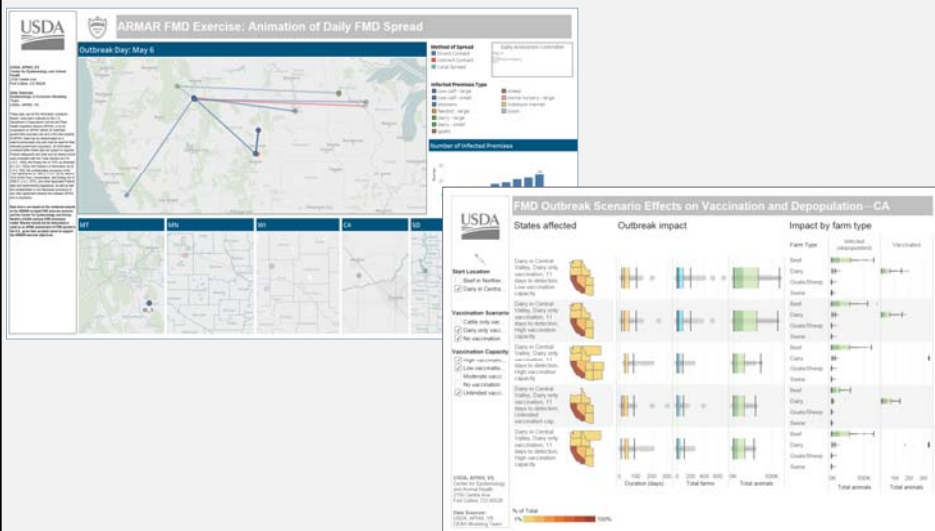
## Data Workflows: Alteryx



Model Output Tools

9

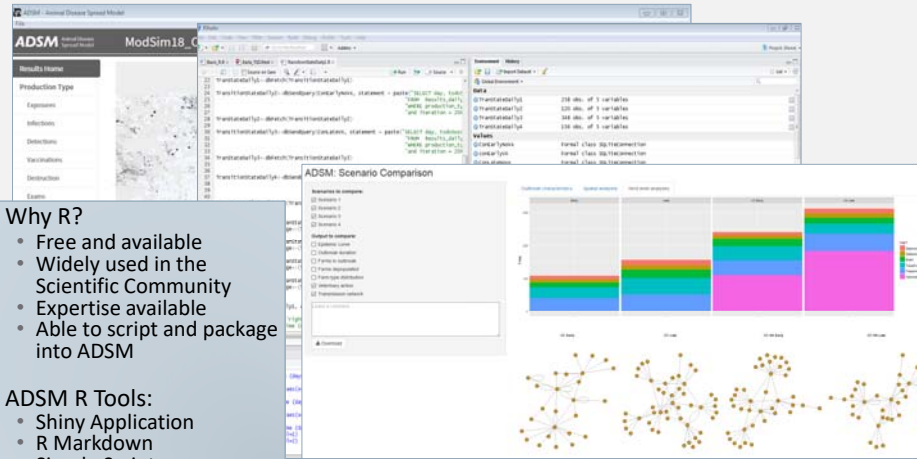
## Interactive, Shareable Dashboards: Tableau



Data Analysis and Decision Support Tools

10

## Interactive, Shareable Dashboards: R Program



### Why R?

- Free and available
- Widely used in the Scientific Community
- Expertise available
- Able to script and package into ADSM

### ADSM R Tools:

- Shiny Application
- R Markdown
- Simple Scripts

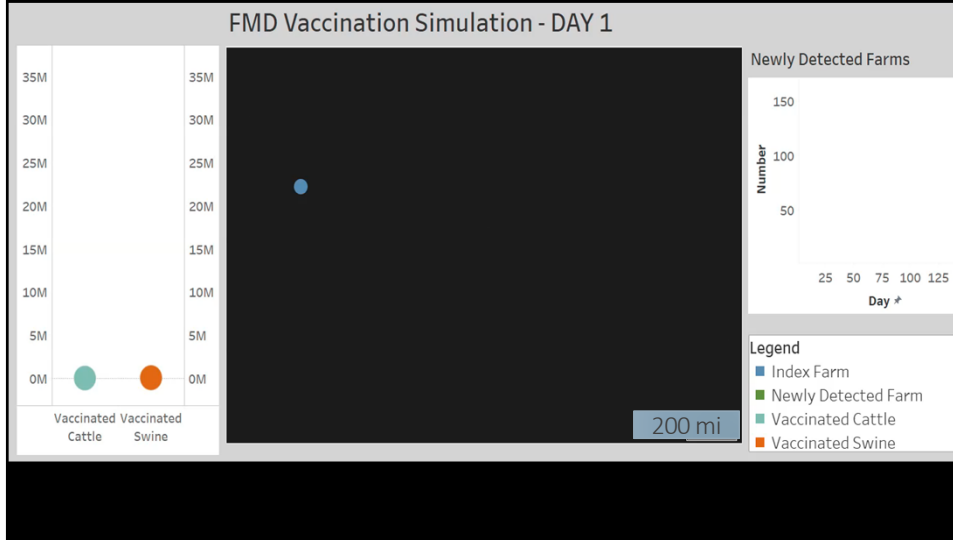
## Data Analysis and Decision Support Tools

11

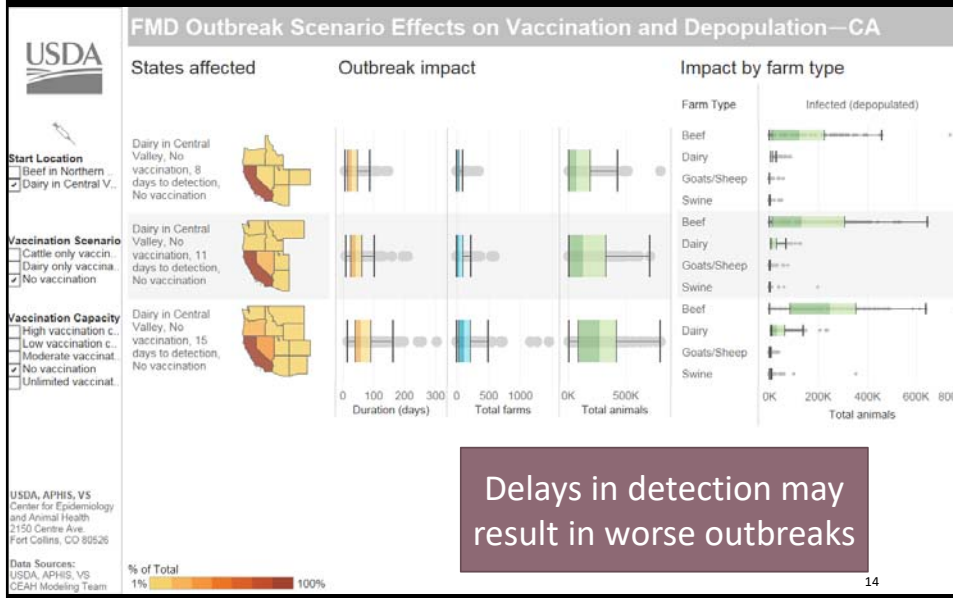
## Decision Support for Emergency Preparedness: Example Use Cases



### Example: blanketed vaccination, 80km ring



### Example: delays in disease detection

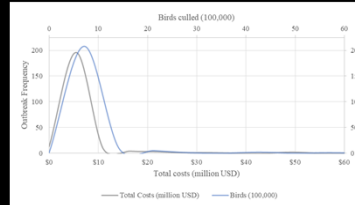




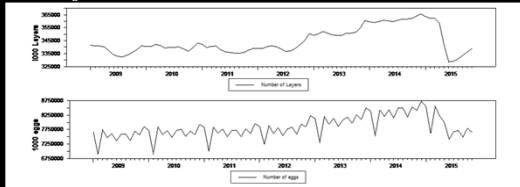
## Economic Analysis

- Impact of outbreaks on prices
- Indemnity
- Regionalization
- Surveillance
- Trade impacts and recovery

Density Graph of Birds Culls and Total Response Cost  
Source: Seeger et al. (unpublished)



Total Number of Layers and Eggs in the United States, January 2009 to November 2015 from USDA-AMS  
Source: Huang et al. 2016



Economic Impact Estimates for 2014/2015 U.S. HPAI Outbreak  
Source: Seitzinger and Paarlberg, 2016

Changes in Returns to:	Absolute Change from Base (million Dollars)	Change from Base (Percent)
Red Meats Processing	1.1	
Eggs and Layers	55.6	26.7
Broilers	-275.7	-1.5
Turkeys	-214.2	-6.8
Dairy Cattle and Milk	-0.1	
Beef Cattle	74.8	0.1
Swine	21.5	
Lambs and Sheep	0.4	
Crops	2.3	
Soybean Processing	712.1	
Land Values	-150.8	
Value Added	-180.1	
<b>Total Welfare Producers</b>	<b>1043.1</b>	



United States Department of Agriculture

## QUESTIONS?

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