Veterinary Services

A simulation based evaluation of the time to detect EA/NA H5N2 HPAI virus infection in commercial turkey flocks under various active surveillance testing protocols

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Overview

- Current active surveillance protocol
  - Test 1 pool of 5 oropharyngeal swabs taken from dead birds randomly selected from the available mortality from each house using rRT-PCR

- Sampling protocol options under consideration
  - Increase the number of oropharyngeal swabs in a test pool from 5-swabs to 11 swabs
  - Swab 8 bell-drinker water-pans per-house and test 2 pools of 4 swabs
  - Take an oropharyngeal swab and a clocal swab from the same dead bird and test 1 pool of 11 oropharyngeal swabs and 1 pool of 11 cloacal swabs

Performance Measures

Zones of an Outbreak Response

- Time to HPAI detection
  - The average time from HPAI introduction to detection in the flock
  - An estimate of the time that flocks are infectious (shedding) and are a hazard to other flocks
  - Goal: The shortest time to detection to reduce risk of transmission through local area spread
- HPAI Detection probability
  - The proportion of outbreaks (houses) detected (or not detected)
  - An estimate of the chances of missed detections that might result in spread through product movements
  - Goal: The highest detection probability to reduce the risk of spread through higher risk product movements (e.g., live birds)
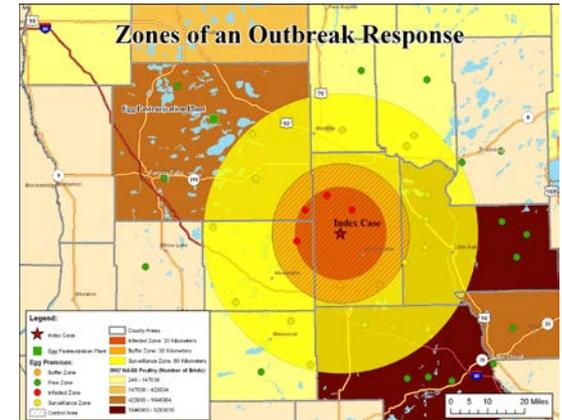
Surveillance Protocols Evaluated

- Time to HPAI detection
  - Daily testing for surveillance in the HPAI Control Area
  - Indiana H7N8 drinker sampling protocol proposed by the University of Minnesota
    - 2 pools of 4 swabs (8 bell-jar drinkers/ 4 each side of house)
  - Targeted dead bird surveillance
    - 2 pools of 11 oropharyngeal swabs per-house
    - 1 pool of 5 oropharyngeal swabs per-house

- HPAI detection probability
  - Testing on two consecutive days prior to product movement
  - Targeted dead bird surveillance
    - 1 pool of 5 oropharyngeal swabs per-house on 2 days
    - 1 pool of 11 oropharyngeal swabs per-house on 2 days
    - 1 pool of 11 oropharyngeal + 1 pool of 11 cloacal swabs from the same dead birds on 2 days (handled in separate tubes)

Surveillance Objective
Earliest Detection

- Targeted dead-bird surveillance

  – Detect the **first occurrence** of a HPAI infected dead bird among all the dead birds in the dead-bird pool from a house

- Drinker sampling

  – Detect the **first occurrence** of a HPAI contaminated bell-jar drinker contaminated by the first infectious bird in a house

Normal + HPAI Mortality
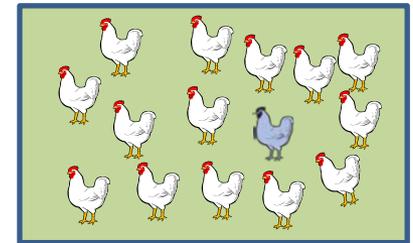
Pooled sample of swabs

HPAI detected via RRT-PCR testing
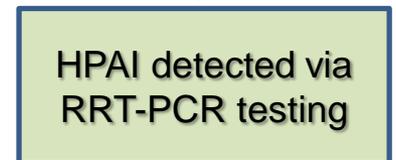
HPAI Virus Strain Variation
Time to Death (Days) Mean (95% P.I.)

Empirical distributions fit to data:

A/NorthernPintail/WA/2014 **H5N2**[A]

Mean 4.90 (3.59 to 6.37)
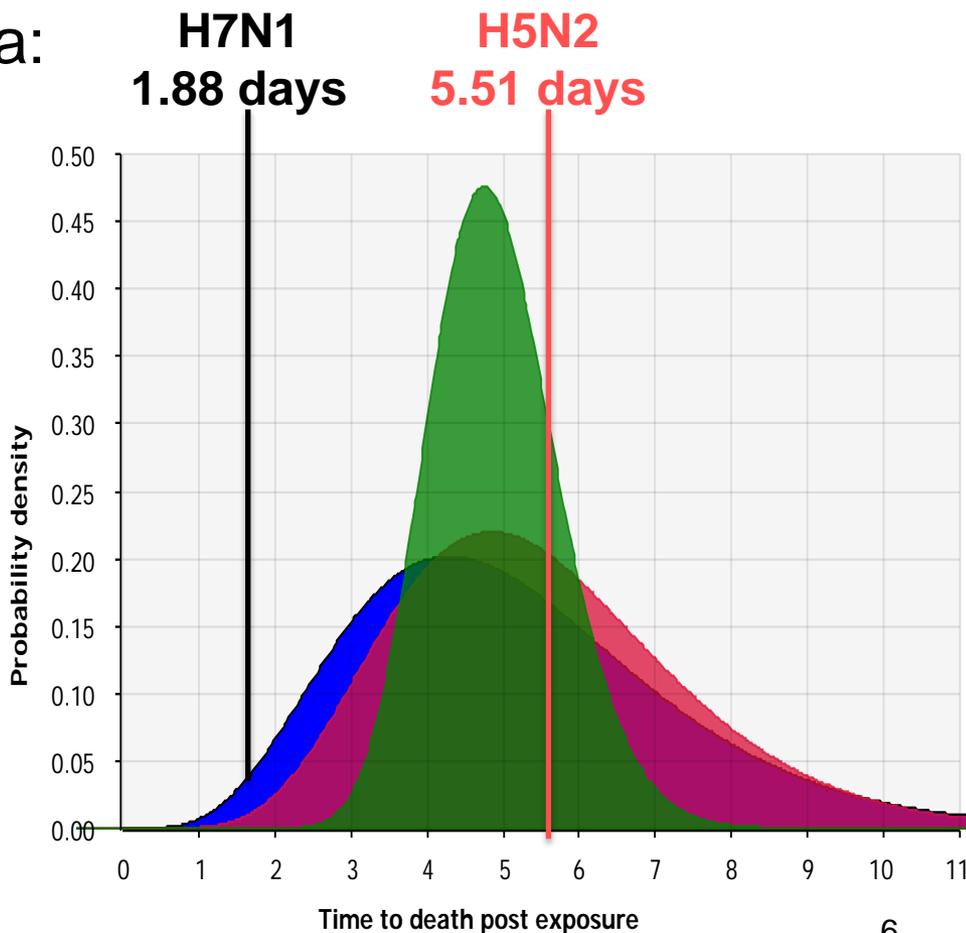
A/chicken/IA/2015 **H5N2**[B]

Mean 5.18 (2.23 to 9.11)

A/turkey/MN/2015 **H5N2**[C]

Mean 5.51 (2.79 to 8.99)

A/ostrich/Italy/2000 **H7N1**[D]

Mean 1.88 (0.75 to 3.25)

(Only the mean is shown)

[A],[B],[C] Spackman et. al, ARS SEPRL

[D] Saenz et.al., (2001)

H7N1
1.88 days

H5N2
5.51 days

Probability density

Time to death post exposure

6

Simulation Modelling Study
6000 simulated outbreaks

- Within-flock HPAI disease transmission model

$$P_{inf} = 1 - \exp(-\beta\left(\frac{I}{N}\Delta t\right))$$

  – Variability in Mean Death Time for HPAI virus strains

  – Uncertainty and variability in the rate of HPAI spread (β)

- Models of active surveillance protocols

  – Variability in house size for tom turkeys

  – Variability in normal daily mortality patterns
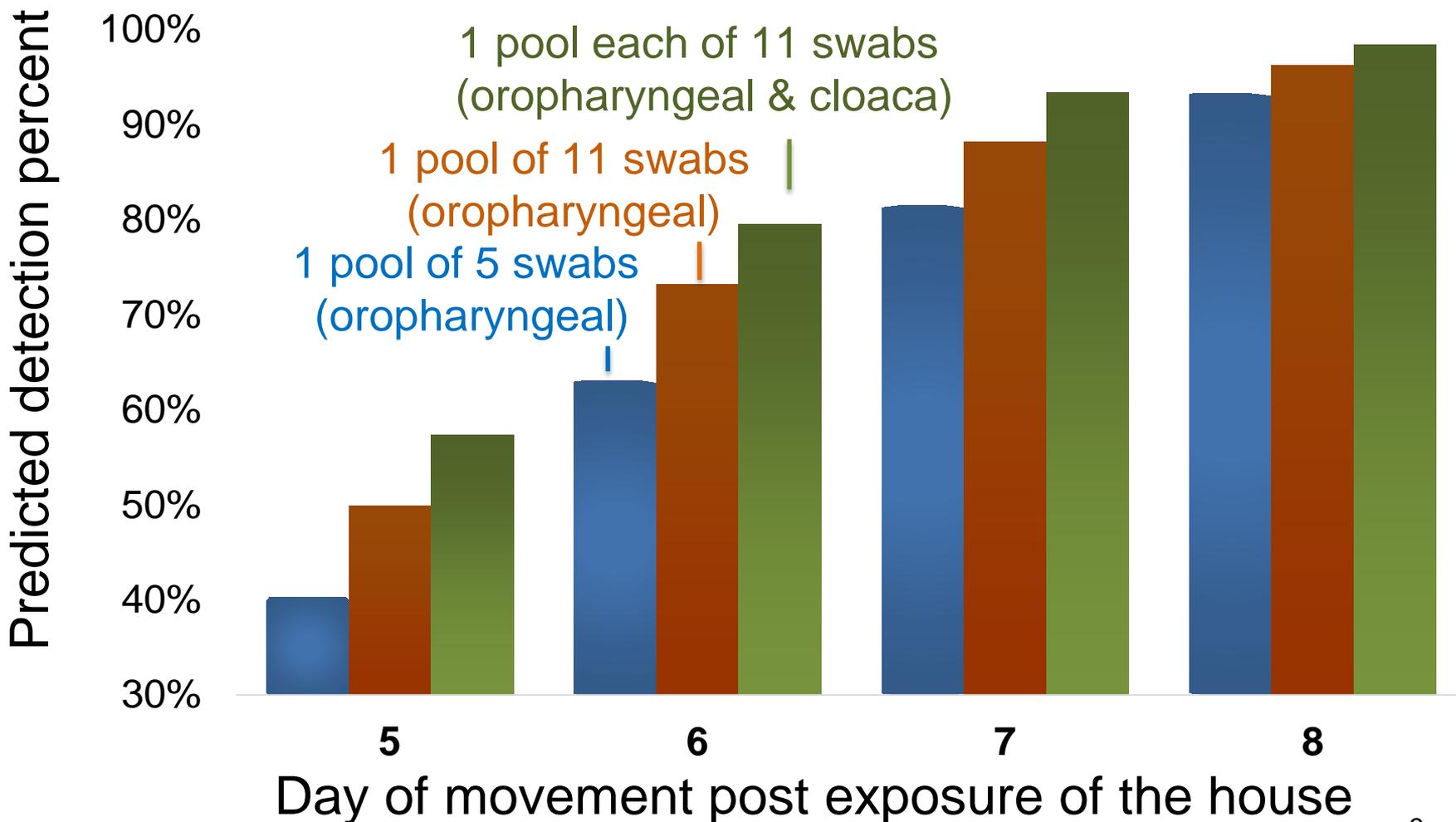
  – Uncertainty in RRT-PCR test characteristics

Drinker Sampling Evaluation

- Key model parameters
  - 150 birds per bell-drinker per-house
  - Sip-rate (mean16 sips per-day)
  - 2 Sips for bell-drinker to become HPAI positive

- Key assumptions
  - Birds don't have a preference for a drinker
    - » i.e., they can drink from any drinker
  - No decay of HPAI virus titer over time in water
    - » Biofilm provides a stable media for virus survival
    - » No titer dilution with water replacement
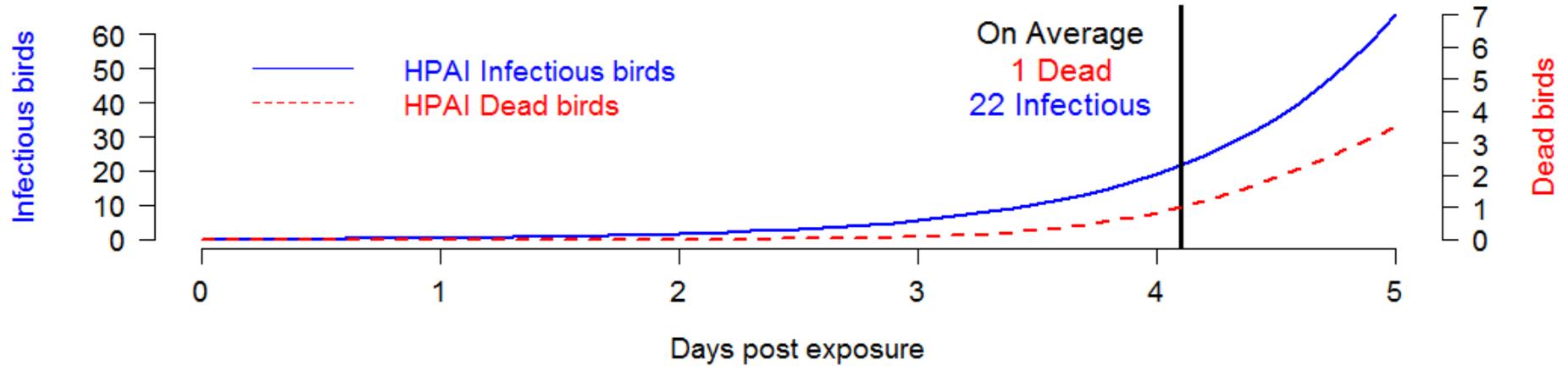 - Sick birds drink at the same rate as healthy birds

Results: HPAI Detection Probability
Testing on 2 Consecutive Days Prior to Movement

1 pool each of 11 swabs (oropharyngeal & cloaca)

1 pool of 11 swabs (oropharyngeal)

1 pool of 5 swabs (oropharyngeal)

Predicted detection percent

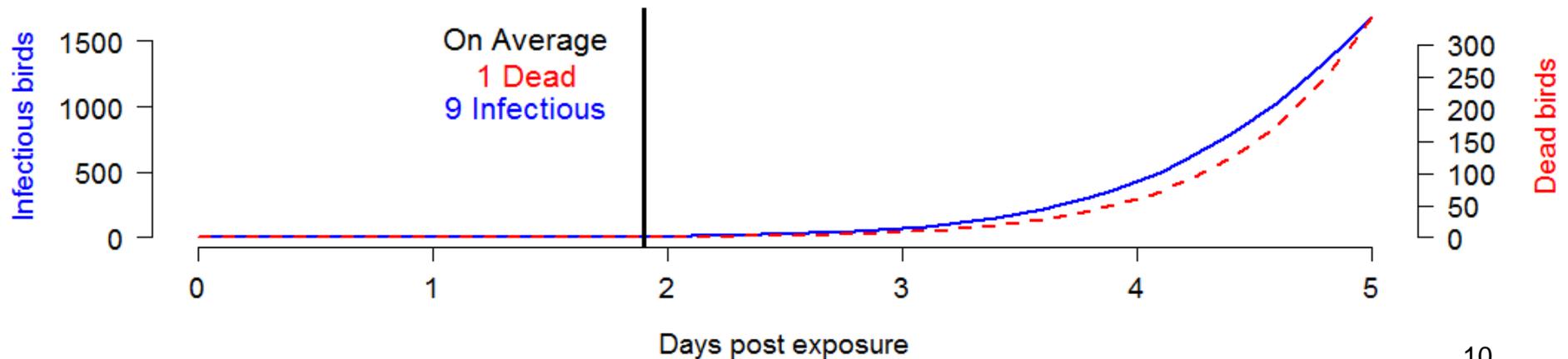Day of movement post exposure of the house

Drinker Sampling Evaluation: 6000 simulated outbreaks

H5N2 HPAI virus (Turkey MN 2015)

H7N1 HPAI virus (Italy 2000)

Results: Time to HPAI Detection (Mean Days with 95% P.I.)

Daily testing protocol (per house)		H5N2 HPAI Turkey MN 2015 **Long MDT**	H7N1 HPAI Italy 2000 **Short MDT**
Drinker	2 pools of 4 swabs	3.4 (1 to 6)	2.4 (1 to 4)
Dead birds	2 pools of 11 swabs	5 (3 to 7)	2.4 (1 to 4)
Dead birds	1 pool of 5 swabs	5.6 (3 to 8)	2.8 (1 to 4)

Sensitivity Analysis
Time to HPAI Detection
Mean Days (95% P.I.)

Sips per bell-drinker per-day			
Sips	10	**16**	22
Time	3.7 (2-6)	**3.4 (1-6)**	3.1 (1-5)

Sips required to get an HPAI positive drinker pan			
Sips	**2**	5	7
Time	**3.4 (1-6)**	4.6 (2-7)	4.9 (3-7)

Risk Management Considerations

- Performance of drinker sampling is HPAI strain dependent
  - Drinker sampling may result in a gain of a day or more which could shorten the time to depopulation or enhanced biosecurity
  - Strong potential for LPAI surveillance
  - Further research on key parameters is needed
- Risk of spread by surveillance crews or flock-service personnel should be considered
  - Barrel surveillance (dead birds) used in past outbreaks
- Drinker sampling results are useful as a screening test but are preliminary
  - Could be useful as an early warning but ramifications of a false positive have to be considered
  - Confirmation takes additional time

Questions?