

# A SIMULATION BASED EVALUATION OF ACTIVE SURVEILLANCE PROTOCOL OPTIONS FOR THE MOVEMENT OF BROILERS TO SLAUGHTER



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# Background

- Managed movement of broilers is critical for business continuity in an HPAI outbreak
- The unrecognized or unintentional movement of infectious birds from monitored flocks may result in further HPAI spread
- Pre-movement active surveillance is a key measure to increase confidence that HPAI infected broilers are not moved to processing

# Flexibility in Pre-movement Active Surveillance

- Flexibility in pre-movement active surveillance enables risk managers to choose appropriate options given,
  - Relative risks of different movement scenarios
  - Resource constraints
  - Logistical constraints (e.g., turn around time for test results)
- The goals of this presentation are:
  - Evaluate various pre-movement active surveillance options for moving broilers to incorporate flexibility
  - Evaluate the impact of a pre-movement isolation period on active surveillance

# Pre-movement Active Surveillance Features Evaluated

**Comparison 1:** Using a rRT-PCR pooled sample with 11 swabs each vs. 5 swabs each

- The protocol requires testing 1 pooled sample for every 50 dead birds from each house on the premises on two consecutive days before movement

**Comparison 2:** Collecting rRT-PCR samples 1 day earlier given logistical constraints (i.e., a longer turn around time for test results)

**Comparison 3:** Performing supplementary antigen capture (AC) tests close to movement in addition to regulatory rRT-PCR testing

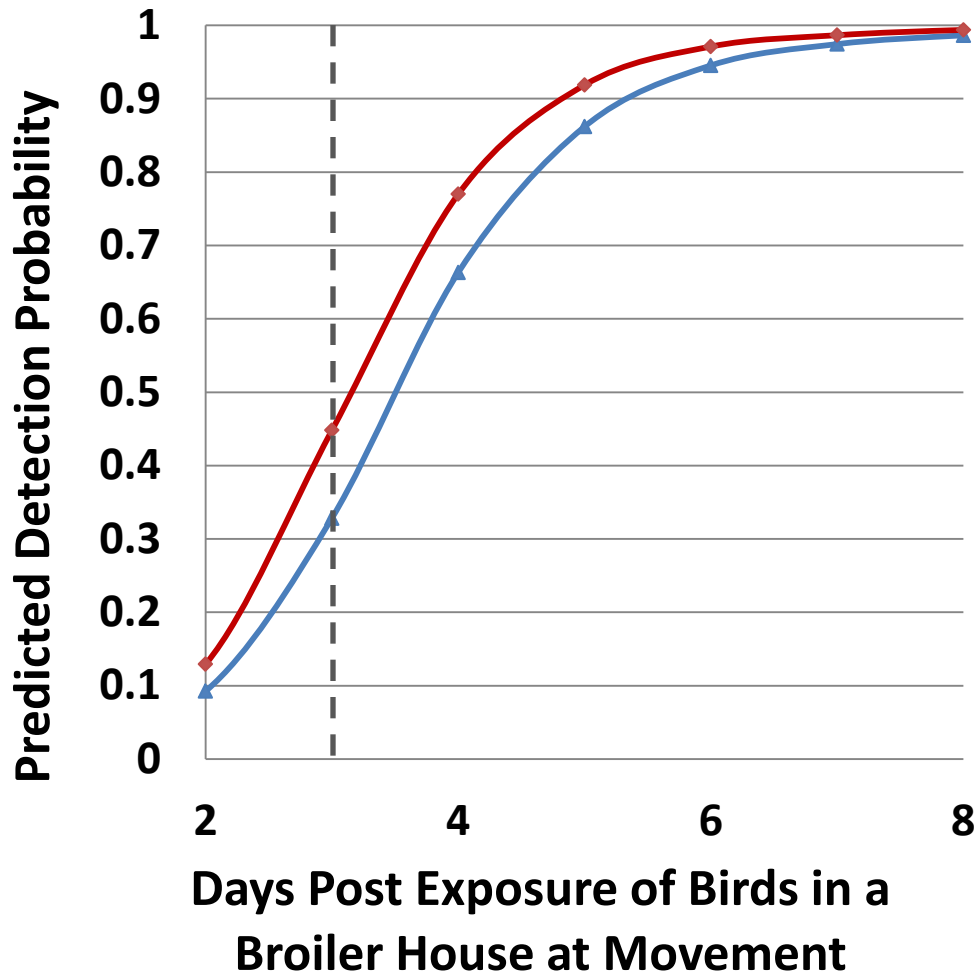
- a) With rRT-PCR testing as in **Comparison 1**
- b) With rRT-PCR testing performed 1 day earlier as in **Comparison 2**

# Comparison 1: Impact of the Number of Swabs per Pooled Sample Under Baseline Options

- Previous research showed that using a pooled sample with 11 swabs instead of using a pooled sample of 5 swabs did not adversely impact rRT-PCR test diagnostic sensitivity
- Baseline options:
  - **5 or 11 swabs per pooled sample**
  - Sample for 2nd test result collected within 24 hr. of movement
  - Samples for 1st test result collected the day preceding movement
  - Submitted to a NAHLN laboratory
  - Matrix gene rRT-PCR

# Comparison 1: Impact of the Number of Swabs per Pooled Sample on the Predicted HPAI Detection Probability

Predicted detection probability on various days post infection



Pooled sample collected on 2 consecutive days before movement and tested via RRT-PCR

e.g., if movement at 12:00 am Fri. samples are collected Wed. and Thurs. mornings

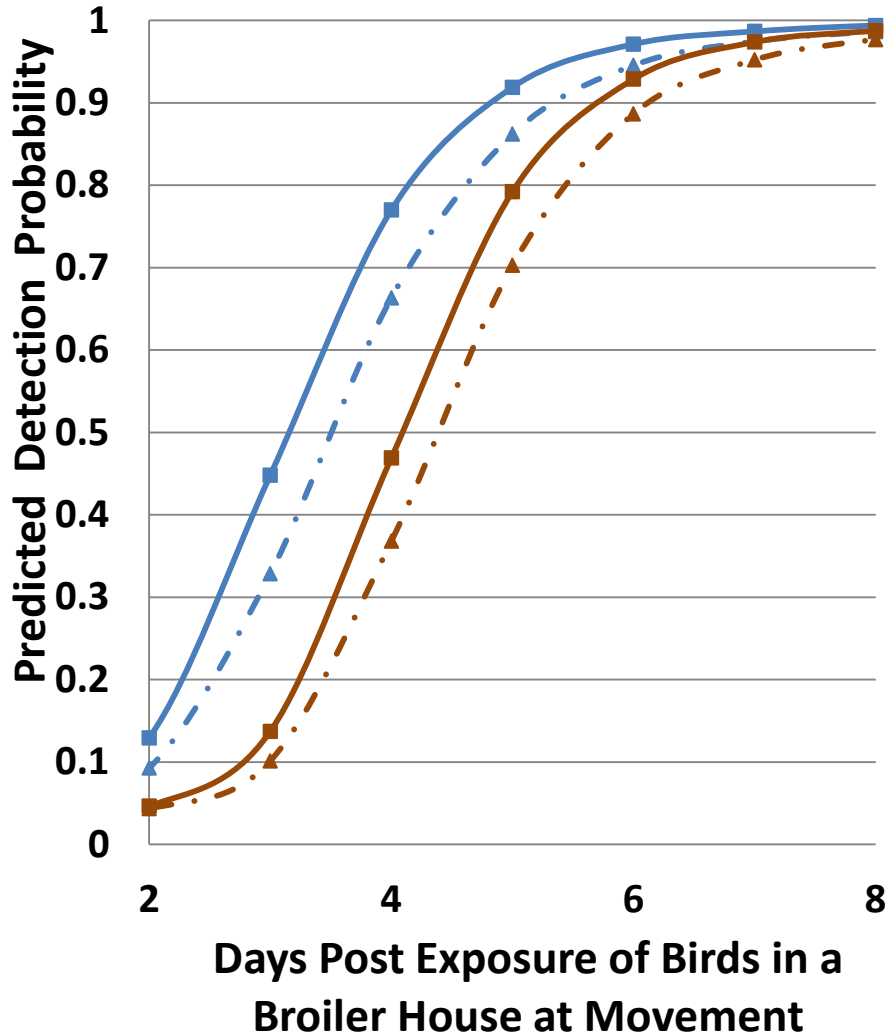
Pool size	HPAI Strain
5 swabs	H5N2
11 swabs	H5N2

## Comparison 2: Impact of Collecting rRT-PCR Samples Earlier In Anticipation of a Longer Turnaround Time

- The baseline options assume less than 12-hours turnaround time from the time of sample collection to receive rRT-PCR results from a NAHLN laboratory
- There is a possibility of longer than 12-hours turnaround depending on distance and resource availability
- The sample collection times may be shifted earlier by a day in anticipation of longer turnaround time
  - e.g., for movement on 12:00 AM Fri., samples would be collected Tues. and Wed. mornings instead of Wed. and Thur. mornings

# Comparison 2: Impact of collecting samples earlier by one day

**Predicted Detection Probability on Various Days Post Infection**



**2 consecutive days of rRT-PCR testing**

Pooled sample size	Sample collection times: Hours prior to movement
5 swabs ▲	18, 42
11 swabs ■	18, 42
5 swabs ▲	42, 66
11 swabs ■	42, 66



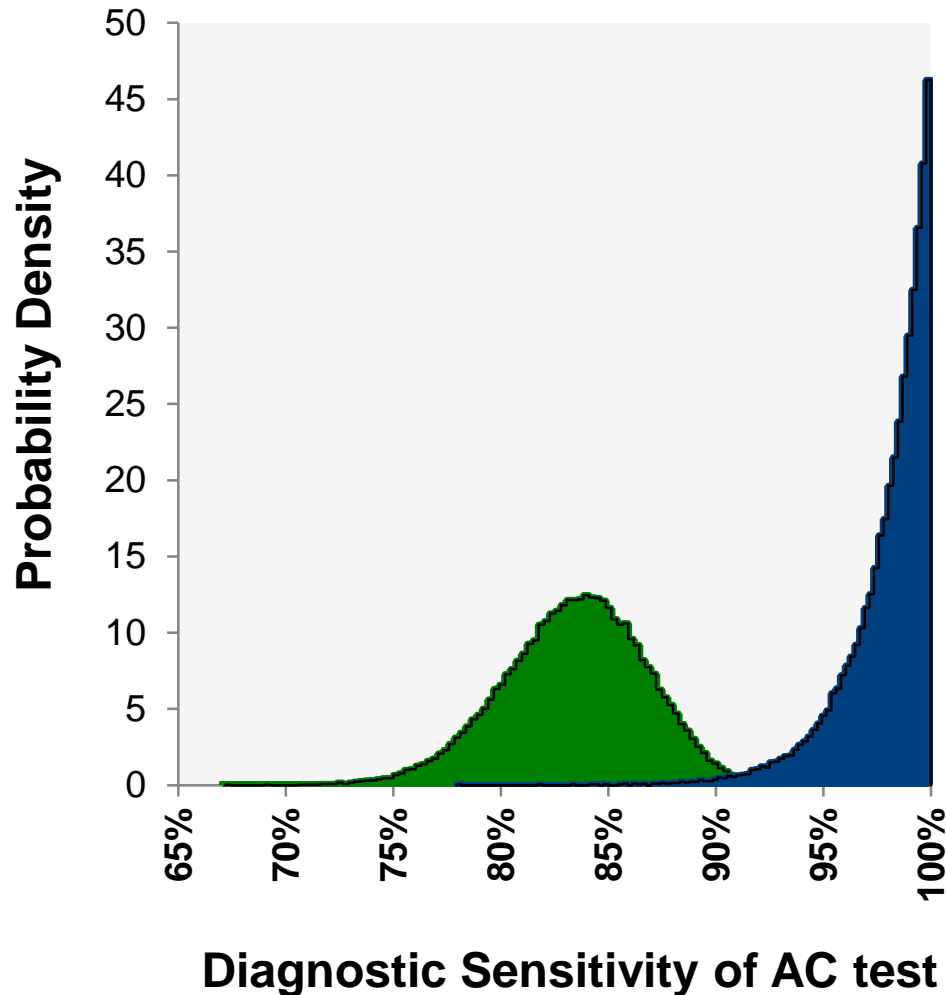
# Leveraging the Logistical Advantages of Supplementary Antigen Capture Testing

- Proposed to be used by industry to supplement not replace regulatory RRT-PCR testing
- Potential benefits in HPAI response:
  - Logistical advantage: ability to test closer to movement to slaughter
  - Provides additional HPAI detection probability
  - Stop movement in the event of a non-negative test
    - Further diagnostic investigation is conducted
- HPAI viral titers are highest in morbid and dead birds (i.e., within the detection range of AC tests)
  - Analytical sensitivity limits for AC tests range from  $10^4$  to  $10^6$  EID<sub>50</sub>/ml (Marché *et al.* 2010; Soliman *et al.* 2010; Slomka *et al.* 2011)
  - Several studies concluded that AC tests are best suited for use in morbid and dead birds (Chua *et al.* 2006; and others)

# Study to Evaluate Performance of Antigen Capture Tests for H5 and H7 HPAI Strains

- Detection of H5 and H7 highly pathogenic avian influenza virus with lateral flow devices: Performance with healthy, sick and dead chickens
  - Erica Spackman, J. Todd Weaver, Sasidhar Malladi
- Objectives:
  - Quantify how clinical condition correlates to the detection of HPAI virus with AC tests
  - Evaluate whether delayed testing of dead chickens affects detection
- Experiment details:
  - Exposed 50 chickens to a low dose of an H5 and an H7 HPAI virus
  - Delayed swab collection for 12 hr. for half of the carcasses
  - Tested oropharyngeal swabs
    - Commercially available U.S. licensed AC test
    - Quantitative rRT-PCR

# AC Sensitivity in Sick and Dead Birds Infected with Pennsylvania HPAI H5N2



**Sensitivity in dead birds is significantly higher  $p < 0.01$  (Fishers test)**

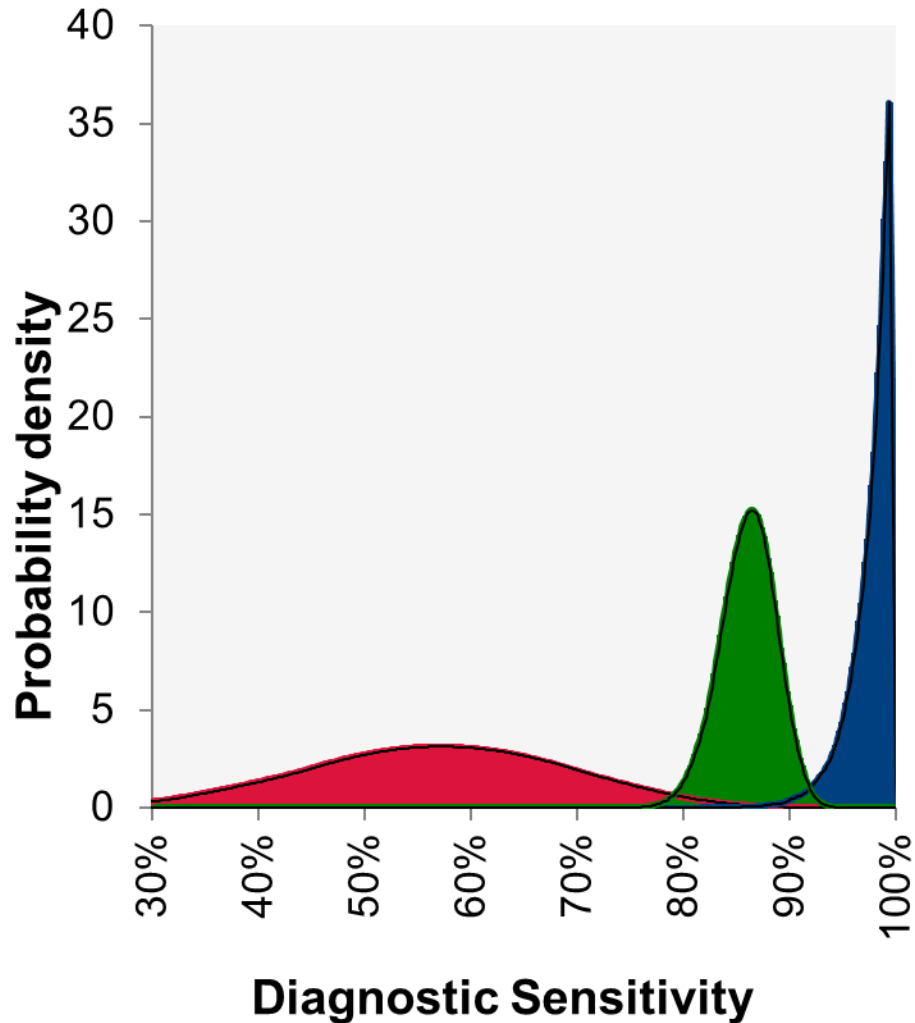
**Diagnostic sensitivity of AC test for HPAI H5N2:**

**Sick birds: 84% (95% C.I., 77 to 89)**

**Dead birds: 97.9 (95% C.I. 92 to 99.9)**

# AC test diagnostic sensitivities for different HPAI strains

## Estimated overall mean (95% Credibility Intervals)



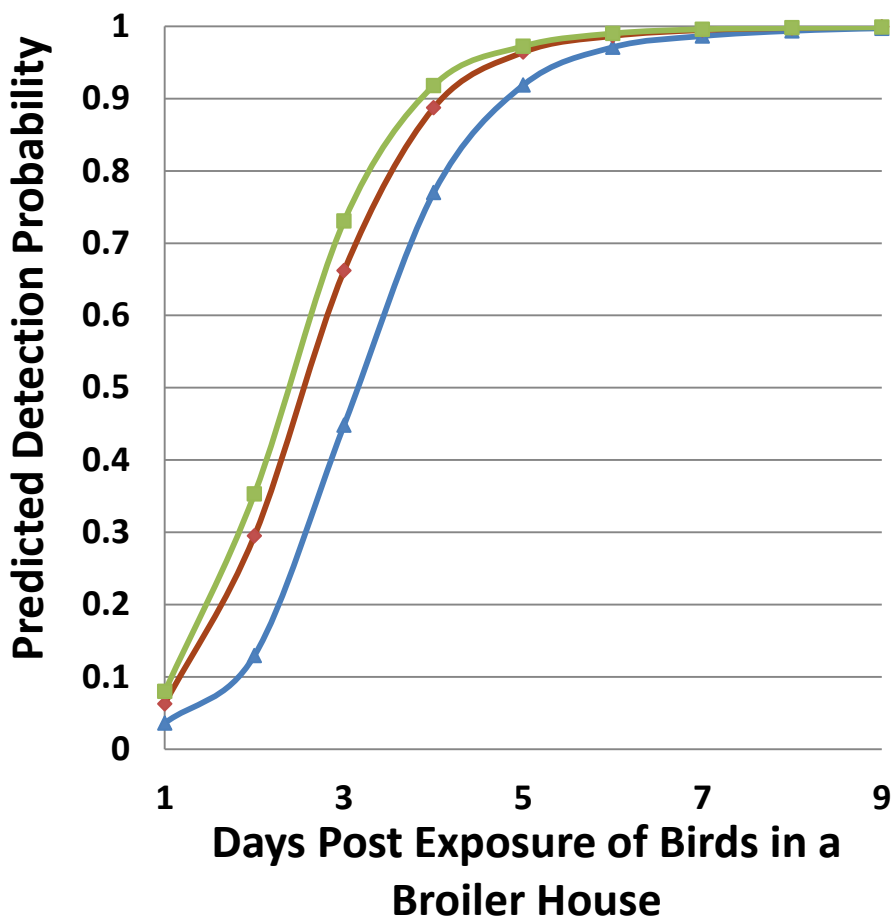
HPAI Strain	Data	Predicted Sensitivity
H7N3 (Jalisco)	14 tracheal swabs (current study)	<b>57%</b> <b>(33 - 80)</b>
H5N1 (Asian several clades)	403 tracheal and cloacal swabs (literature review)	<b>86%</b> <b>(80 - 91)</b>
H5N2 (1983 Penn.)	46 tracheal swabs (current study)	<b>97.9%</b> <b>(92 - 99.9)</b>

## Comparison 3 a: Performing supplementary antigen capture (AC) tests in addition to regulatory rRT-PCR testing

- rRT-PCR testing:
  - 2 Consecutive days of rRT-PCR testing as in baseline scenario (e.g., at 18 and 42 hrs. prior to movement)
  - Pooled samples of 11 swabs from the daily mortality
- rRT-PCR + supplementary AC testing:
  - 2 Pooled samples of 5 swabs from the daily mortality tested by AC (e.g., at 18 or 42 hrs. after second RRT-PCR close to load out)
  - Scenarios with AC test diagnostic sensitivity of 60% and 85% were also evaluated given the uncertainty in its value

# Comparison 3 a: Predicted HPAI Detection Probability Under Two Targeted Active Surveillance Testing Options for HPAI H5N2

**Predicted detection probability on various days post infection**



**Scenario Description**

Scenario	Active surveillance option	AC test sensitivity used in scenario
▲	rRT-PCR only	NA
◆	rRT-PCR & AC	60%
■	rRT PCR & AC	85%

## Comparison 3 b: Impact of Supplementary AC Testing with Earlier RRT-PCR Sample Collection

We compared the likelihood of detection under the following options to evaluate the impact of supplementary AC tests

### Option 1: rRT-PCR testing only

- 2 Consecutive days of RRT-PCR testing where samples are collected earlier in anticipation of more than 12 hr. turnaround time for obtaining results (e.g., at 42 and 66 h prior to movement)
- Pooled samples of 11 swabs from the daily mortality

### Option 2: rRT-PCR and supplementary AC testing

- rRT-PCR testing same as in option 1
- AC testing 2 - pooled samples of 5 swabs from the daily mortality **42 hrs. after second RRT-PCR (close to load out)**
- Scenarios with diagnostic sensitivity of 60% and 85% were also evaluated given the uncertainty in its value

## Logistical advantages:

- Testing at load-out as an added layer of protection
- Testing in anticipation of a longer turn-around time in receiving RRT-PCR results

Movement  
time



Time line days

RRT-PCR

RRT-PCR

RRT-PCR

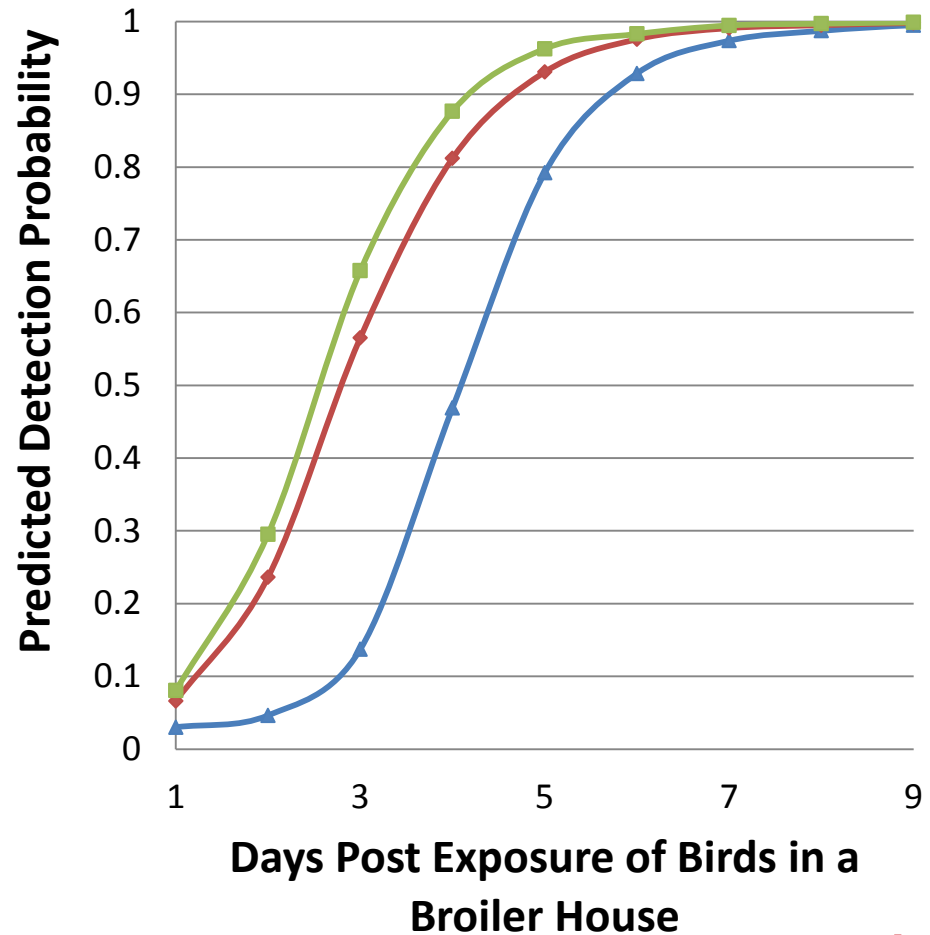
AC Test



# Comparison 3 b: Predicted HPAI Detection Probability With or Without AC Tests in Addition to rRT-PCR

Active Surveillance Option	AC test sensitivity
1 RRT-PCR only	NA
2 RRT-PCR + AC	60%
2 RRT PCR + AC	85%

Predicted detection probability on various days post infection



# Impact of Pre-movement Isolation Period (PMIP)

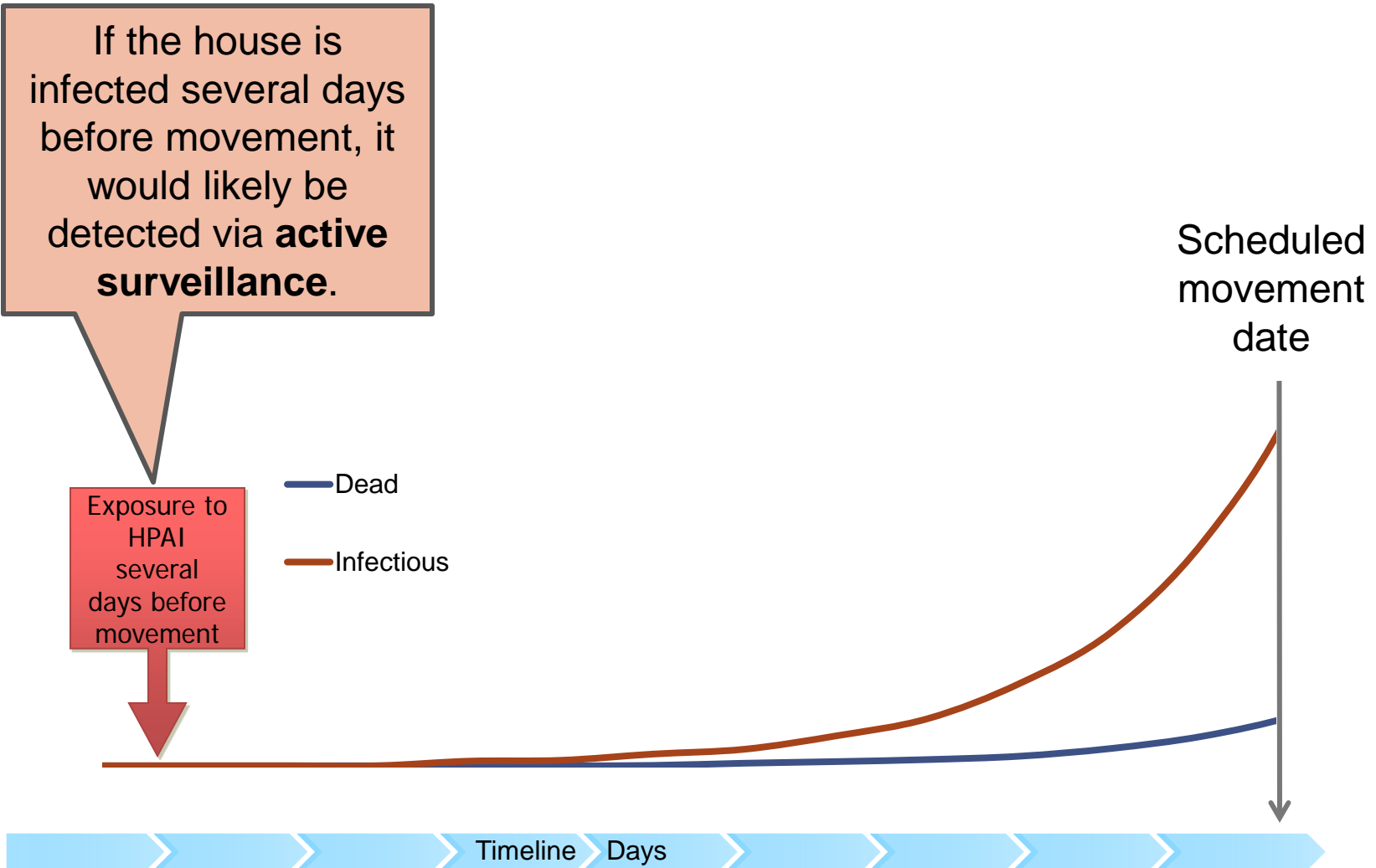
If the house is infected several days before movement, it would likely be detected via **active surveillance**.

Scheduled movement date

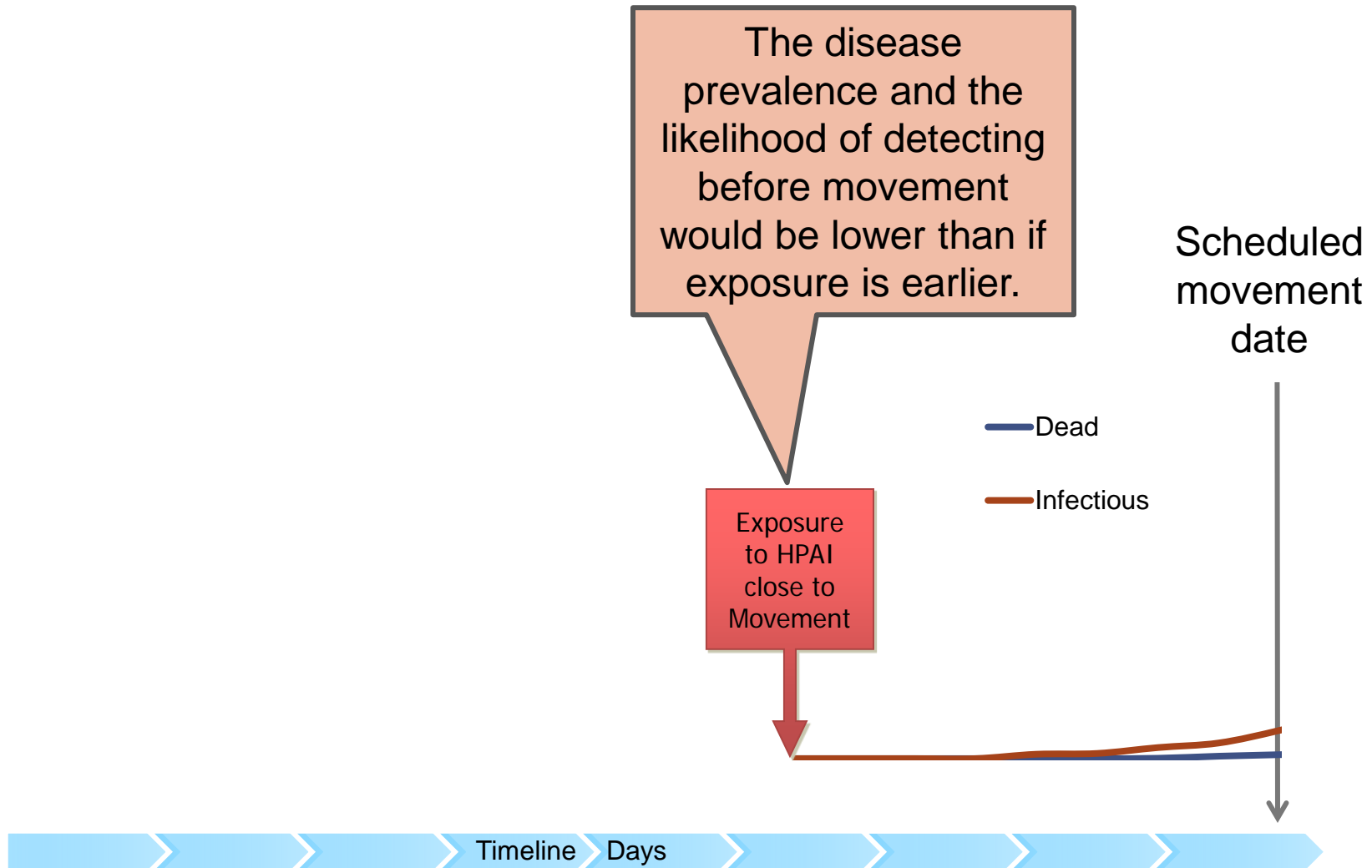
Exposure to HPAI several days before movement

— Dead  
— Infectious

Timeline Days



# Impact of Pre-movement Isolation Period (PMIP)



# Impact of Pre-movement Isolation Period (PMIP)

If the house is infected several days before movement, it would likely be detected via **active surveillance**.

Exposure risk close to the time of movement is reduced by **PMIP biosecurity**

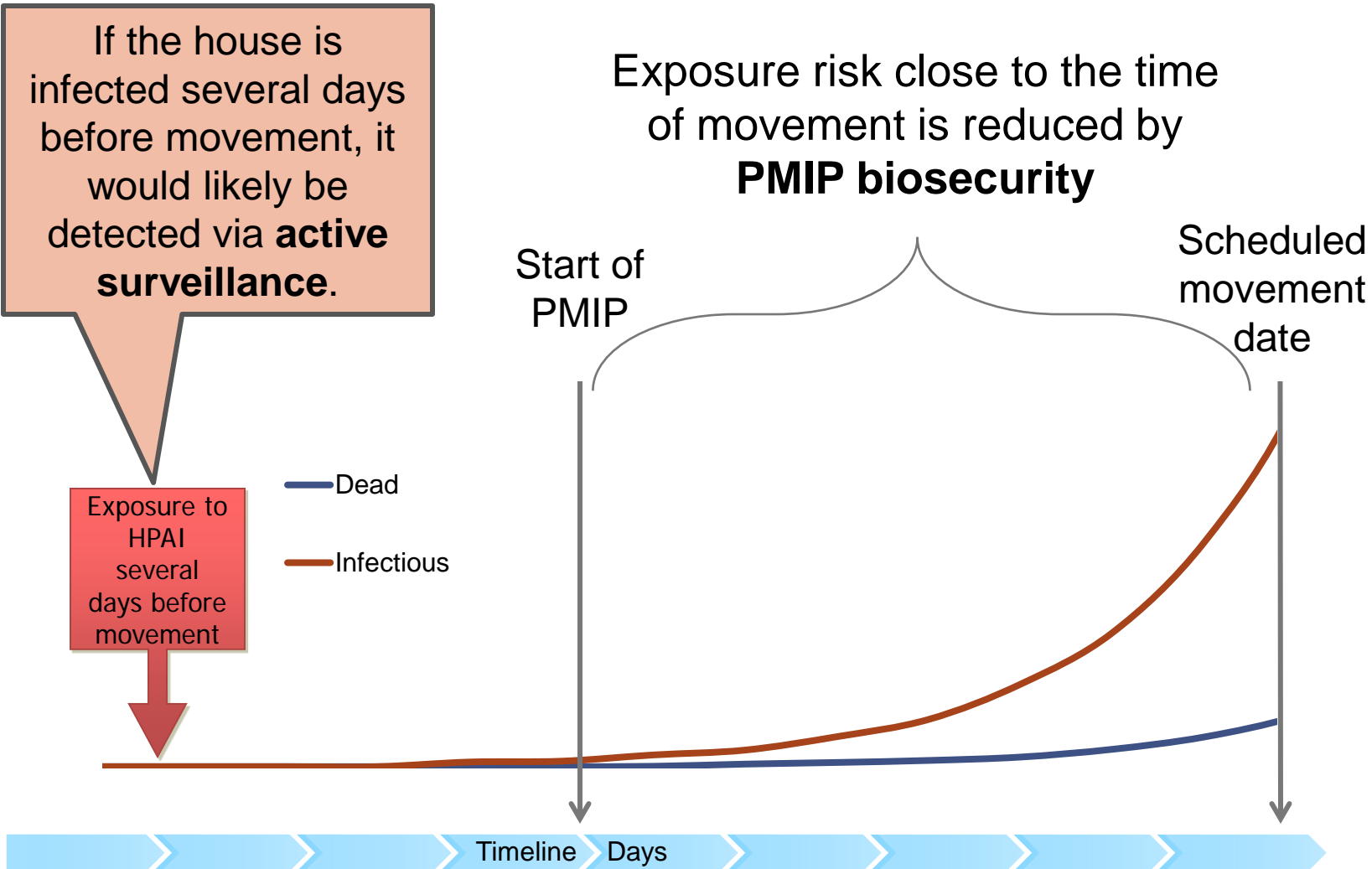
Start of PMIP

Scheduled movement date

Exposure to HPAI several days before movement

— Dead  
— Infectious

Timeline Days



# Baseline PMIP Measures

- During PMIP
  - Non-critical operational visits are prohibited
  - Critical operational visits continue with strict biosecurity
- Critical operational visit biosecurity (e.g., feed delivery)
  - Vehicle C&D (infected zone)
  - Dedicated vehicles (infected zone)
  - Routing to minimize proximity and contact with poultry
  - Driver does not enter the poultry house
  - Driver wears PPE and follows hand hygiene protocol

## Probability of detecting HPAI Under various PMIP durations

Simulation results if the flock (house) became exposed to HPAI virus **before** implementing PMIP biosecurity (HPAI H5N2)

### Predicted detection probability under various PMIPs

<b>Active surveillance option (dead bird testing)</b>	4 Days	5 days	6 days
rRT-PCR testing of a pooled sample of <b>5 swabs</b> each on 2 consecutive days	96.3%	98.3%	99.1%
rRT-PCR testing of a pooled sample of <b>11 swabs</b> each on 2 consecutive days	98.1%	99.3%	99.4%

# RRT-PCR

# AC

**2 days before  
movement**

**1 day before  
movement**

**Movement  
day**

**Within a few  
hours of  
movement**

**Tuesday  
morning**

**Wednesday  
morning**

**Thursday  
morning**

**Friday  
12:30 AM**

**Option Swabs  
per pool**

## Baseline options

Option	Swabs per pool	2 days before movement	1 day before movement	Movement day	Within a few hours of movement
1	5		1 pool	1 pool	
2	11		1 pool	1 pool	

## Additional options

3	5		1 pool	1 pool	2 pools of 5 swabs
4	11		1 pool	1 pool	2 pools of 5 swabs
5	5	1 pool	1 pool		2 pools of 5 swabs
6	11	1 pool	1 pool		2 pools of 5 swabs
7	11	1 pool	1 pool		
8	5			2 pools	
9	11			2 pools	

# Overall Conclusions

- Using a rRT-PCR pooled sample with 11 swabs each vs. a pooled sample with 5 swabs each could result in a moderate gain in detection probability – especially recent exposures
- Collecting rRT-PCR samples earlier to accommodate logistical constraints (i.e., a longer turn around time for results) can decrease detection probability
- Supplemental flock-side AC testing conducted by industry veterinarians has the potential to enhance HPAI detection probability, particularly in situations where there are logistical constraints



# Overall Conclusions

- Active surveillance and pre-movement isolation period (extreme biosecurity) can increase confidence that HPAI infected and undetected broilers are not moved to processing
- Further studies on the performance of AC tests would improve confidence in their field application during a HPAI outbreak
  - Evaluation of AC test performance in dead birds for different strains of HPAI virus
  - Effects of pooling on AC testing protocols