Exotic Disease Modeling and Decision Making

FAZD CENTER

NATIONAL CENTER FOR FOREIGN ANIMAL AND ZOONOTIC DISEASE DEFENSE

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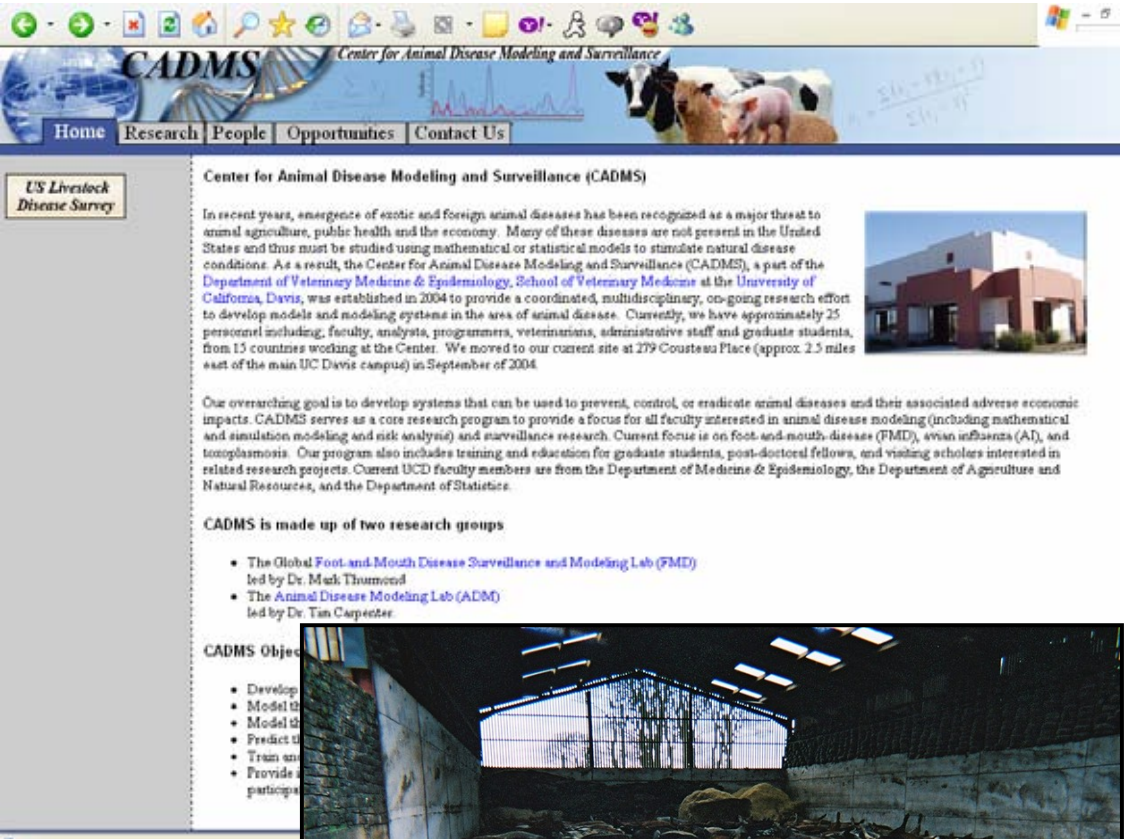
CADMS Modeling Base



FMD in the US

20 - 25 FTEs

- Computational biology, Computer science, Ecology, Engineering, Entomology, Epidemiology, GIS, Graduate students, Medicine, Modeling, Parasitology, Postdoctoral fellows, Statistics, Veterinary Medicine, Wildlife

US

- Universities
- National Labs
- USDA, DOI
- State Depts. of F&G and F&A
- Industry

International

- Argentina, Australia, Canada, Chile, China, Colombia, DK, NZ, France, Germany, Kenya, Kuwait, Pakistan, Iran, Spain, Thailand, UK

FMD UK 2001 Epidemic

Total Farms Depopulated

10,157

- **Infected Premises 2,030**
- **Dangerous contacts 4,762**
- **Contiguous premises 3,369**
- **32 week duration**

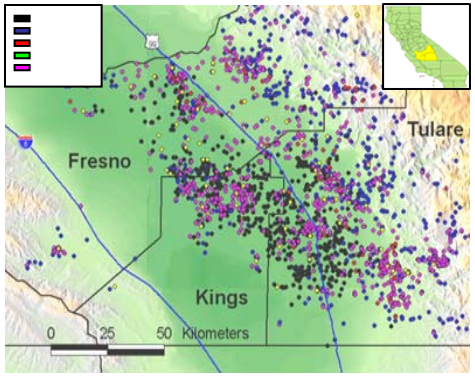
Slaughter/Disposal Numbers = 6-10 million livestock ("officially" 6,456,000: 10% of UK total)

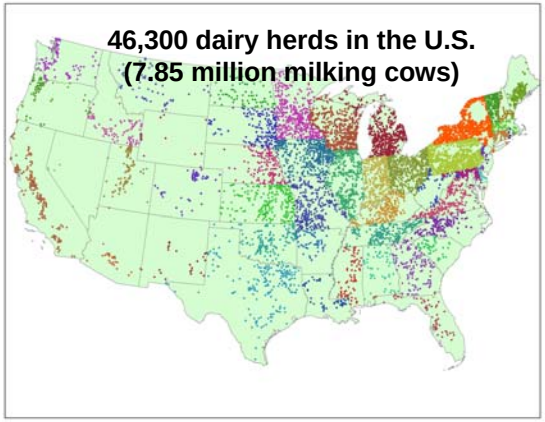
Daily average of animals slaughtered = 9,000 - 80,000

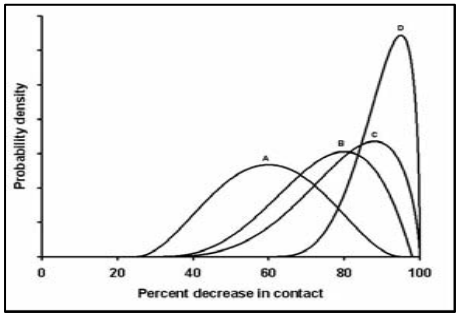
Peak daily disposal = 100,000 carcasses

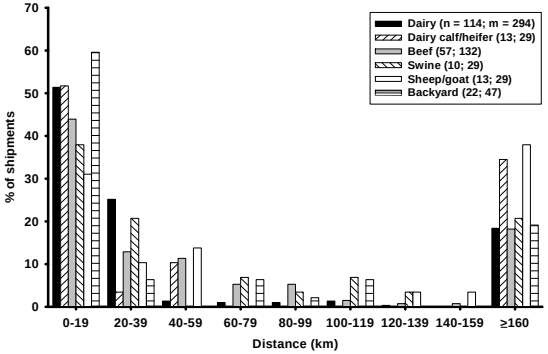
Photo: Pam Hullinger, CDFA

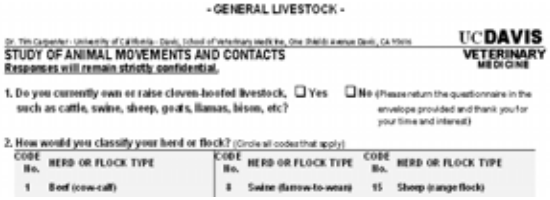
Davis Animal Disease Simulation (DADS) Model











- 30 years FMD modeling
- Spatial
- Stochastic
- Data driven
- Painfully detailed
- Resource constrainable
- Highly individual animal based
- National level spread & control
- (Inter)national collaborators

Model Assumptions (inputs and controls)

- Contact data
  - Simple model (generic)
  - Complex model (herd type specific)
- Geographic data (premises)
  - Random (NASS/random)
  - Precise
- Control constraints
  - Circular (ring)
  - Regional (geopolitical)

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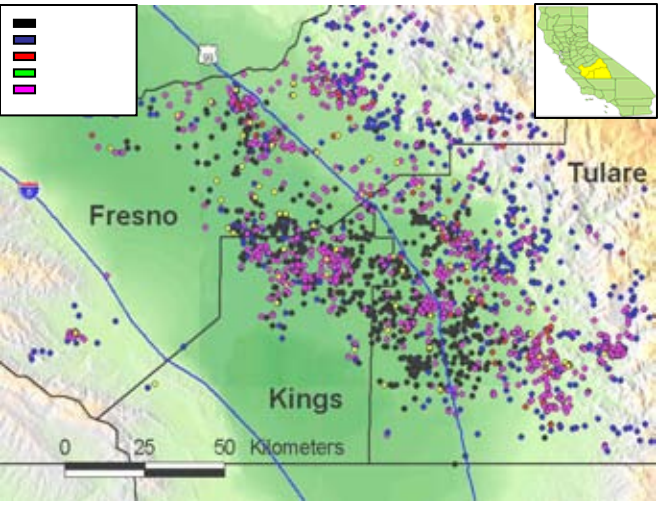
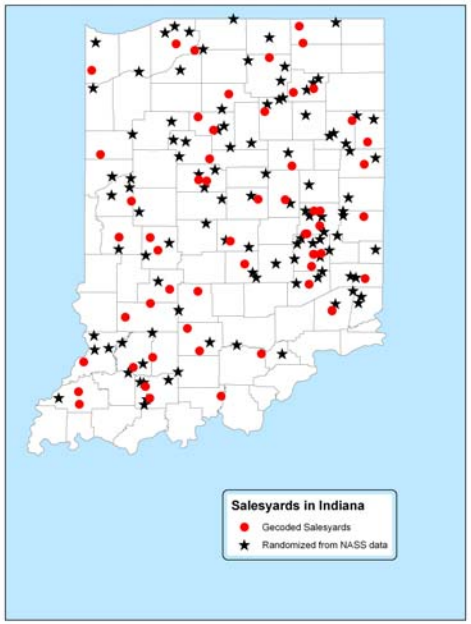
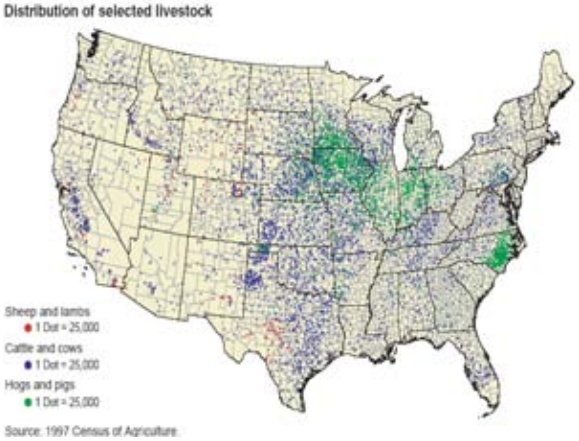
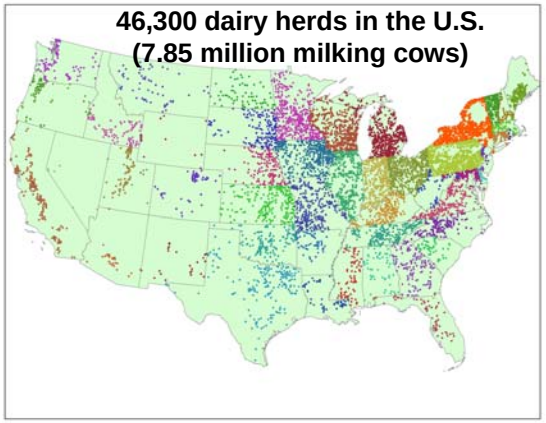
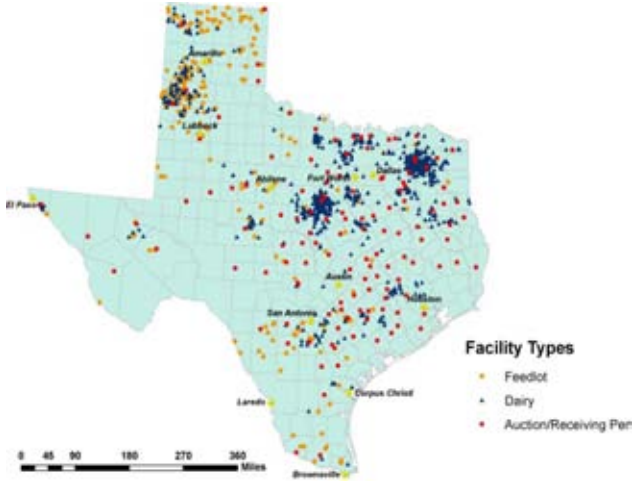
Geographic Data

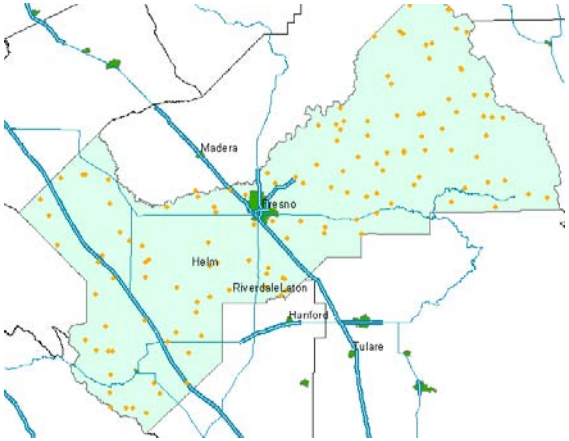


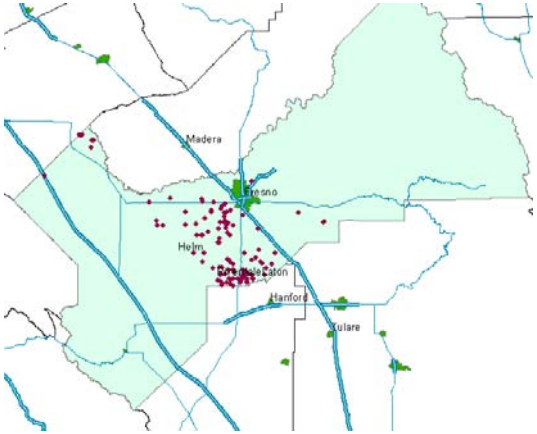




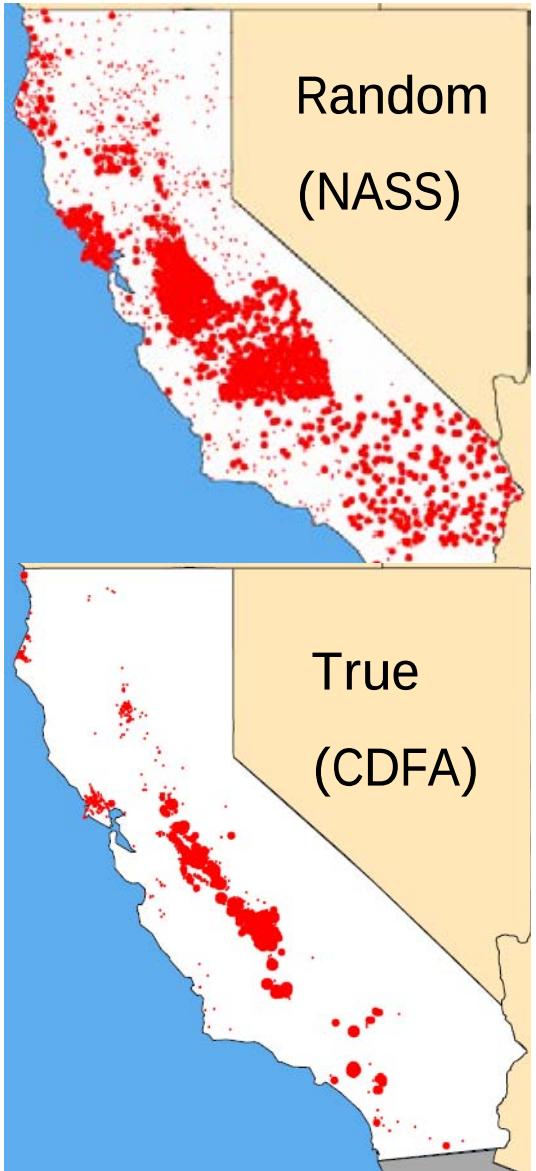








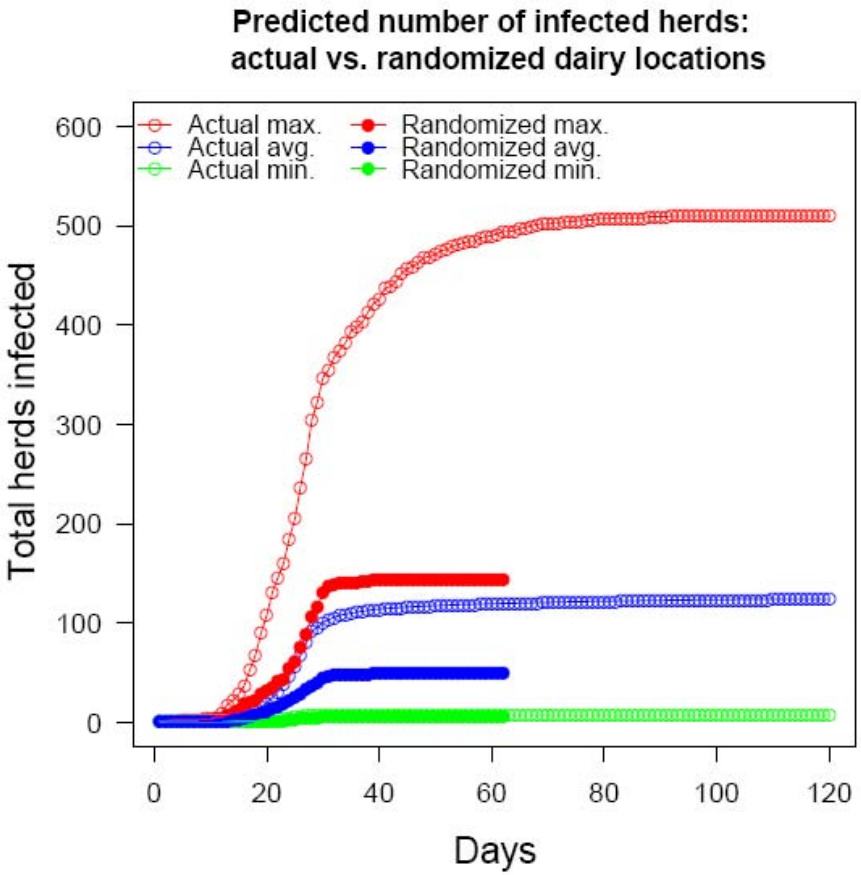
Geolocation Data: CA Dairies



- NASS vs. true locations
  - More disperse
  - Overestimates (25%) dairies
- Implications
  - Diminishes local area spread (LAS) potential
  - Reduces planning benefit

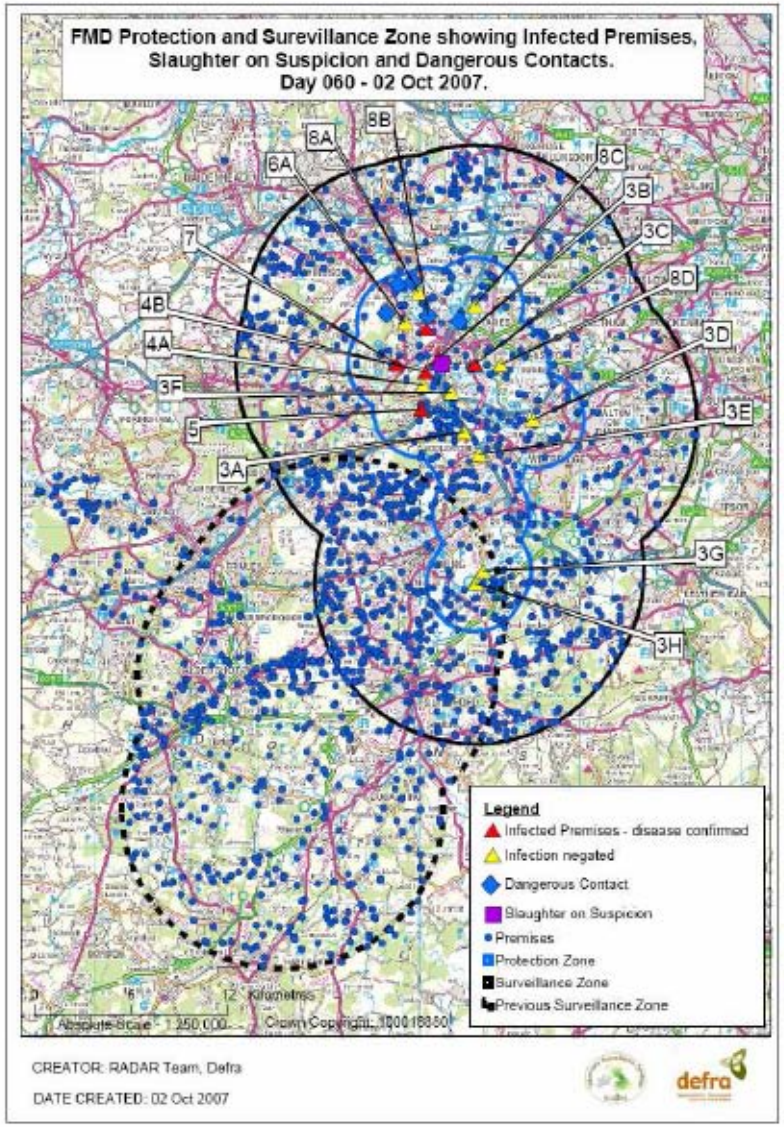
CDFA = Calif. Dept. of Food and Agriculture

Simulation Results: Random vs. Actual Locations



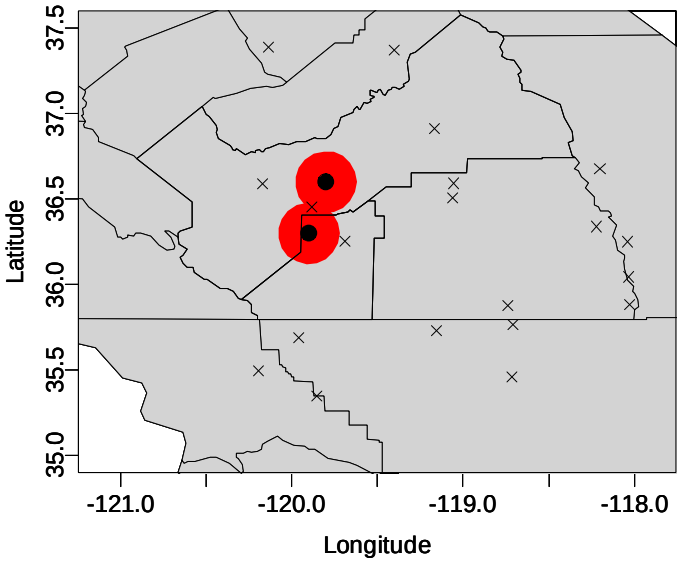
- NASS vs. true data sims.
  - Min. similar but early end
  - Mean 60% underestimate
  - Max. 75% underestimate
- Implications
  - Underestimates epidemic impact and duration
  - Potentially misdirects resources
  - No info. > misinformation?

Ring Controls in UK 2007

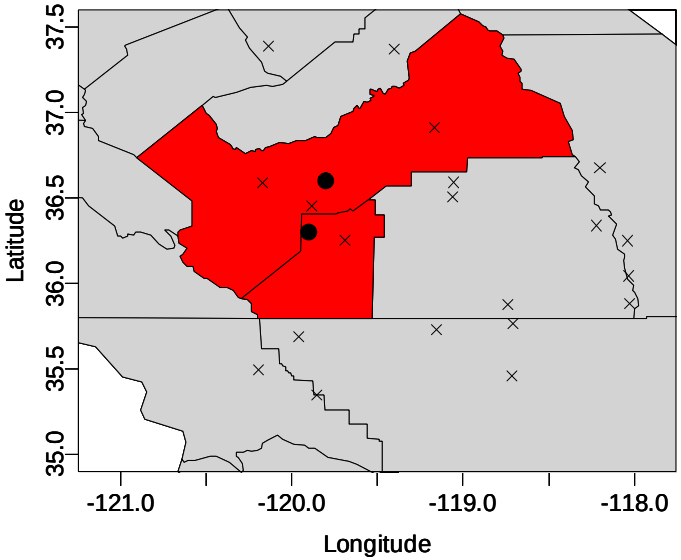


- Premises statuses updated daily
- “Target” constantly changing
- Resource allocation efficiency?
- Disease control impact?

Circular vs. Areal Surveillance

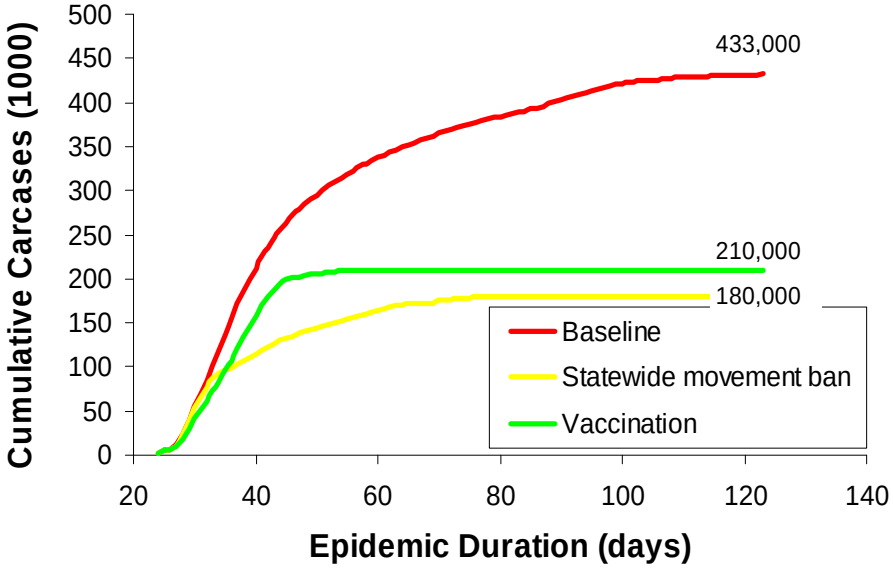


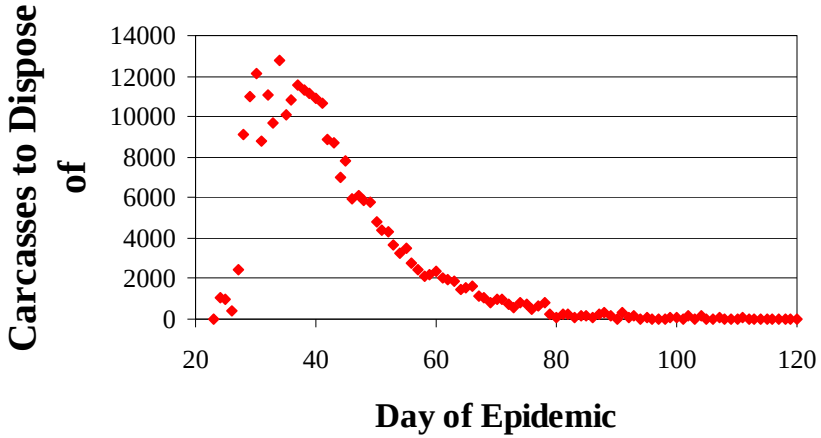
- Regional control benefits
  - 10% decrease in IPs
  - 10% decrease in epidemic duration
  - 40% increase affected premises
  - 80% decrease in surveillance zone definition



- Additional applications
  - Vaccination/culling
  - Movement
  - Expansion to states or regions vs. counties

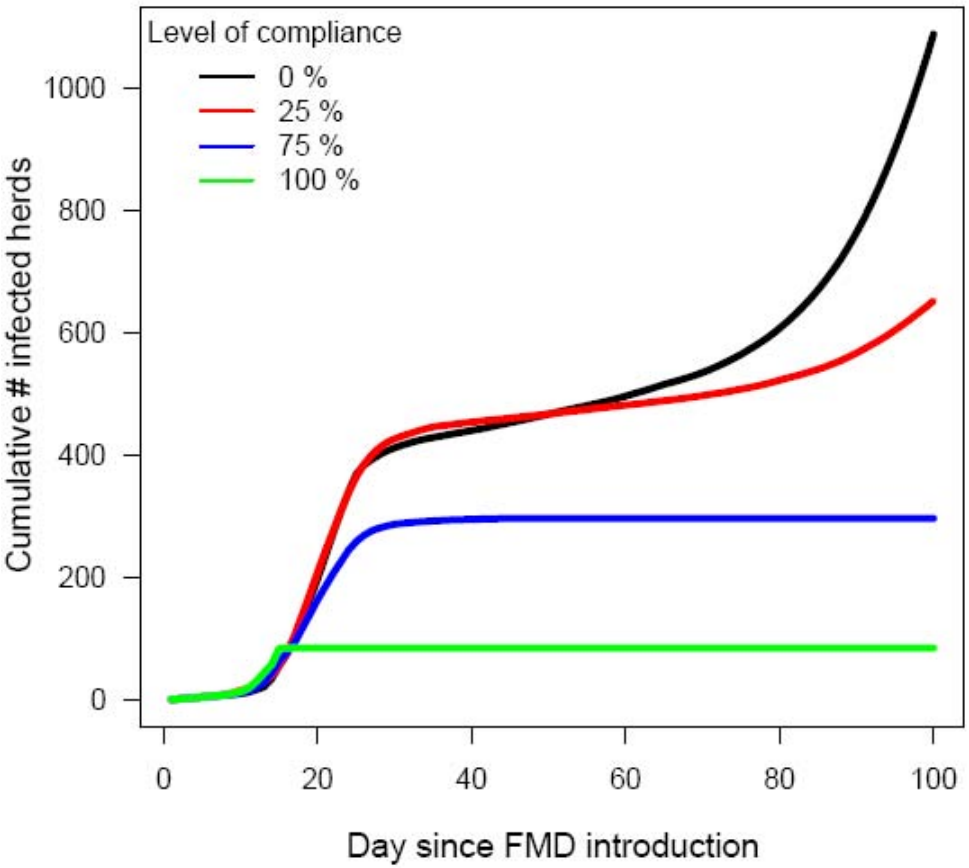
Results (day/location-specific)





- **Vaccination will reduce the impact by ½; trade problems**
- **Animal movement ban as effective; without trade restrictions**
- **As in UK 2001, we are unprepared to deal with carcass disposal**

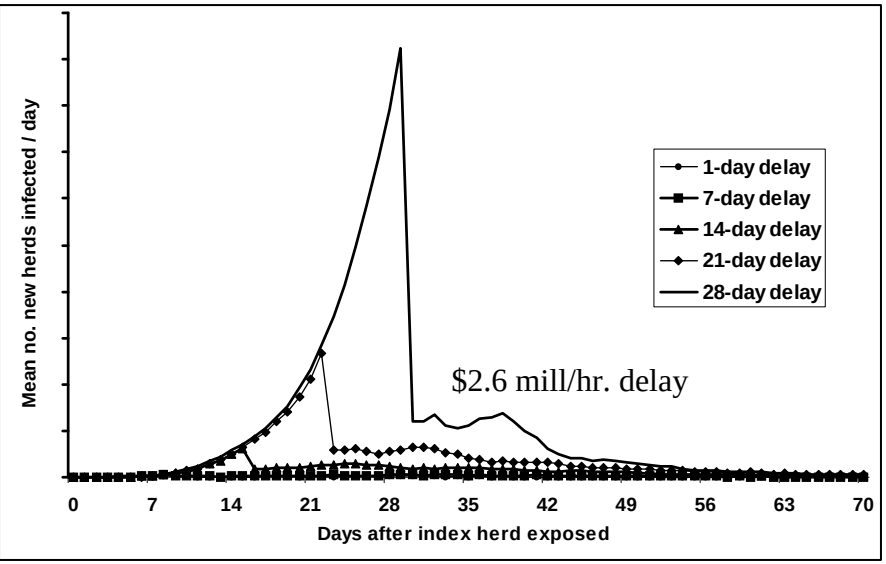
Simulating Traceability (NIAI)



- **Increased speed and accuracy of trace backs and forward**
- **↓ Epidemic size**
- **↓ Epidemic duration**
- **↓ Manpower**
- **Valuable even if non-mandatory**

NIAI = National individual animal identification

Diagnostic Delay Impact



- Expected 21-delay diagnosing index case
- Benefit (direct cost savings) of 1-day earlier detection ($2 - 3M/hr)

Dairy Council of California
Healthy Eating Made Easier

Western United Dairymen

National Pork Producers Council

FARM BUREAU FEDERATION

Washington Cattlemen's Association

TAD

Professional Dairy Heifer Growers Association

Colorado Livestock Association

FAZD CENTER
National Center for Foreign Animal Diseas

USDA

cdfa

National Hog Farmer

Hoof Trimmers Association Inc

Oregon Meat Goat Producers

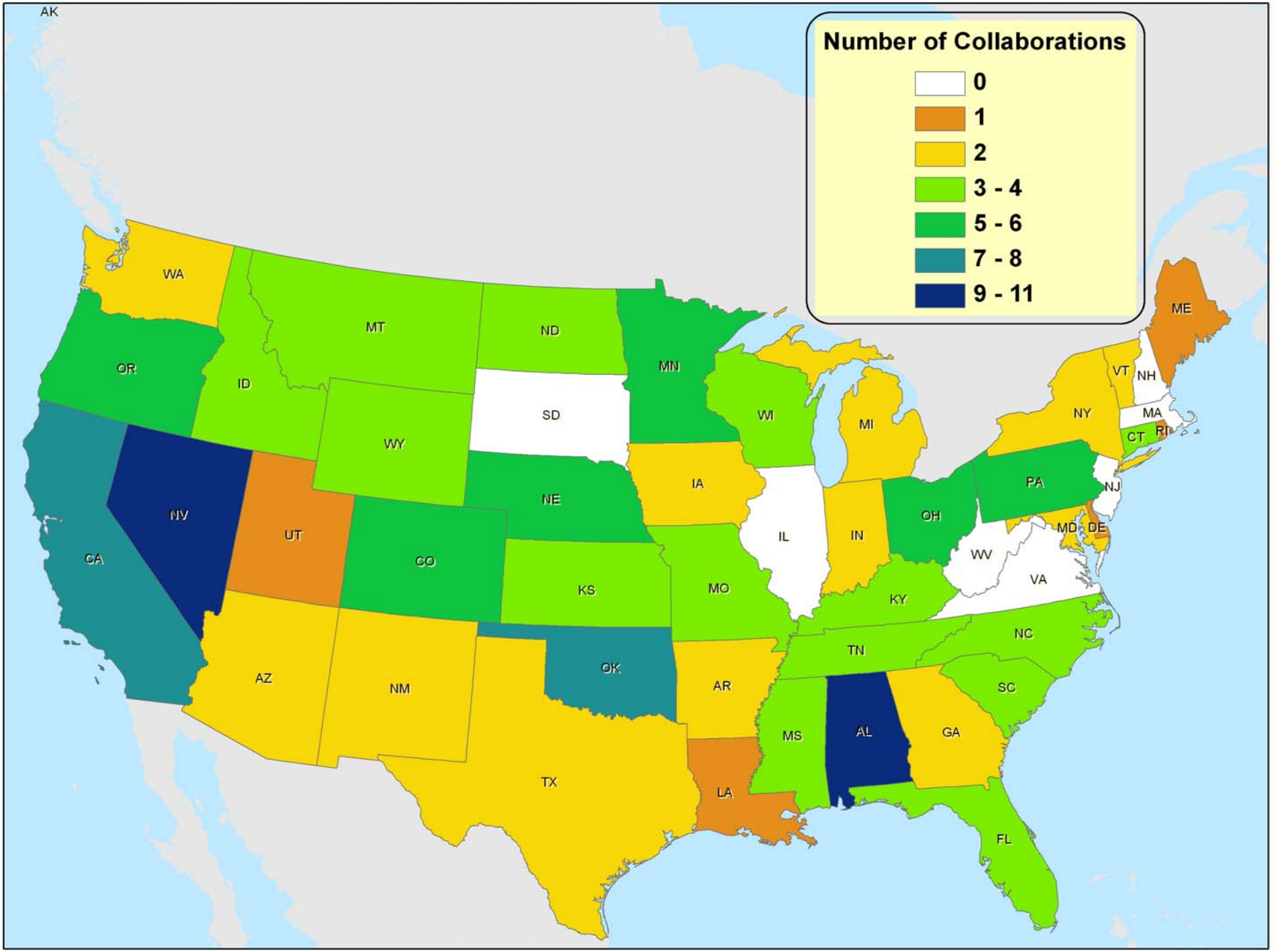
Beef USA

United Dairymen of Idaho

CCA

California Dairy Campaign

LMA
Livestock Marketing Association


Number of Collaborations
0
1
2
3 - 4
5 - 6
7 - 8
9 - 11
AK
WA
OR
CA
NV
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NM
ND
SD
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KS
OK
TX
MN
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MA
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CT
NJ
DE
MD

Conclusions

- Simulation modeling is a useful tool to inform decision makers.
- Care must be taken to insure models are sufficiently complete and provide useful information.
- Disease simulation models may be integrated with transportation and economics models to provide a suite of decision support models.