Protecting Public Health by Limiting Influenza A Virus Spread in Pigs at Agricultural Fairs

Monday, June 6, 2016
2:00-3:00 pm Eastern

Council of State and Territorial Epidemiologists

Webinar Housekeeping

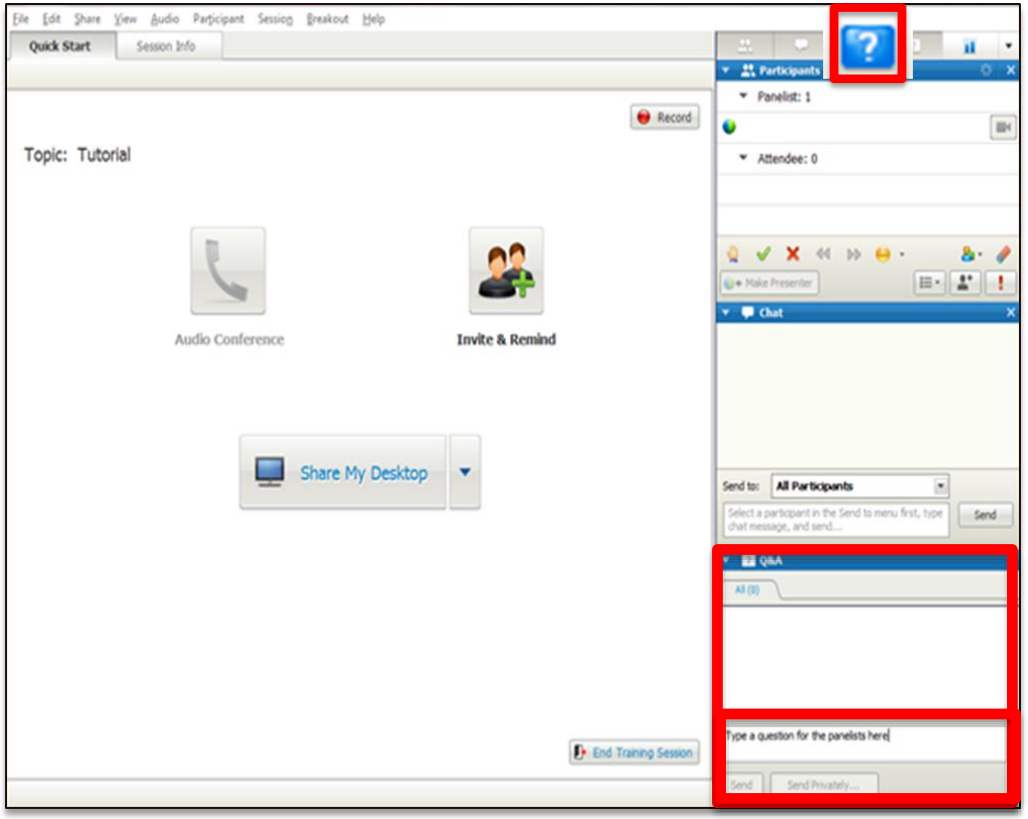
CSTE

Webinar Housekeeping

- **Please note that today's webinar is being recorded**
  - The webinar recording and presentation slides will be available in the webinar library on CSTE's website: http://www.cste.org/?page=WebinarLibrary
- **All phone lines have been placed on mute**
- **There will be a question-and-answer session at the end of the webinar**
  - To ask a question, please use the Q&A box on the right side of your screen

To Ask a Question

- Click on the blue question mark tab on the top right panel of your screen
- This will open the Q&A box on the bottom right panel on your screen
- Type a question and click Send
- Questions will be answered during the Q&A period



Learning Objectives

By the end of the webinar, participants will be able to:

1. Discuss zoonotic transmission of influenza A virus in the context of agricultural fairs.
2. Describe potential ways to control influenza A virus transmission during agricultural fairs and livestock exhibitions.
3. Understand the scientific evidence behind the recommendation of limiting swine exhibitions to 72 hours or less.

THE OHIO STATE UNIVERSITY
COLLEGE OF VETERINARY MEDICINE

6 June 2016

Protecting Public Health by Limiting Influenza A Virus Spread in Pigs at Agricultural Fairs

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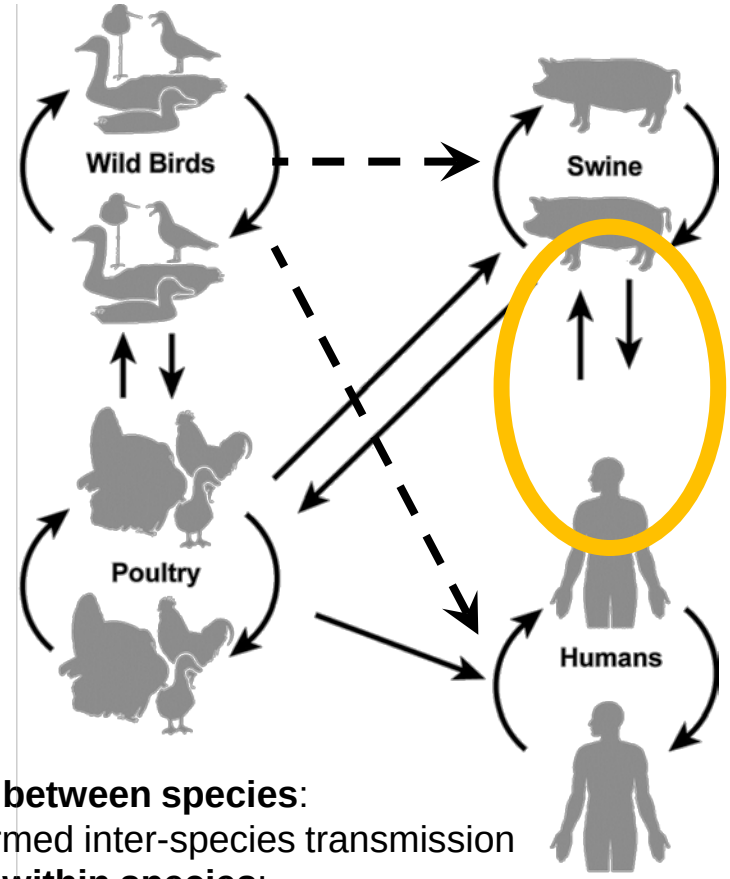
The Ohio State University

Background

- Pigs play a critical role in the ecology and epidemiology of influenza A viruses infecting humans.
- Interspecies transmission received considerable publicity following the emergence of the influenza A (H1N1)pdm09 virus.



Solid lines between species:
Confirmed inter-species transmission
Solid lines within species:
Intra-species maintenance cycle
Dotted lines between species:
Suspected interspecies transmission

Changes in Nomenclature

- Swine Influenza Virus
- **Influenza A Virus in Swine (IAV-S)**

- Pandemic influenza A (H1N1) 2009 virus
  - **Influenza A (H1N1)pdm09**

- Animal-origin influenza viruses identified in humans
  - **“Variant” denoted with a “v”**

Agricultural Fairs

Unique swine-human interface

- Non-commercial swine (youth education programs)
- Multi-source pigs
- High people:pig ratio (~150 million people)
- Pigs and people comingled for a prolonged period of time

Public Health Importance

306 documented human cases of H3N2v across 10 states during the summer of 2012

80% of the cases from two states

- **138 cases in Indiana**
- **107 cases in Ohio**

16 hospitalizations and one fatality

Jhung et al., Clin Infect Dis. 2013 Dec;57(12):1703-12

Majority of the cases had prolonged direct or indirect exposure to swine (exhibitors or their family members)

Linked to 14 of Ohio's agricultural fairs

7 participating in surveillance project

Sampling Methods

Weights

Shows

Sale

Entry

4-36 hours

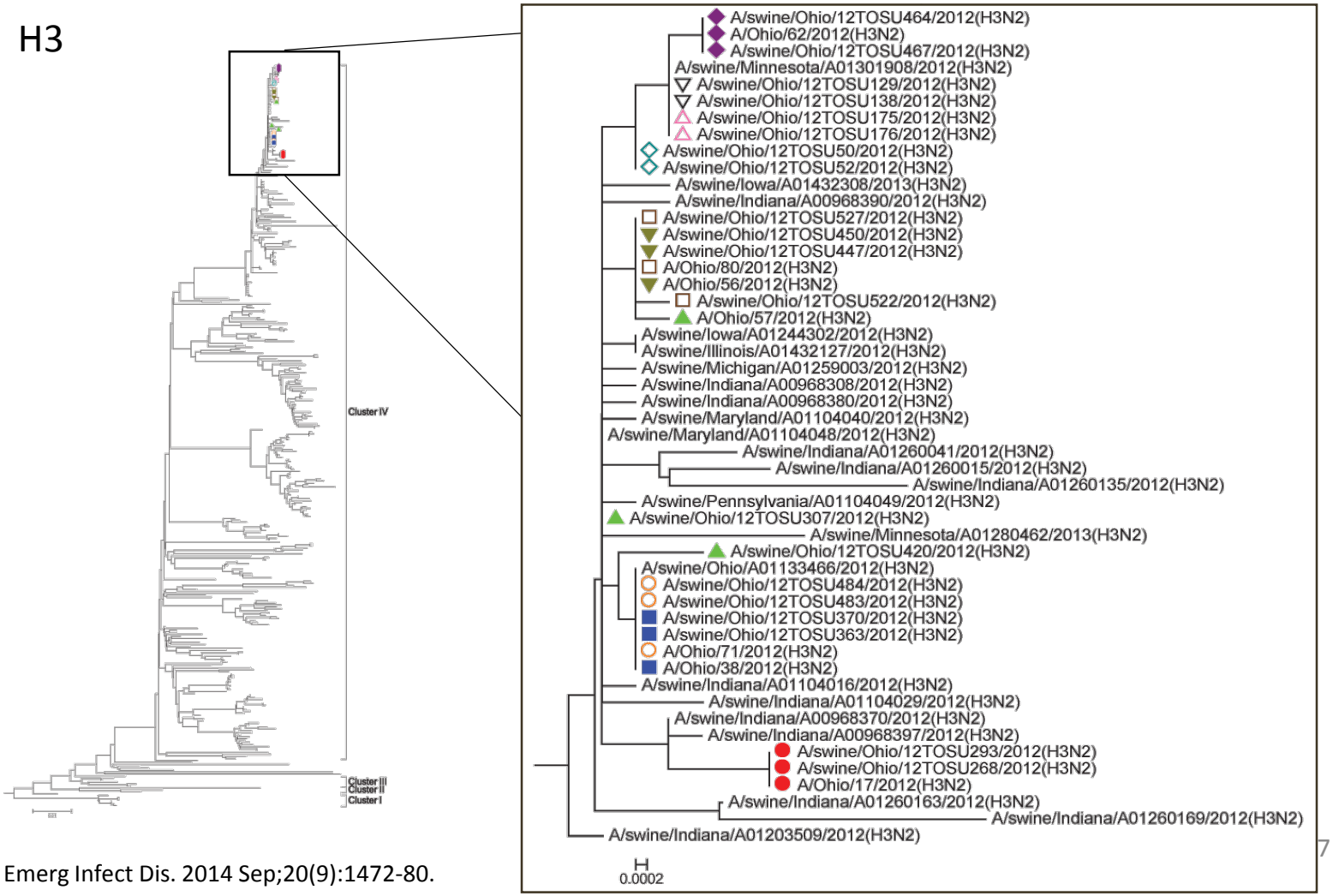
Exhibition Period

3-10 days

Departure

4-36 hours

H3



Bowman et al., Emerg Infect Dis. 2014 Sep;20(9):1472-80.

Agricultural Fairs

Agricultural fairs have been held in the U.S. since 1811

- Family events
- Celebration of agricultural heritage and achievement
- Agricultural education

Percent of fairs/exhibitions ≥ 1 pig IAV positive

	2009	2010	2011	2012
Ohio	**20.0% (3/15)**	**18.8% (3/16)**	**27.3 % (6/22)**	**25% (10/40)**

Percent of sampled pigs testing IAV positive (all fairs)

2009	2010	2011	2012
13.4% (40/299)	**10.8% (34/315)**	**17.7 % (81/459)**	**19.3% (161/834)**

Percent of sampled pigs testing IAV positive (positive fairs)

2009	2010	2011	2012
72.7% (40/55)	**56.7% (34/60)**	**57.8 % (81/140)**	**68.8% (161/234)**

Policy Working Group

- American Association of Swine Veterinarians
- Centers for Disease Control and Prevention
- Council for State and Territorial Epidemiologists
- International Association of Fairs and Exhibitions
- Minnesota Center for Influenza Research and Surveillance
- National Assembly of State Animal Health Officials
- National Association of State Public Health Veterinarians
- National Pork Board
- National Swine Registry
- USDA, APHIS, VS
- USDA, NIFA, Youth & 4-H

National Assembly of State Animal Health Officials (NASAHO)
National Association of State Public Health Veterinarians (NASPHV)

Measures to Minimize Influenza Transmission at Swine Exhibitions, 2013

It is estimated that 150 million people visit agricultural fairs each year in North America. Agricultural exhibitions provide valuable educational venues for the public. Equally important, the exhibition of swine is an important learning opportunity for thousands of youth exhibitors, 4-H and FFA members across the United States. Showing swine for these youth at their county or state fair is the culmination of many months of work dedicated to the care and training of their animal.

Pigs can be infected with human, swine and avian origin influenza A viruses. While rare, influenza A viruses can spread from pigs to people and from people to pigs, but it usually requires close contact between pigs and people. This has happened in different settings, including agricultural fairs. When people are infected with swine origin influenza A viruses, it is termed as a variant virus infection and denoted with a "v" after the subtype (e.g. H3N2v). In the past 5 years, cases of influenza A H1N1v, H1N2v and H3N2v have been associated with swine exhibitions. In 2011 there were 12 cases of H3N2v reported from 5 states. In 2012 there were a total of 309 cases of H3N2v identified in 12 states. The majority of cases reported exposure to pigs prior to onset of illness and were exhibitors and others in close contact with pigs at agricultural fairs. Sixteen of these individuals were hospitalized and one death was reported. Eleven of the 16 hospitalized cases, as well as the person who died, were people considered to be at high risk for complications from influenza infections. People at high risk include children younger than 5 years of age, people 65 years of age and older, pregnant women and people with certain long-term health conditions (like asthma, diabetes, heart disease, chronic respiratory disease, weakened immune systems, and neurological or neurodevelopmental conditions.)

These cases led to the formation of the Swine Exhibitions Zoonotic Influenza Working Group that has developed a set of measures to minimize influenza virus transmission between swine, from people to swine, and from swine to people at swine exhibitions. Influenza viruses are unpredictable and their impact and circulation can vary by year. It may not be possible to prevent all transmission of influenza viruses at swine exhibitions. The measures described here are offered for careful consideration depending on the needs of the specific exhibition and can be implemented in part or in total. They are not intended to supersede federal, state, or local regulations. These measures were formulated based on current evidence and the collective knowledge of the Swine Exhibitions Zoonotic Influenza Working Group. It is expected that this document will be updated regularly as additional information becomes available.

The suggested measures have been organized to address activities before, during, and after swine exhibitions. Measures are further divided into actions that may minimize risk to swine and risk to humans, although there is significant overlap between those two groups.

1

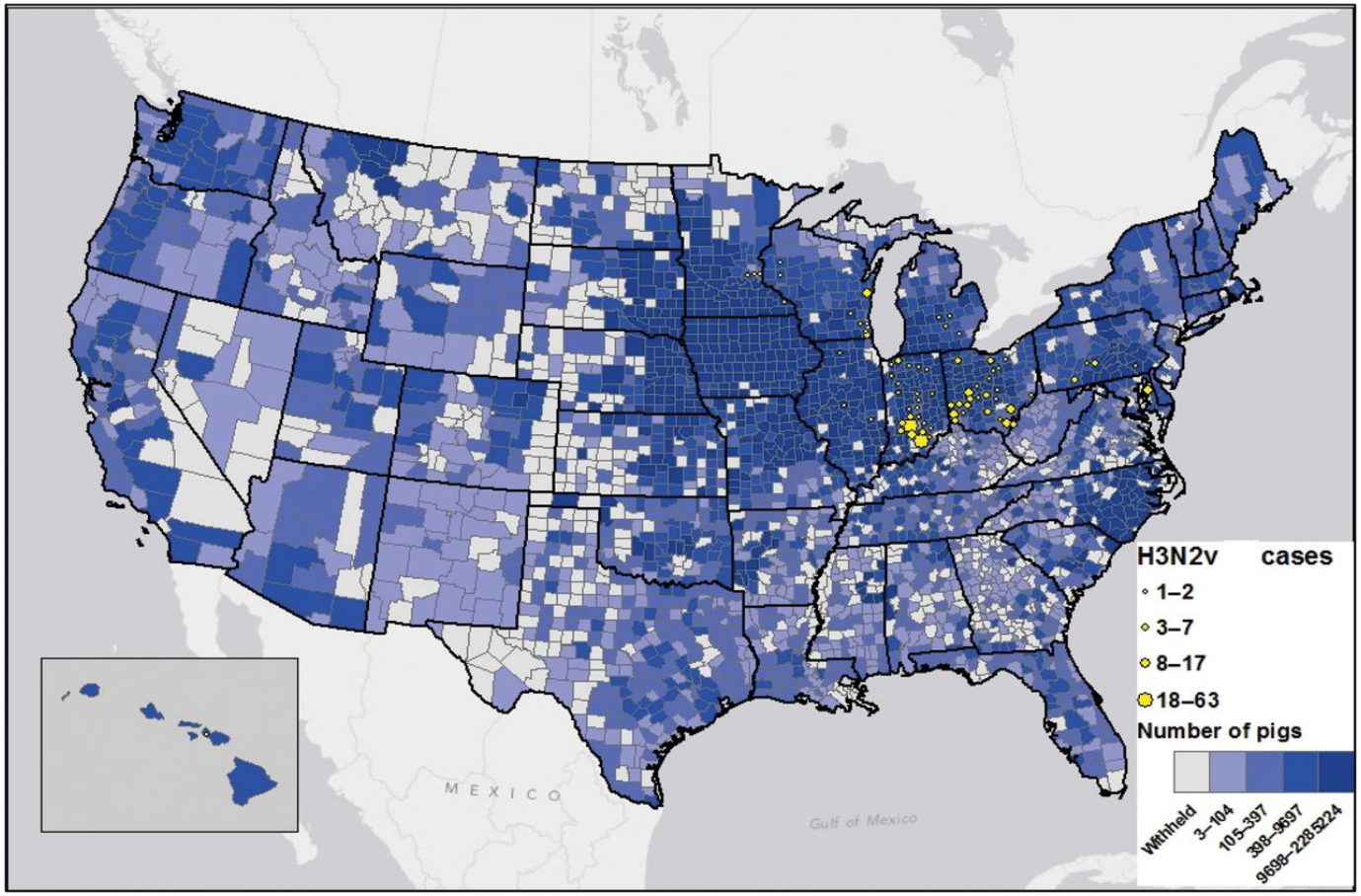
What are “exhibition swine” ?

- Swine that are shown for evaluation of the animal or the handler.
- Swine can be shown at multiple times, across multiple locations, in exhibitions open to any age competitor. Examples: 4-H and FFA projects

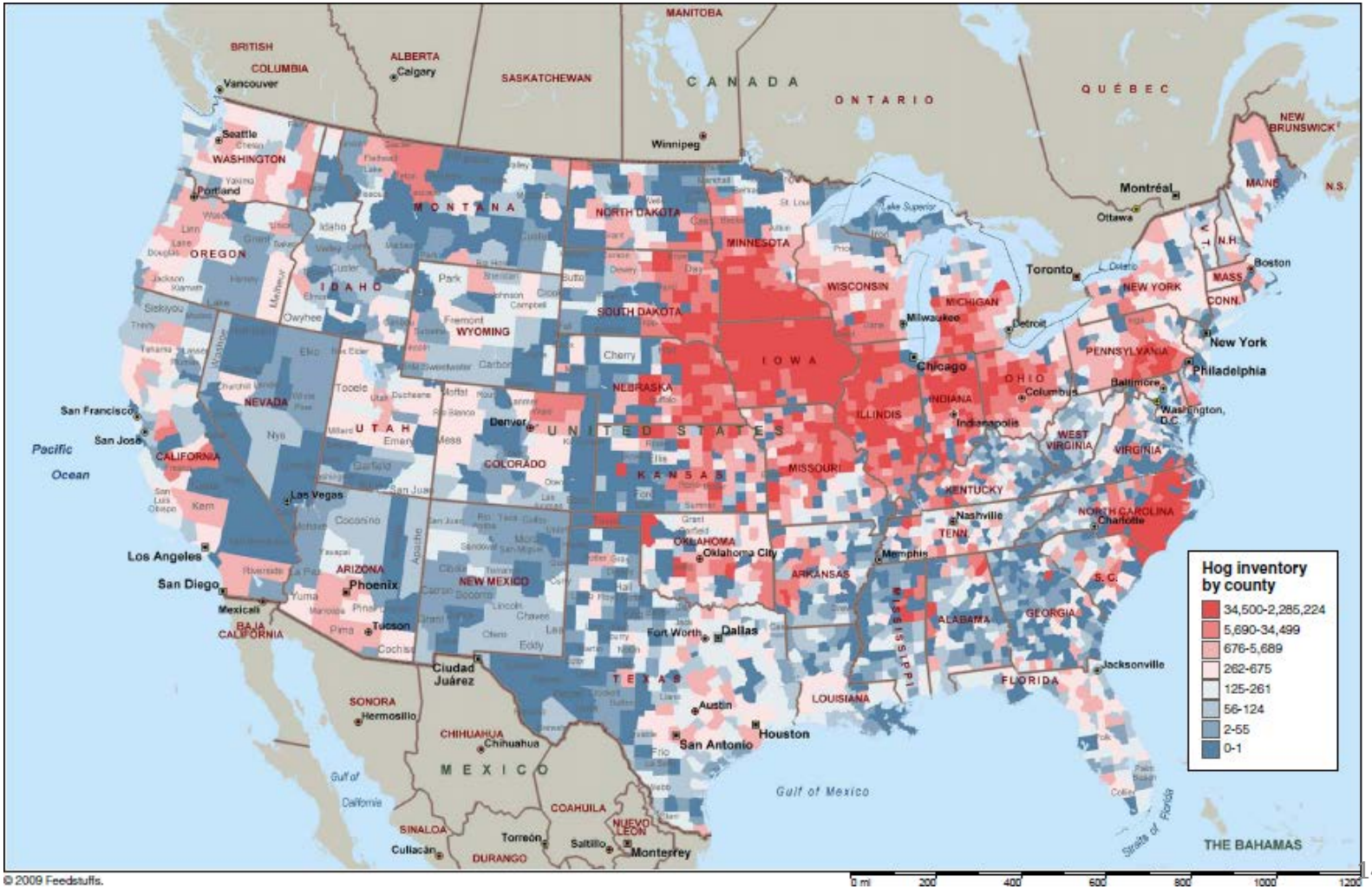
	Exhibition Swine	Commercial Swine
Size of industry	1 million	66 million
Humans that are exposed	Naïve (?)	Continually exposed
Size of farm	Small (?)	$\bar{x}$ = 1,044 head
Biosecurity plan	(?)	Yes
Population integrity	Low, multiple exhibitions (?)	High

Wayne *el at,* JAVMA, 2012.
& USDA, Agriculture Census, 2012.

Geographic distribution of influenza A(H3N2) variant virus cases, by county, United States, July–September 2012, and number of pigs by county (2007).



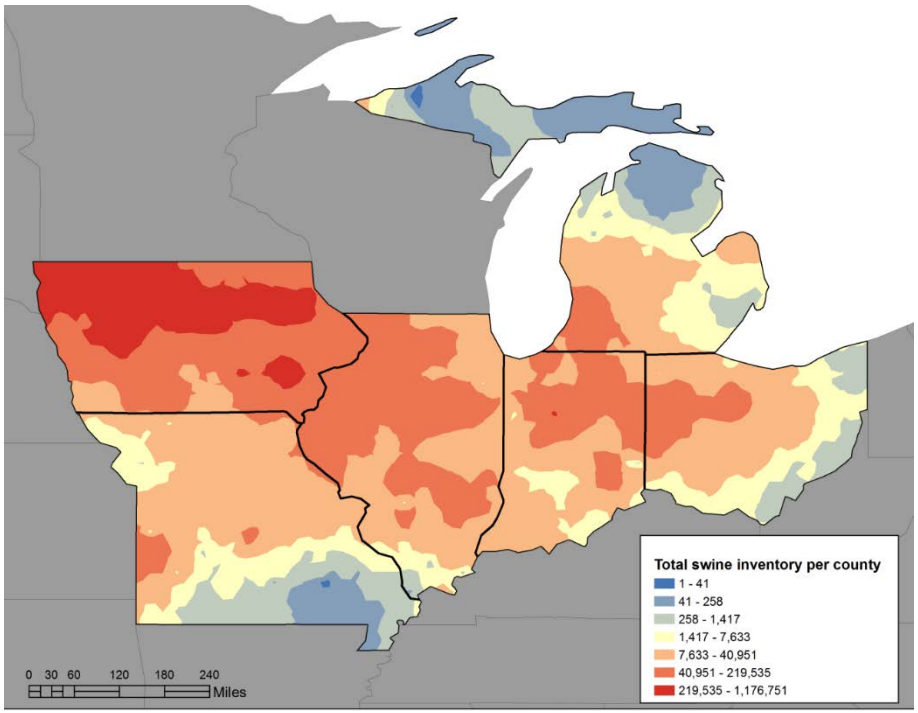
Jhung et al.,
Clin Infect Dis.
2013;57:1703–1712


Hog inventory by county
34,500-2,285,224
5,690-34,499
676-5,689
262-675
125-261
56-124
2-55
0-1
© 2009 Feedstuffs.
0 mi
200
400
600
800
1000
1200

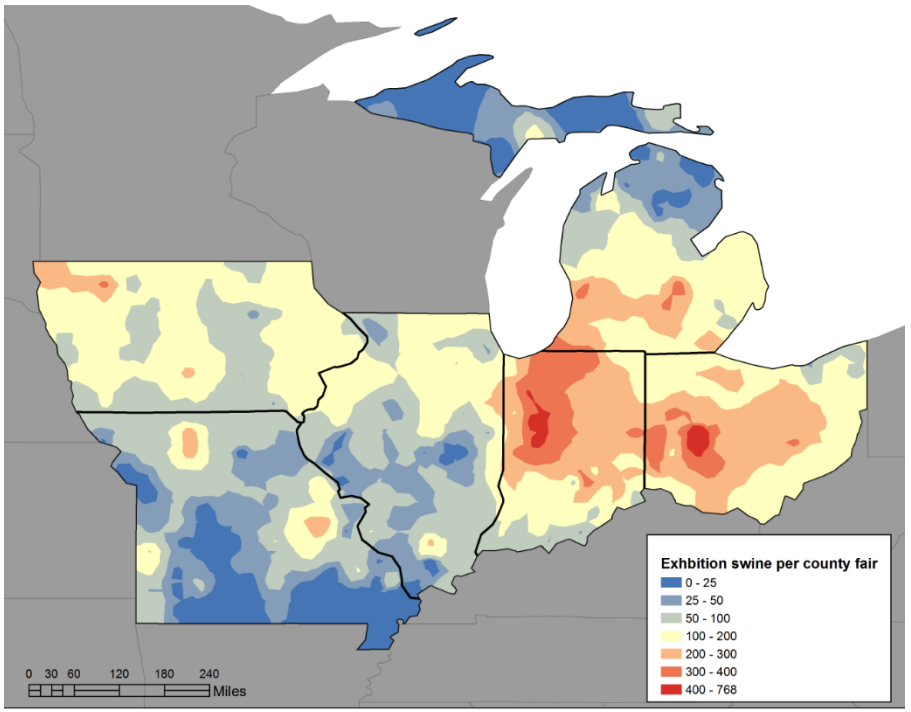
Determine the geographical distribution of exhibition swine

- Six states participated: Illinois, Indiana, Iowa, Michigan, Missouri, and Ohio
- Fair organizers and state animal health officials reported total number of exhibition swine attending fairs on a county basis during 2013.
- The reported swine per county were interpolated to the geometric centroid of each county.
- A continuous spatial distribution developed using inverse distance weighting based on 15 neighbors.

Total swine inventory



Exhibition swine per county fair

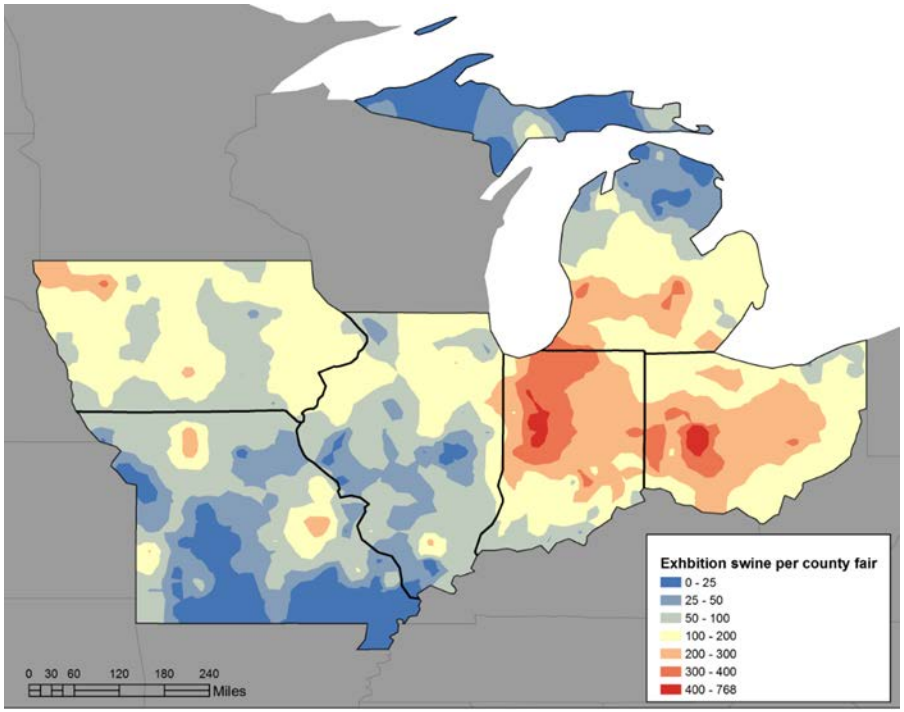


Lower concentration

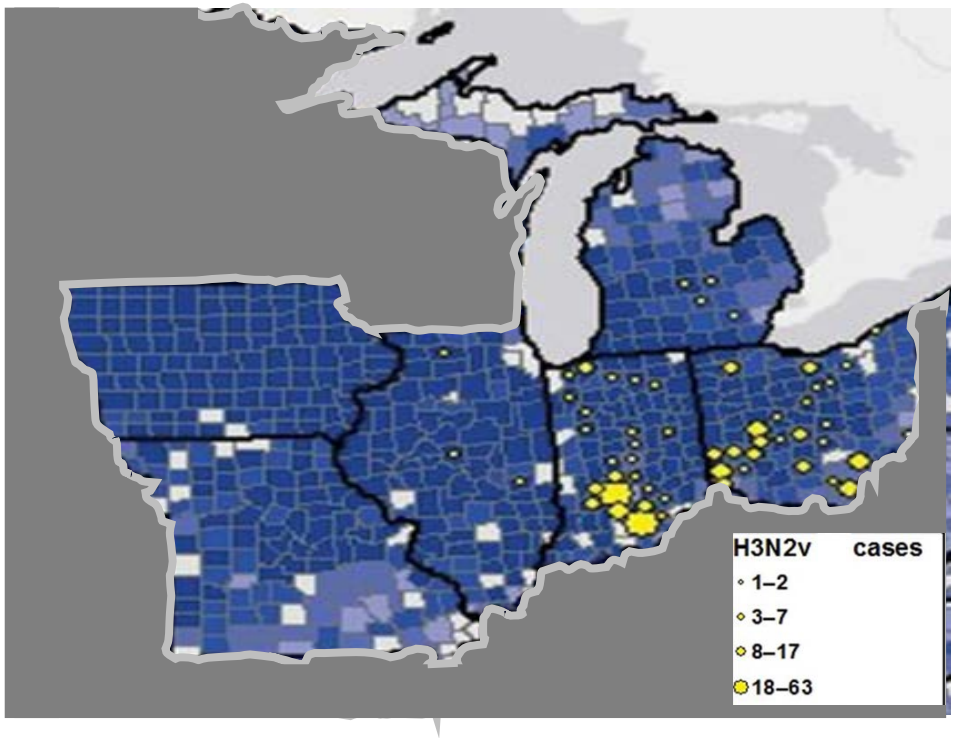
Higher concentration

Bliss N. et al, JAVMA (in press)

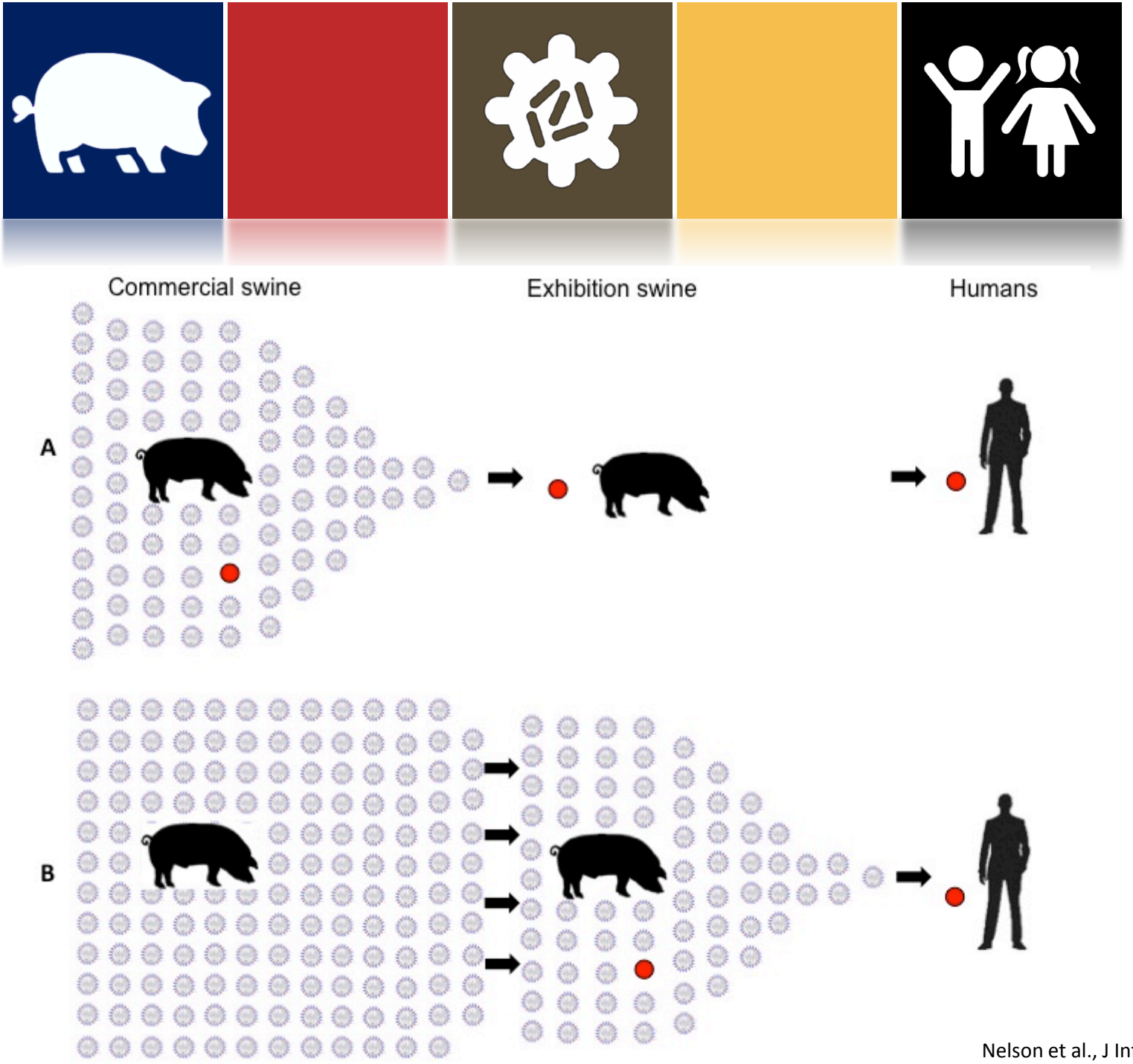
Exhibition swine



Human cases with total swine

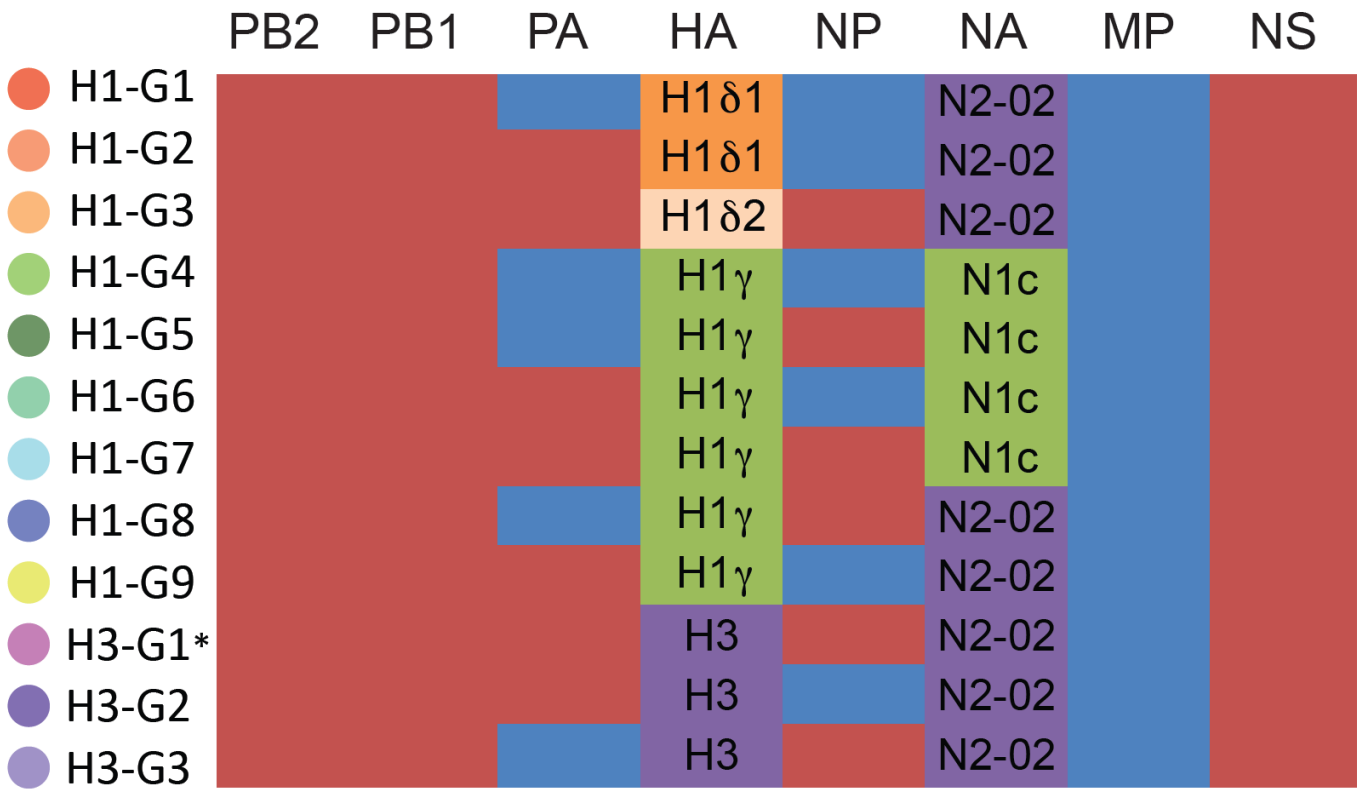


Modified from Jhung et al. Clin Infect Dis, 2013



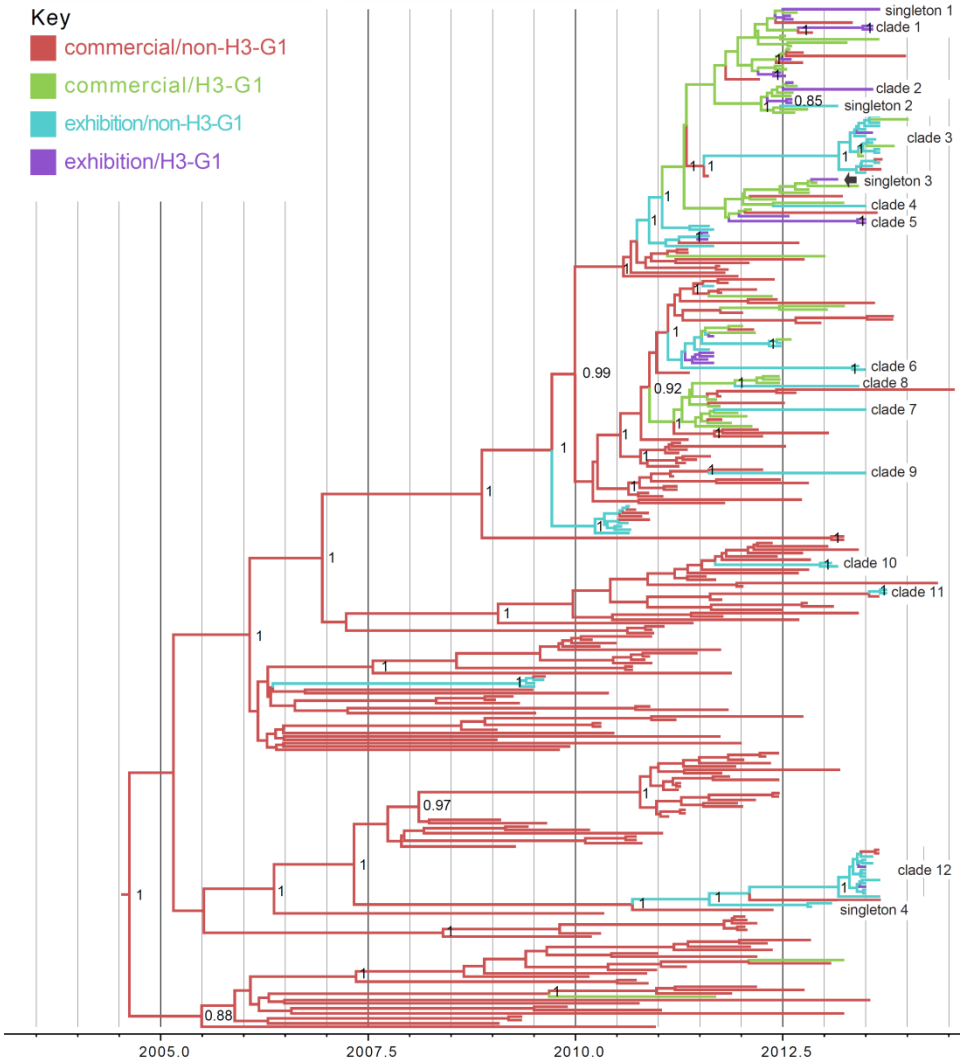
Nelson et al., J Infect Dis, 2016

2013 Genotypes



Nelson et al., J Infect Dis, 2016

PB2



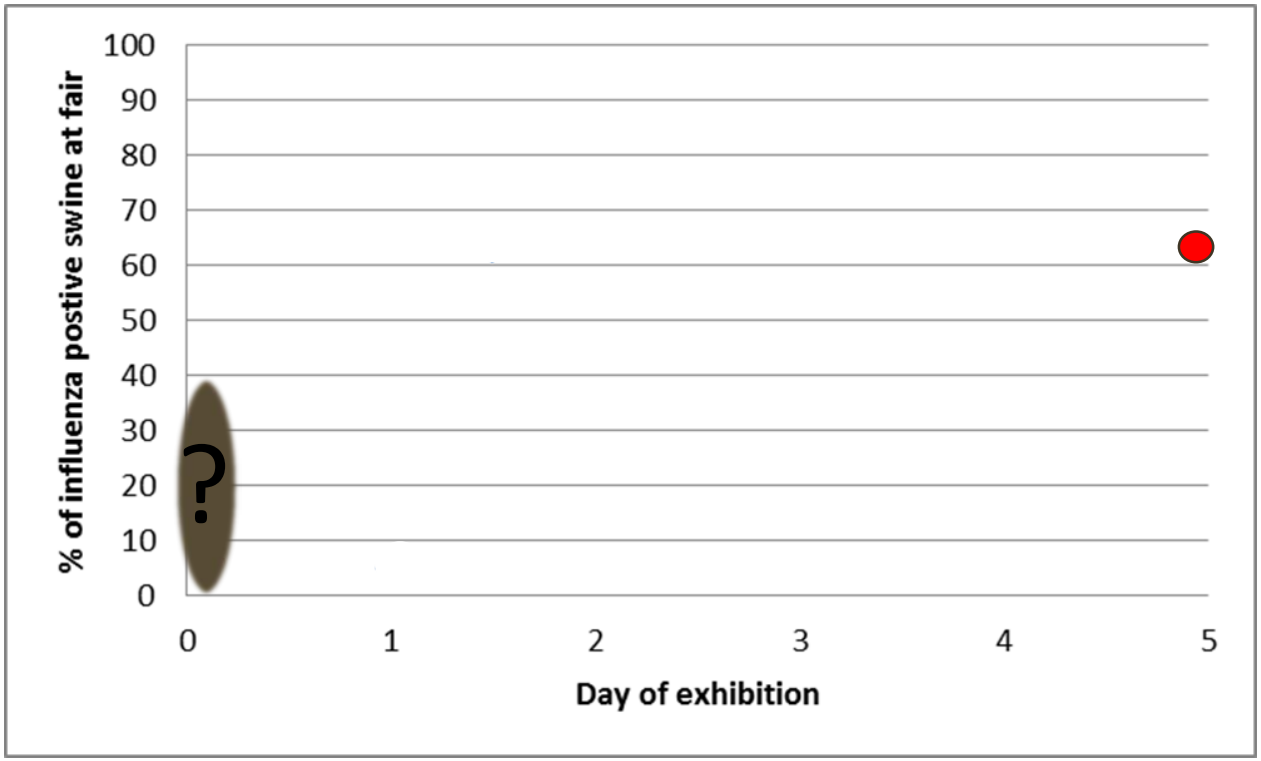
Nelson et al., J Infect Dis, 2016

Conclusions

- Frequent introduction of IAVs from commercial swine populations.
  - Extent of viral exchange between commercial and exhibition swine was unexpected
- Reassortment between viruses co-circulating in exhibition swine further increases viral diversity.
- Exchange of viruses between exhibition swine in Indiana and Ohio.

State	Percent of fairs/exhibitions ≥ 1 pig IAV positive					
	2009	2010	2011	2012	2013	2014
Ohio	20.0% (3/15)	18.8% (3/16)	27.3 % (6/22)	25% (10/40)	36.1% (13/36)	18.2% (6/33)
Indiana					41.6% (15/36)	63.6% (14/22)
Iowa					14.3% (1/7)	6.3% (1/16)
Texas					22.2% (2/9)	
Colorado					0% (0/10)	
West Virginia					0% (0/1)	0% (0/1)
Kentucky				1/1 (100%)	0% (0/1)	1/1 (100%)
TOTAL	**20.0% (3/15)**	**18.8% (3/16)**	**27.3 % (6/22)**	**26.8% (11/41)**	**31.0% (31/100)**	**30.1% (22/73)**

Objectives


% of influenza postive swine at fair
100
90
80
70
60
50
40
30
20
10
0
?
0
1
2
3
4
5
Day of exhibition

Objectives

1. Determine the prevalence of influenza A virus in exhibition swine during arrival at agricultural fairs.

2. Characterize the on-farm management practice used for exhibition swine and identify where exhibition swine are located geographically.
   - Determine the risk factors associated with bringing a swine infected with influenza to a fair.

- During 2014, nine agricultural exhibitions (Exhibitions A-I) located in Indiana and Ohio were enrolled.
- Exhibition swine entering the fair were sampled during the first time they could be uniquely identified by ear tag.

Trailer

Exhibition A

Pen

Exhibition D and E

Chute

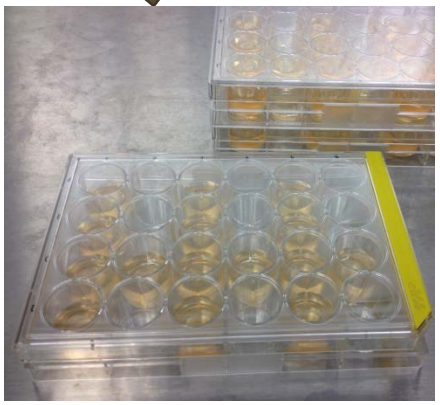
Exhibition B-C, F-I

Methods

Snout wipes collected

Samples placed in viral transport media and frozen

Sample RNA screened via rRT-PCR for influenza A virus



rRT-PCR positive (Ct ≤ 35) samples inoculated for virus isolation on MDCK cells

Fair

Exhibition A

Exhibition B

Exhibition C

Exhibition D

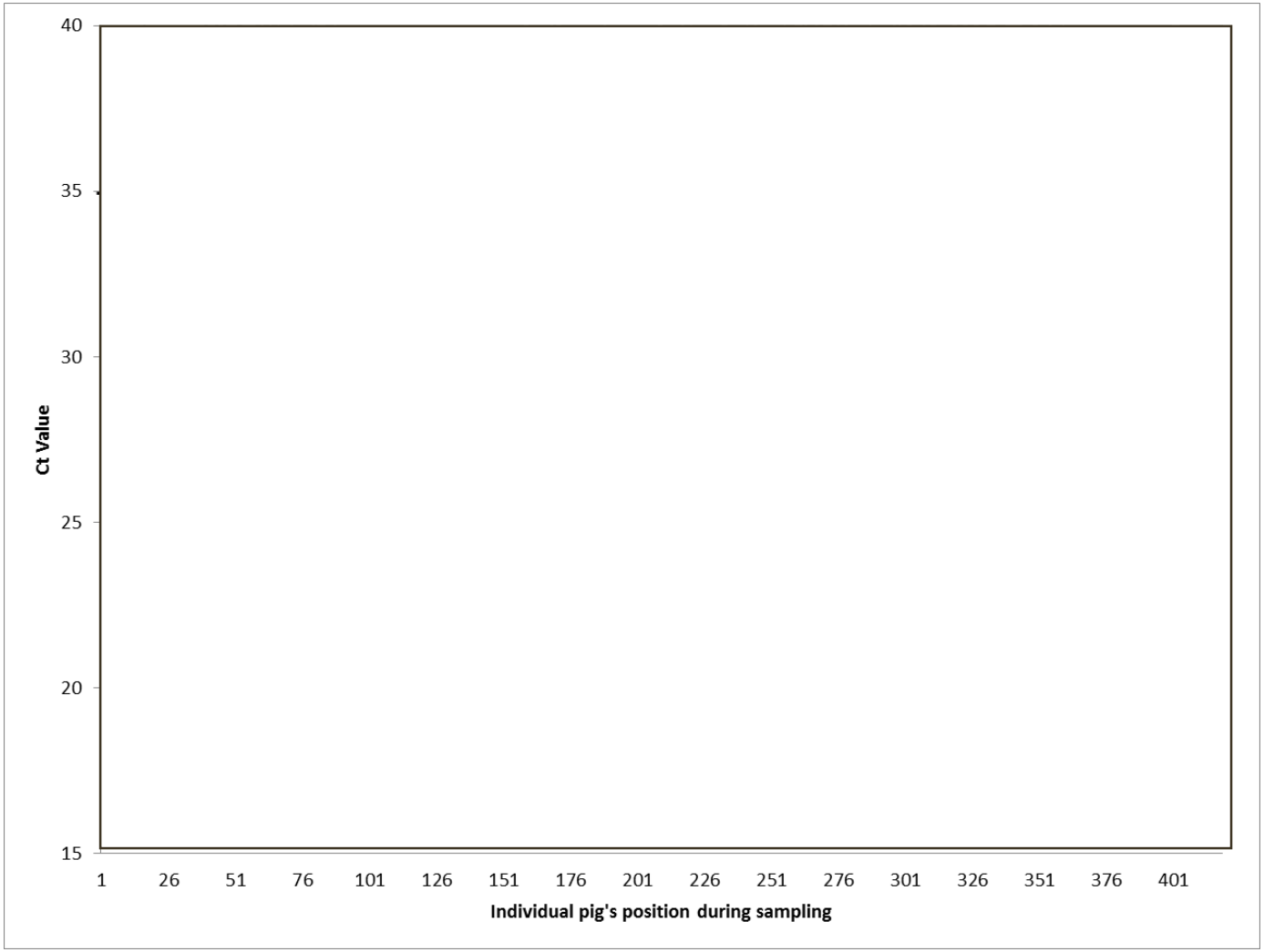
Exhibition E

Exhibition F

Exhibition G

Exhibition H

Exhibition I

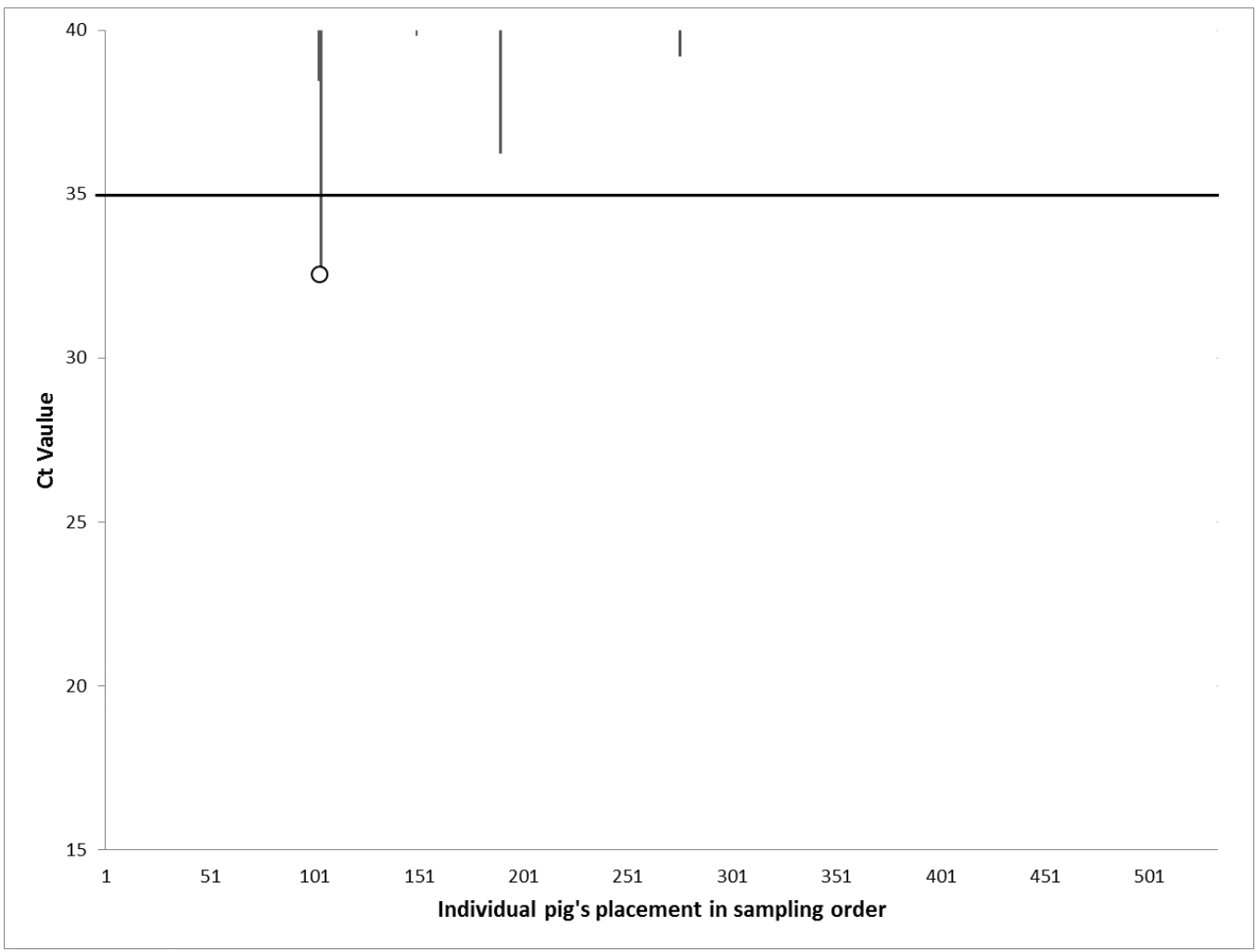


Exhibition B:

- Sampled in chute
- rRT-PCR positive: 144
- Isolates recovered: 43

Key:

- ● H1N1
- o H3N2
- ★ H1H3 N1N2



Exhibition E:

- Pigs sampled in pen prior to weigh-in.
- rRT-PCR positive: 1
- Isolates recovered: 1

Key:

- ● H1N1
- o H3N2
- ★ H1H3 N1N2

Conclusions

- The frequency of influenza virus isolation was low among arriving swine.
- Exhibition swine movement and corralling activities are likely to enhance pathogen transmission during exhibitions.
- Focus should be placed on mitigating influenza A virus spread during swine exhibitions rather than attempting to completely preclude entry of the influenza A virus infected swine.

Survey of on-farm practices

- A 24 question survey was administered to the adults accompanying the swine exhibitors at the fairs.
- 480 surveys were collected, over the nine exhibitions with 5,462 swine.
  - 52 of the surveys dropped from study
- Surveys were associated with swine sampled upon entry.
  - Surveys that were not associated with individual pigs were used for descriptive data.

Descriptive data findings: swine herd

- Most survey participants reported not having swine year round.
- Obtained swine from an off-farm source (75.4%).
  - Most sales occurring between March and April (84.3%).
- Exhibition swine were raised in small herds (median, 6; range 1-6500).
- The same location as other livestock (66.5%).
  - Cattle (53.5%)
  - Poultry (32.6%)
  - Goats (32.4%)
  - Horses (27.3%)
  - Sheep (24.8%)
  - Other (llamas, buffalo, rabbits, etc.) (11.7%)

Descriptive data findings: movement

- Participants reported showing swine at an average 3.38 exhibitions during 2014.
  - (median 2; range 0-50)
- Brought swine back to the farm from an average from 2.88 exhibitions.
  - (median 2; range 0-40)
- Number of exhibitions attended by an individual pig averaged 2.19.
  - (median 1; range 0-30)
- Average travel time from loading to exhibition for these pigs was 3.20 hours.
  - (median 2 hours; range 5 minutes – 24 hours)

Exhibition swine management

- Half of the premises (48.6%) implemented some form of isolation for returning swine.
- Contact with swine or the environment of swine, other than their own, occurred at least once a week at 45.2% of the premise of the participant.
- Commercial swine production was reported at 13.3% of the premises as where the exhibition swine were raised.

At least one swine testing IAV positive via rRT-PCR	Odds Ratio	*P* value	95% confidence interval	Number of rRT-PCR events
No. of swine on premise January 1st, 2014	0.999	0.936	0.996 – 1.001	11
No. of swine on premise the day prior to attending exhibition	0.999	0.976	0.993 - 1.001	15
Maximum no. of swine on premises in 2014	1.000	0.789	0.998 – 1.068	15
No. of exhibitions attended by swine from premise in 2014	0.952	0.651	0.775 – 1.068	15
No. of exhibitions that swine returned to premise in 2014	1.053	0.234	0.956 – 1.142	14
Open houses/sales hosted on premise were people would come into contact with swine	3.933	0.035	1.097 – 13.064	6
New swine were directly mixed into existing herd on premise	2.131	0.266	0.603 – 6.966	15
Swine were obtained from an off-farm source	0.457	0.247	0.140 – 2.100	15
Distance from premise to closest commercial farm	0.948	0.682	0.751 – 1.201	15
Other livestock were raised on same premise as swine	0.627	0.562	0.185 – 2.255	6
The total time, in minutes, swine were on trailer during transportation to exhibition	1.001	0.153	0.999 – 1.003	15
No. of exhibitions attended by individual swine in 2014	0.943	0.635	0.748 – 1.092	21
No. of exhibitions that was planned to be attended by individual swine after current exhibition	0.858	0.794	0.387 – 1.333	9
Individual swine was reported as receiving a vaccination to influenza	2.828	0.143	0.773 – 15.606	3

Risk Factor

- Participants that hosted and open house or sale had 3.93 times the odds of having an IAV positive pig compared to the odds of participants that did not host an open house or sale.
  - 95% CI: 1.1 – 13.01
  - p = 0.035

- An open house/sale is an event hosted, prior to the fair, for other people at the farm to purchase swine.

- We think that this is identifying is the professional showmen.

Exhibition swine management

	Vaccinated	Not vaccinated
No. of pig with reported vaccination status	62.74% (197/314)	37.26% (117/314)
No. of rRT-PCR positive samples	7.77% (15/193)	2.88% (3/104)
No. of virus isolates	33.33% (5/15)	33.33% (1/3)

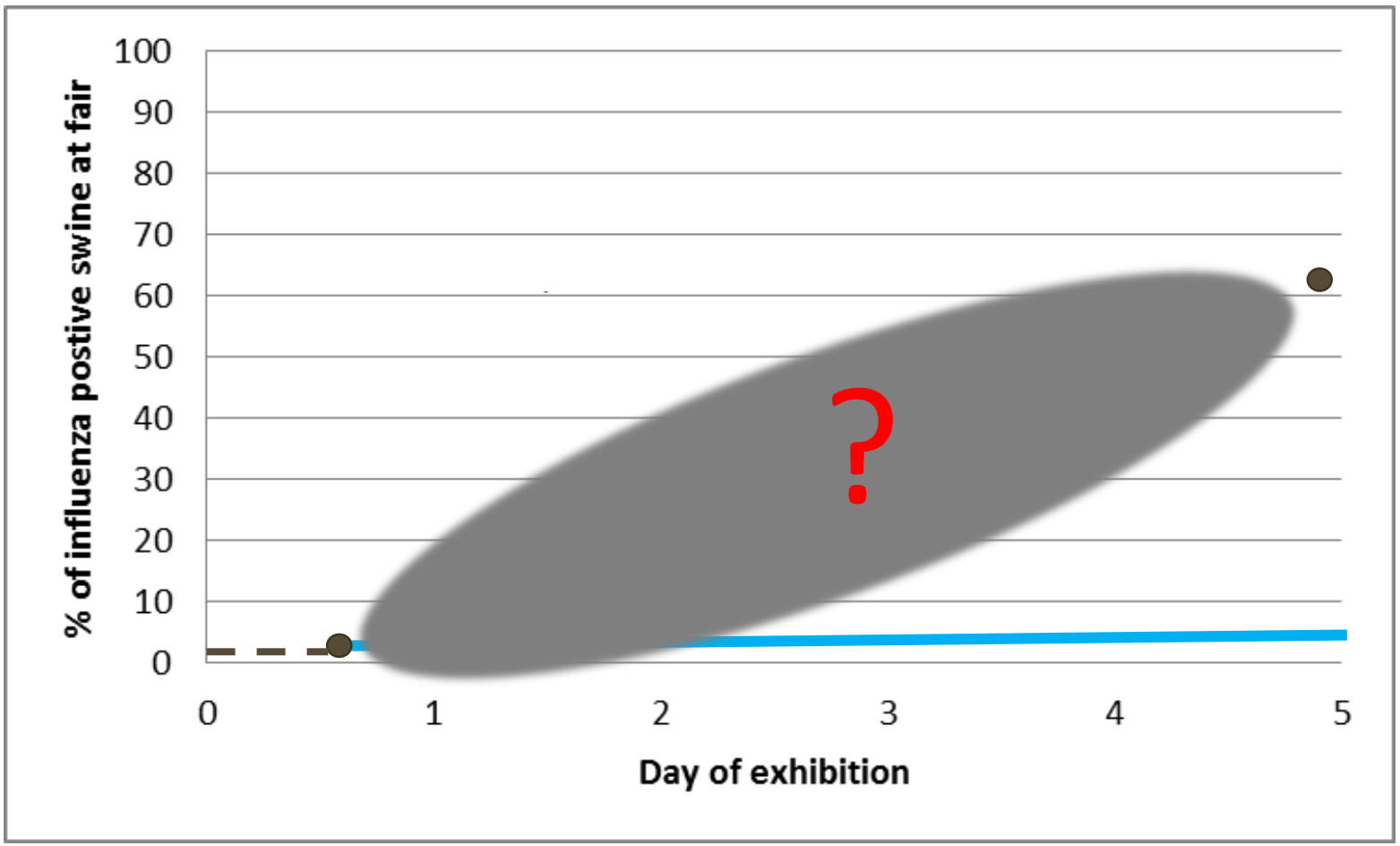
- 62.7% of swine were reported as vaccinated for influenza
- Having a reported vaccination status did not protect for influenza

Vaccination of swine, may repress clinical signs of disease without preventing infection or transmission

Loving *et al,* J Virol ,2013

Conclusion

- The exhibition swine industry is composed of a diverse mixture of farm types and management practice differed from commercial swine production.
- There exists an interaction between commercial and exhibition swine industries. Although this is still poorly defined, this helps us to understand the viral gene flow between these two swine populations.


% of influenza postive swine at fair
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
Day of exhibition
?

Shorten swine exhibitions

"Shorten the total time pigs are on the exhibition grounds, ideally exhibition swine should be on the exhibition grounds no more than 72 hours."

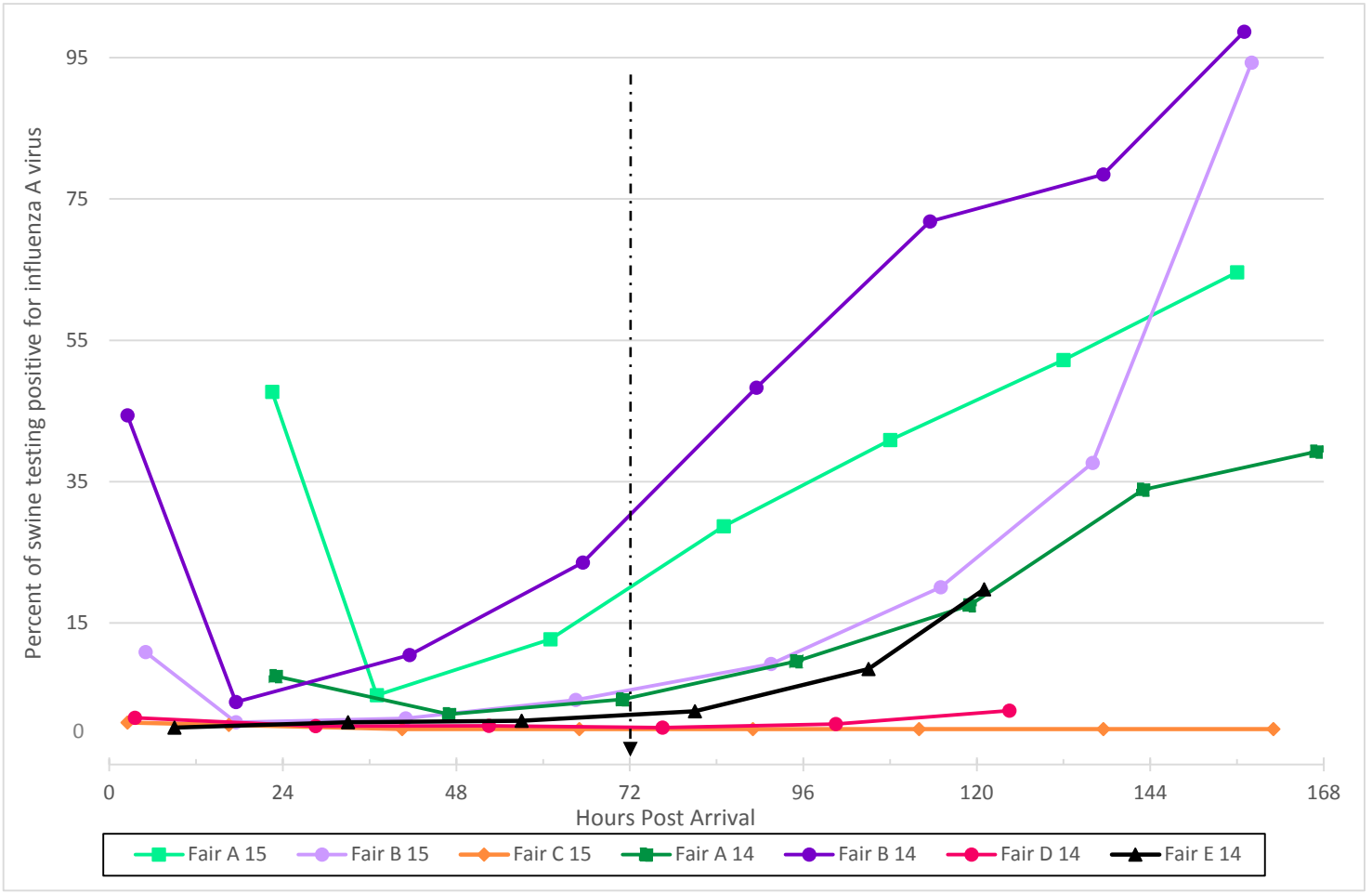
-Measures to Minimize Influenza Transmission at Swine Exhibitions

Objective:

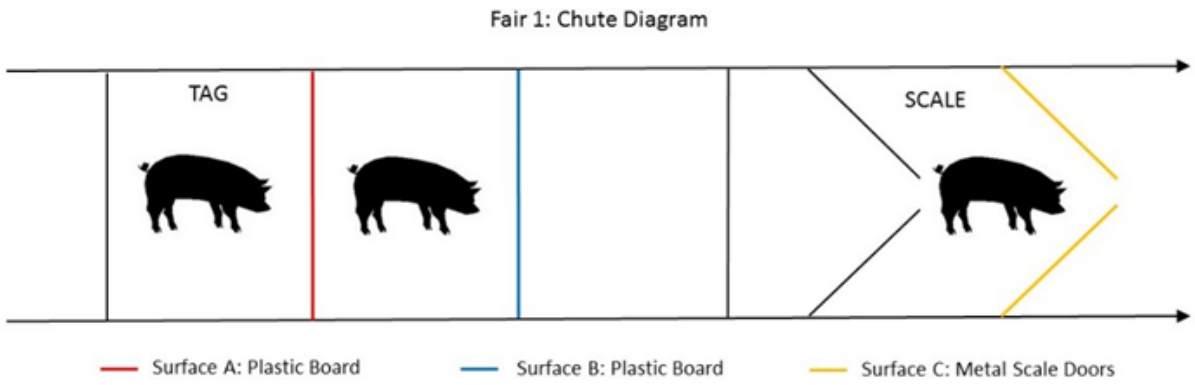
Validate the recommendation of limiting swine exhibitions to 72 hours to prevent zoonotic transmission of IAV-S.

Results

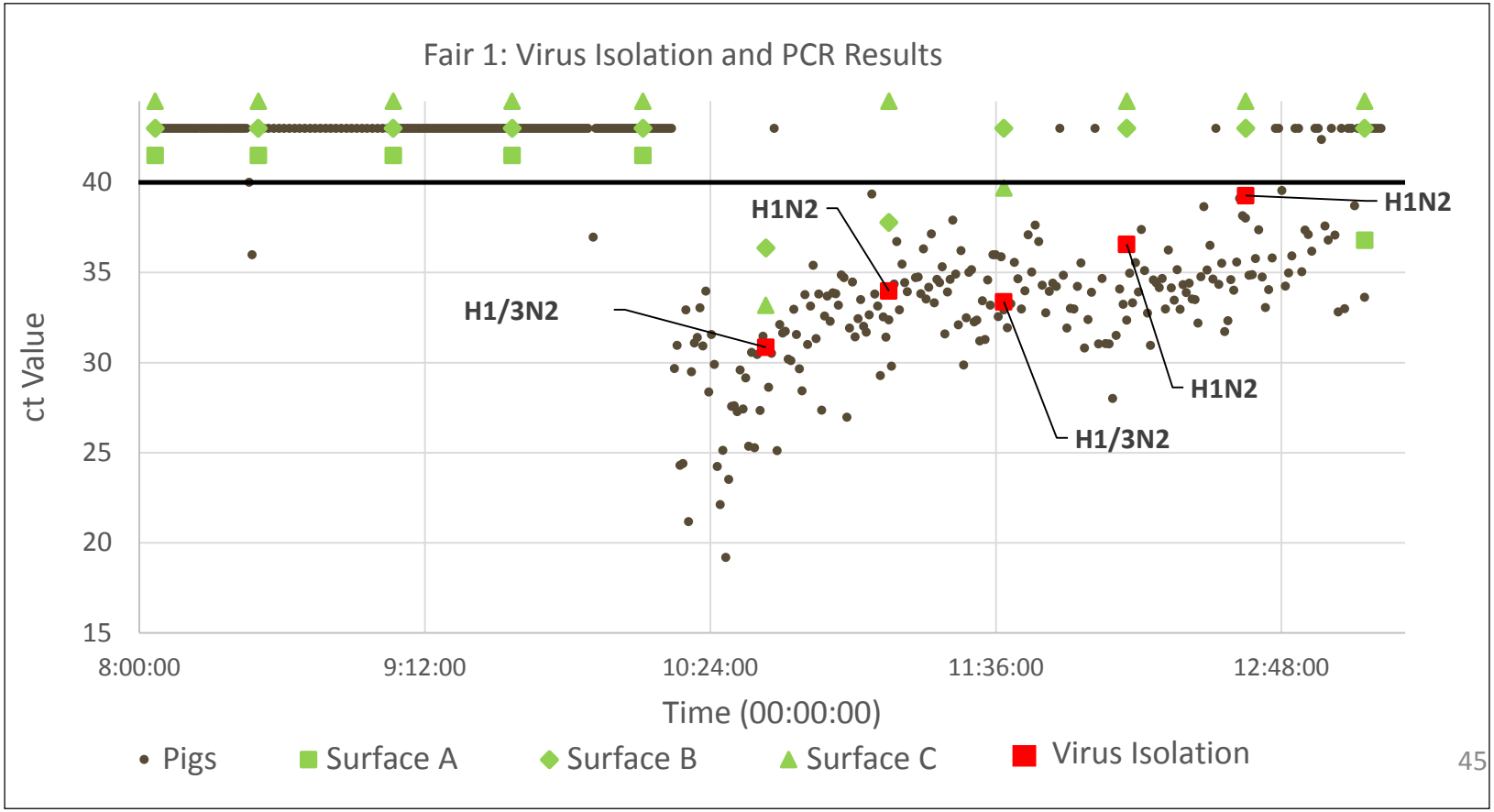
- 6,810 pigs sampled
- 948 (13.9%) were detected as positive during the course of study.
- IAV was detected in the pigs at 7 (44%) of the 16 fairs
  - Sustained IAV transmission at 5 of the 7
- Within those 5 events, the proportion of pigs testing positive for IAV at the conclusion of fairs was 49%.
- If the exhibitions had ended at 72 hours, the proportion of positive pigs would have been <18%.

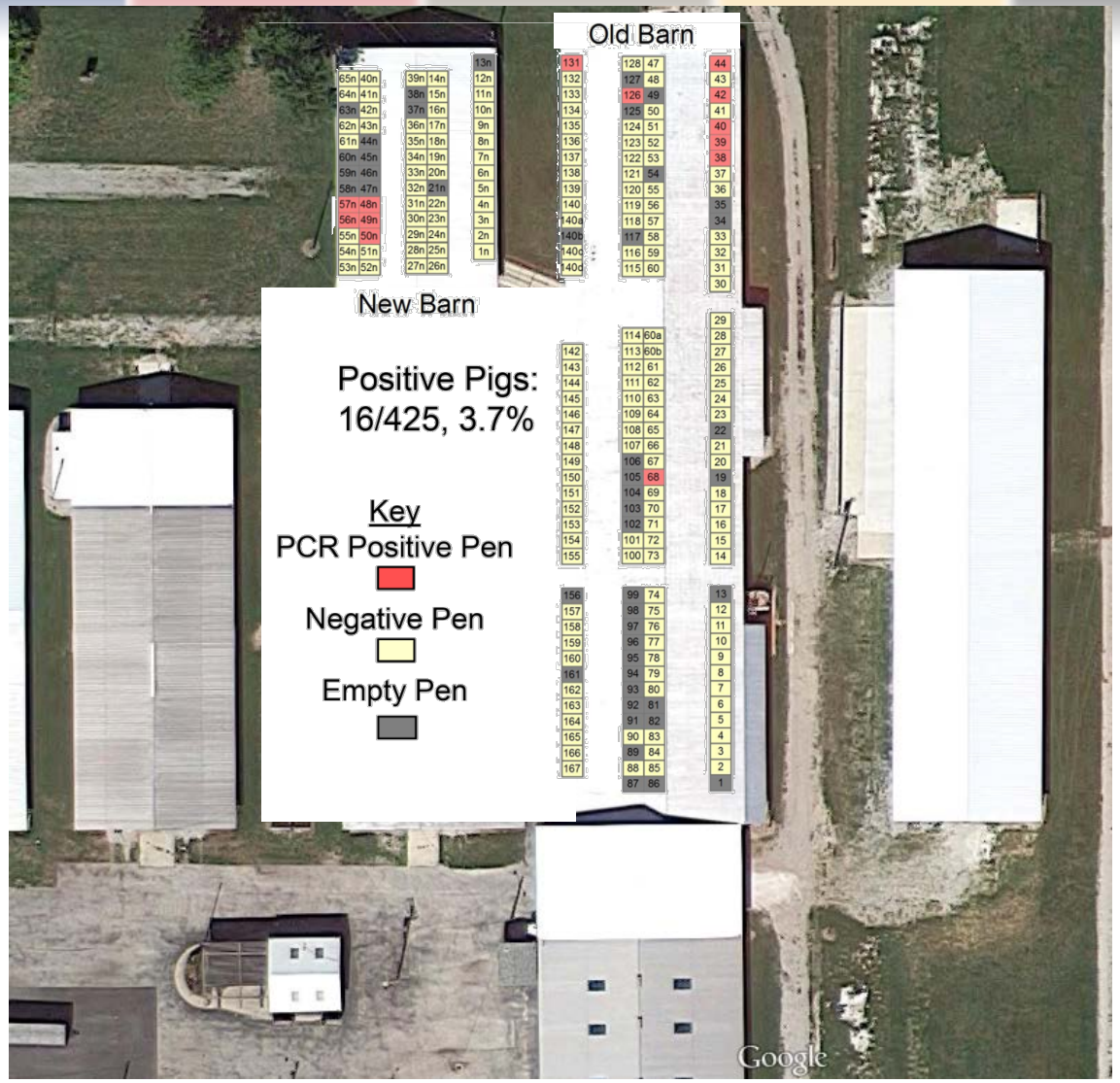

Percent of swine testing positive for influenza A virus
95
75
55
35
15
0
0
24
48
72
96
120
144
168
Hours Post Arrival
Fair A 15
Fair B 15
Fair C 15
Fair A 14
Fair B 14
Fair D 14
Fair E 14

Accelerated Spread

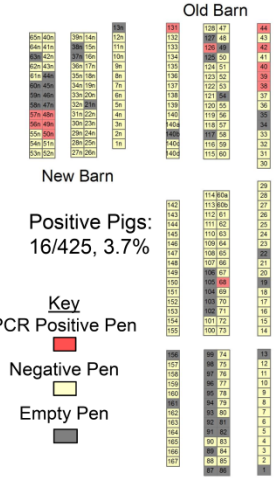


Accelerated Spread




Old Barn
New Barn
Positive Pigs:
16/425, 3.7%
Key
PCR Positive Pen
Negative Pen
Empty Pen
Google

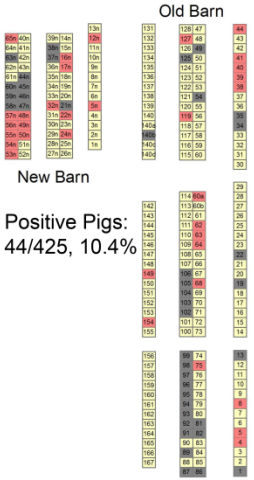
Day 1 Barn Map



Positive Pigs: 16/425, 3.7%

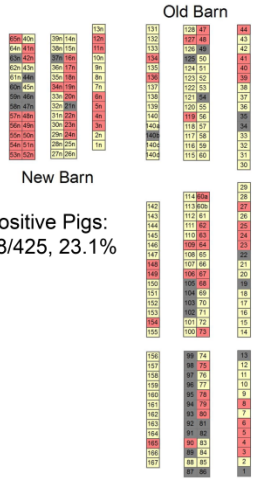
Key
PCR Positive Pen
Negative Pen
Empty Pen

Day 2 Barn Map



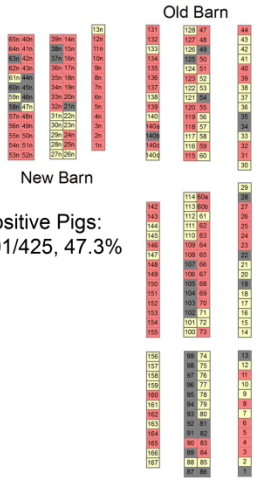
Positive Pigs: 44/425, 10.4%

Day 3 Barn Map



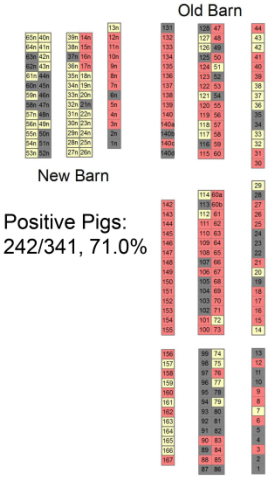
Positive Pigs: 98/425, 23.1%

Day 4 Barn Map



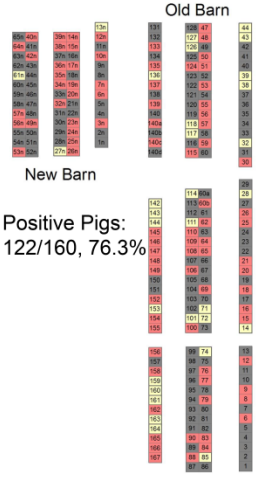
Positive Pigs: 201/425, 47.3%

Day 5 Barn Map



Positive Pigs: 242/341, 71.0%

Day 6 Barn Map



Positive Pigs: 122/160, 76.3%

Summary

- Exhibition swine are a small population relative to the commercial swine industry
  - Unique management practices
  - Unique exposure to humans and other pigs
- Largely unstudied interface between commercial and exhibition swine is important
- IAV continues to circulate in the exhibition swine
    - Reassortment continues to occur
- 72 hour recommendation is valid
  - Altered management practices might help where 72 hours is not achievable.

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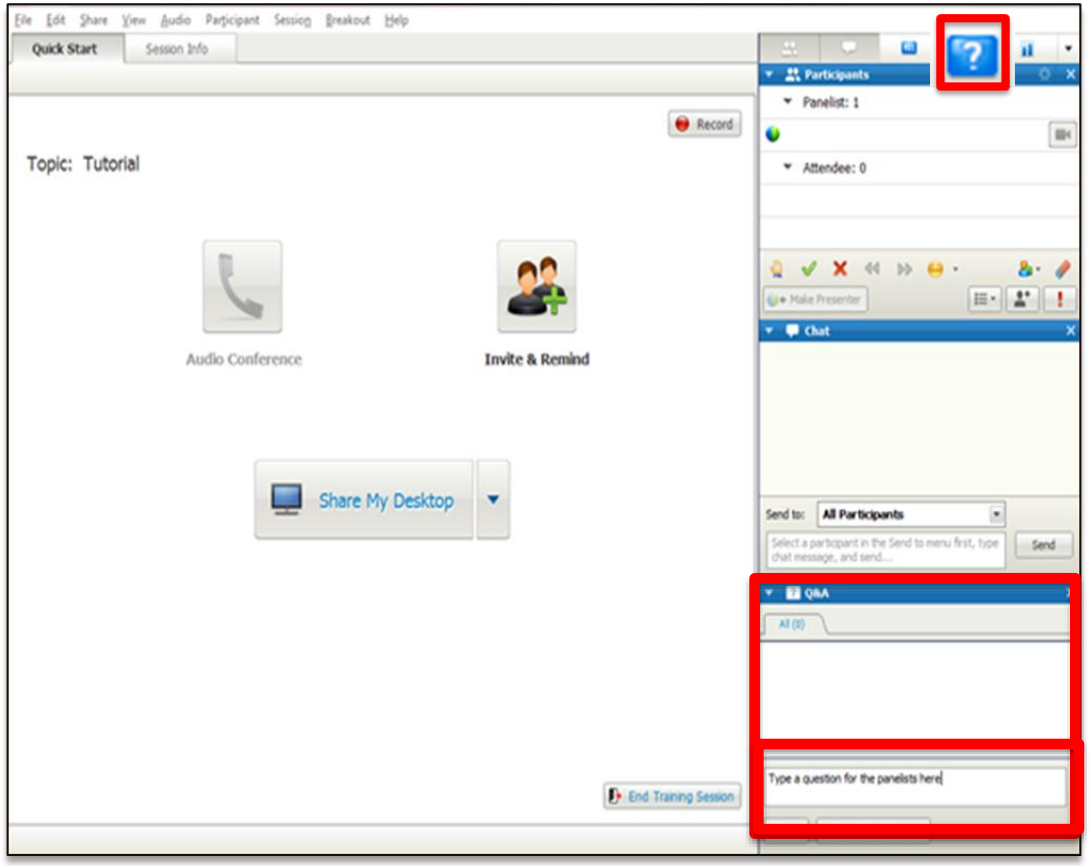

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