Update on Avian Influenza in the US

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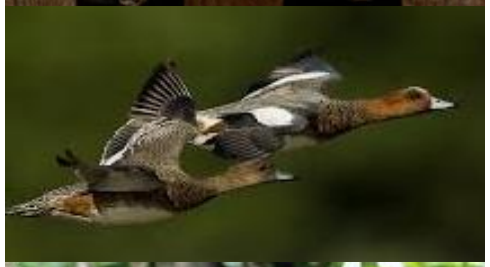


Avian Influenza

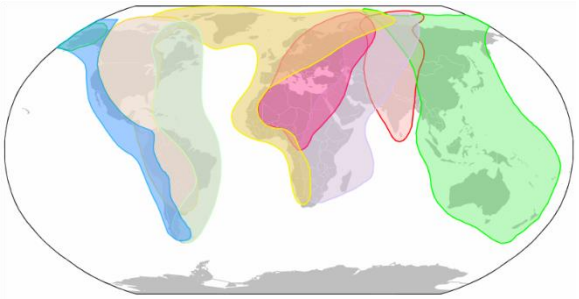
- Influenza A viruses with high pathogenicity (HPAI) and **H5 and H7** subtypes with low pathogenicity (H5/H7 LPAI) are reportable worldwide.
- **Waterfowl are natural reservoir hosts for all influenza A subtypes**, but not usually HPAI.
- Influenza A viruses tend to circulate within flyways seasonally and wax/wane and in multiyear cycles.
- The only HPAI recognized to circulate in natural reservoir hosts emerged in domestic poultry in Asia (goose Guangdong [GsGD] lineage H5N1)


Cinnamon Teal
(*Anas cyanoptera*)


Lesser Snow Goose
(*Chen caerulescens*)


Northern Shoveler
(*Anas clypeata*)


Ring-necked Duck
(*Aythya collaris*)



HPAI Reported Worldwide (US in BLUE)

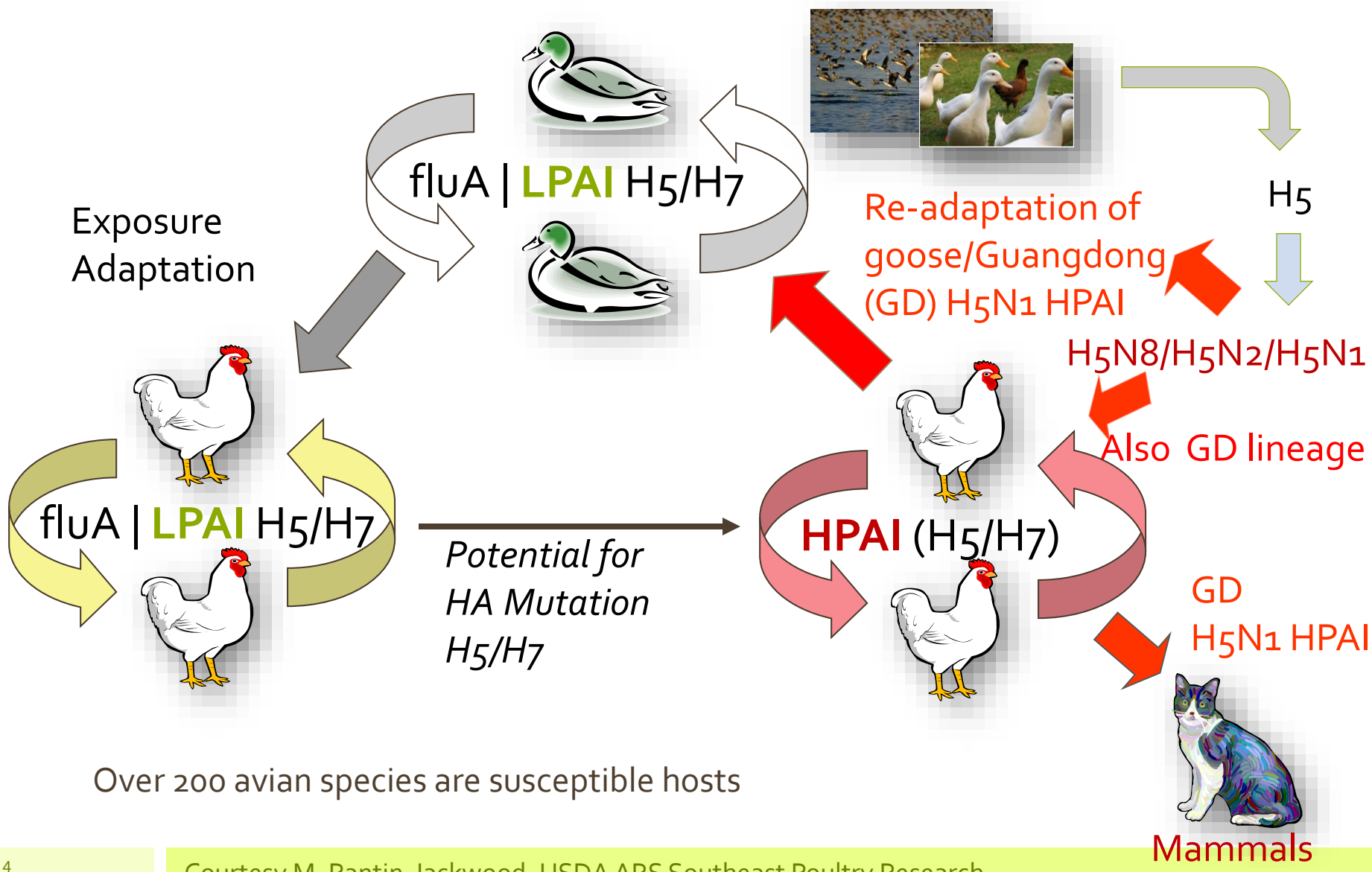
1890's-1950's numerous fowl plague outbreaks, subtypes not known
1924-25 North east US?
1927 New Jersey ?
1934 Germany, H7N1
1959 Scotland, H5N1
1961 South Africa, H5N3
1963 England, H7N3
1966 Canada, H5N9
1975 Australia, H7N7
1979 Germany, H7N7
1979 England, H7N7
1983-84 USA, H5N2
1983 Ireland, H5N8
1985 Australia, H7N7
1991 England, H5N1
1992 Australia, H7N3
1994 Australia, H7N3
1994-95 Mexico, H5N2
1995 Pakistan, H7N3
1997 Australia, H7N4
1997 Italy, H5N2
1996-present Asia/Europe/ Africa, H5N1
1999-2000 Italy, H7N1
2002 Chile, H7N3
2003 Netherlands, H7N7
2004 USA, H5N2 – per cleavage site
2004 Canada, H7N3
2004 Pakistan H7N3
2004 South Africa, H5N2
2005 North Korea, H7N7
2006 South Africa H5N2
2007 Canada, H7N3
2008 England, H7N7
2009 Spain, H7N7
2011 South, Africa H5N2
2012-2013 Taipei, H5N2
2012-2013 South Africa, H7N1, H5N2
2012 Australia, H7N7, H7N2
2012 Mexico H7N3
2013 Italy H7N7
2014-2015 Japan, Korea, Germany, Netherlands, Hungary, Italy, UK, Sweden, Romania H5N8
2014 Russia, H5N1
2014 Canada H5N2
2014-2015 US, H5NX
2015 H5Nx, China, Chinese Taipei ,South Korea
2015-2016 France, H5N's
2016 H7N8 US

Outbreaks in red are ongoing

Goose-Guangdong H5 lineage

Courtesy E.Spackman, USDA ARS Southeast Poultry Research

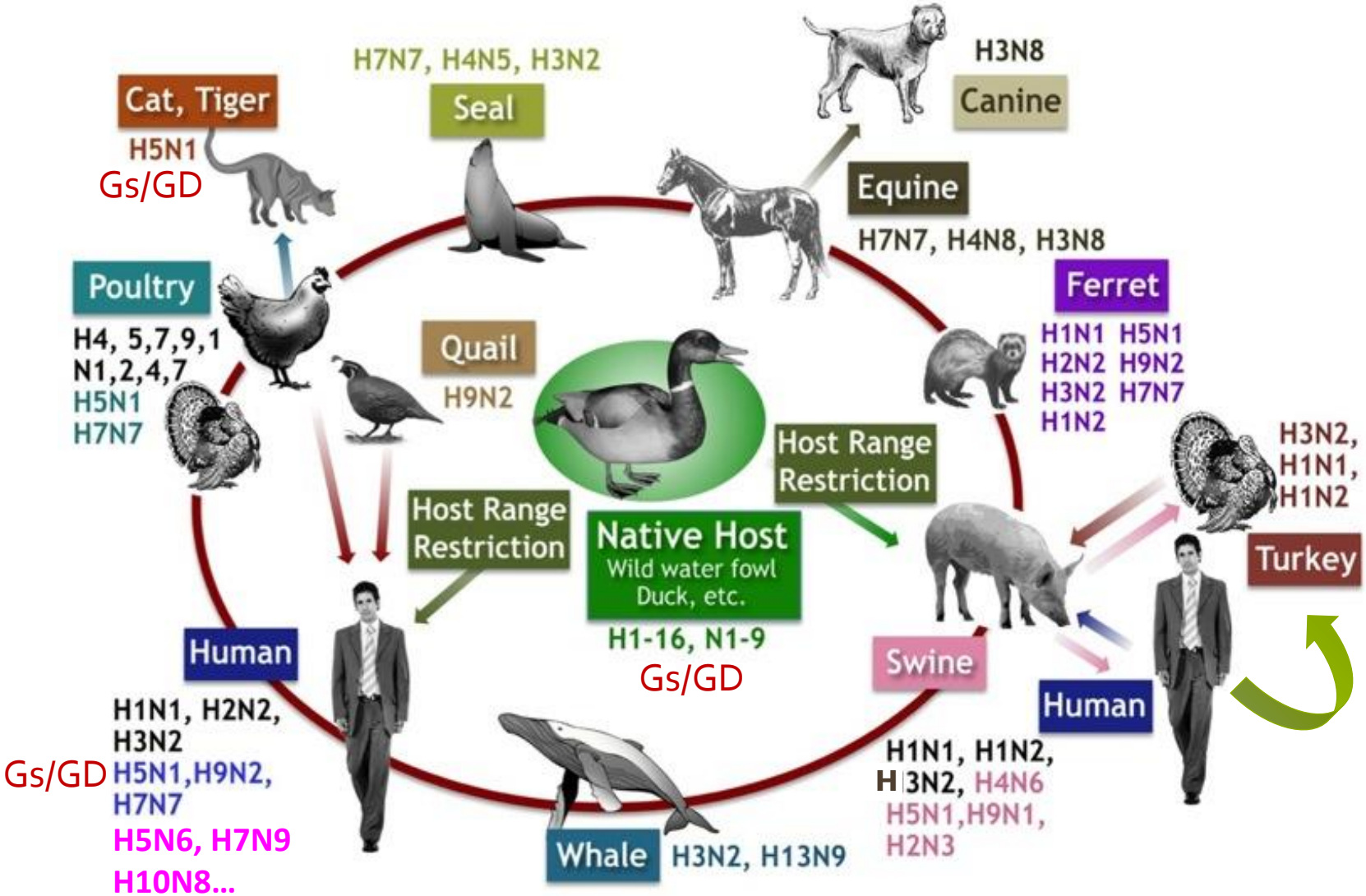
AI Epidemiology



Over 200 avian species are susceptible hosts

Courtesy M. Pantin-Jackwood, USDA ARS Southeast Poultry Research

Host range

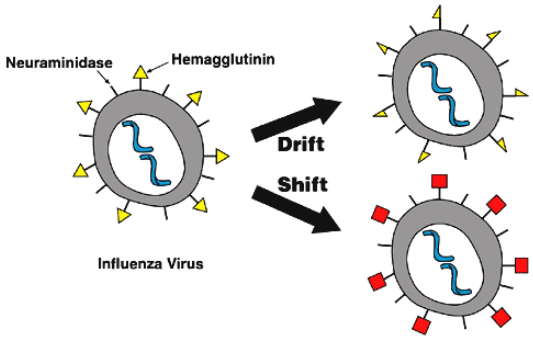


Adapted from: Animal Influenza Viruses: Gap Analysis Workshop Report. 2014. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC. http://go.usa.gov/KpGP

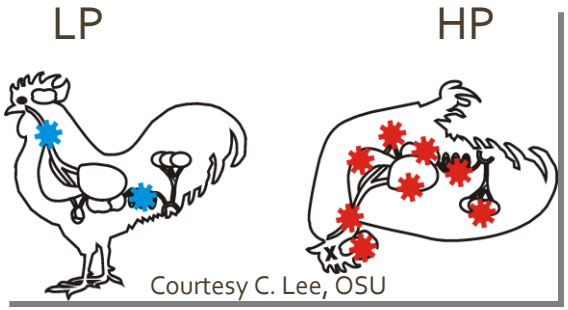
Courtesy A. Vincent USDA, ARS

Influenza viruses can rapidly EVOLVE

- Antigenic **Drift**
- Antigenic **Shift**



- Pathotype: determined in CHICKENS
- Potential for H5/H7 to mutate from LPAI to HPAI
  - Addition of basic amino acids (AA) most common, H5 or H7
  - Accumulation of basic AA
  - Insertion of random sequence (H7)
  - Viruses with different cleavage sites will often circulate simultaneously



- Host Adaptation

  e.g. Gs/GD lineage H5N2

Mallards > Pheasants, Partridges, GF, Pekin, geese > Quail > Turkeys > Chickens

Adapted from E. Spackman and M. Pantin-Jackwood SEPRL

AI Surveillance in the United States

NPIP breeding flocks

- Egg and Meat-Type chickens
- Turkeys, Exhibition Poultry, Upland Game birds and Waterfowl

NPIP production flocks

- Meat-type chickens & turkeys
- Table-Egg Layers
- Upland Game birds and Waterfowl

Live Bird Marketing System

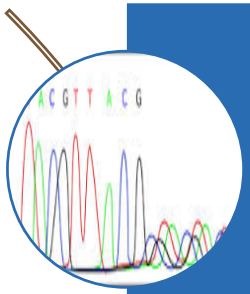
- Producers, distributors, and retail markets
- Backyard flocks, auctions, swap meets, etc.

Other Diagnostics

- Passive surveillance, export testing, foreign animal disease investigations
- Wild bird surveillance

>2 million tests/year

Current Diagnostics

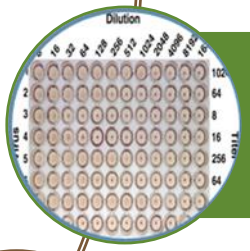


Molecular / Sequencing

- Both screening and confirmation
  - fluA, H5, H7, and H5-icA 2.3.4.4 specific assay
- Subtyping direct from samples using Sanger methods

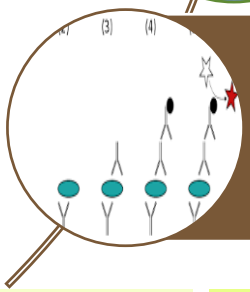
Virus isolation

- Molecular and antigenic characterization
- In vivo pathotyping



Serologic assays

- fluA, subtype specific



Pen-side tests

- Screening test for clinically ill/dead birds – requires confirmation

If fluA detected – forward samples for confirmation and continue with H5/H7 testing

If fluA detected – forward samples and continue with H5/H7

if neg H5/H7 can proceed with SwH1/H3, N1/N2 (subject to user fees) –

If fluA detected – Refer to IAV-S surveillance for guidance on Sw H1/H3 & N1/N2

If fluA detected, forward samples for confirmation and continue H5/H7

Same influenza Type A (fluA) assay for ALL

fluA and subtyping assays may be run in parallel

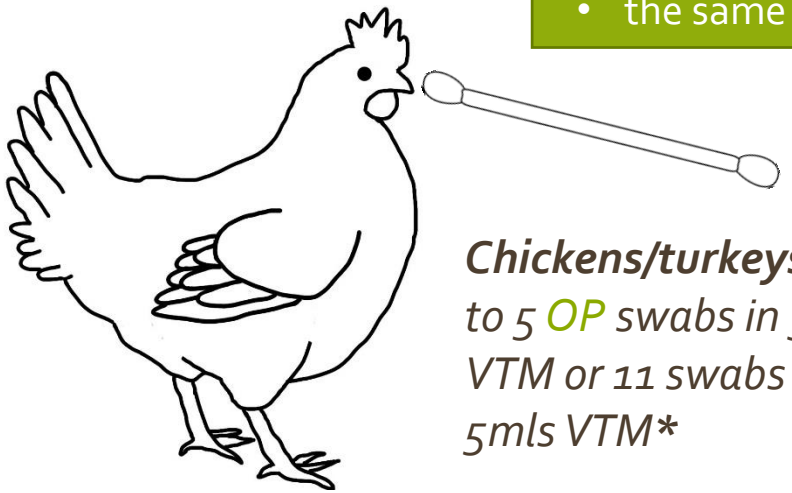
where case presentation warrants

Pool by:
- the same premises
- the same species
- the same sampling route

WI-AV-0020

Avian Sample Collection

https://www.aphis.usda.gov/animal_health/lab_info_services/downloads/WIAV0020.pdf



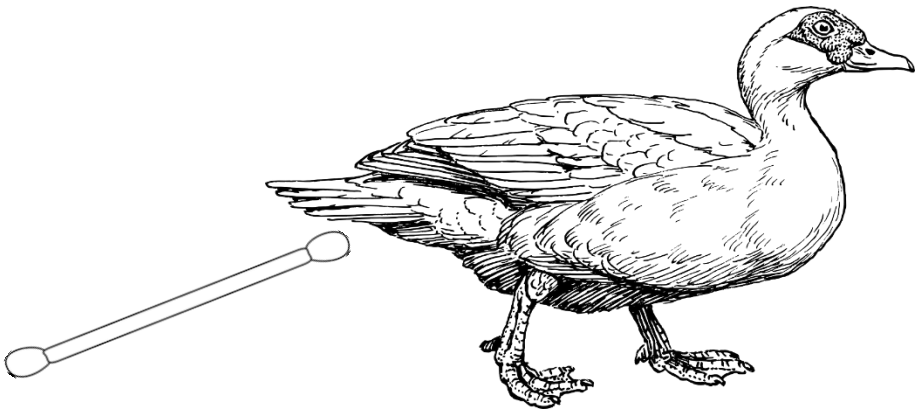
Chickens/turkeys *Up to 5 OP swabs in 3mls VTM or 11 swabs in 5mls VTM**

* Pooling of up to 6 swabs from the same species, location, and sampling route in 3 mls allows for testing of a single 11-swab pool per Secure Supply plans and NPIP surveillance using two tubes rather than three

Domestic waterfowl

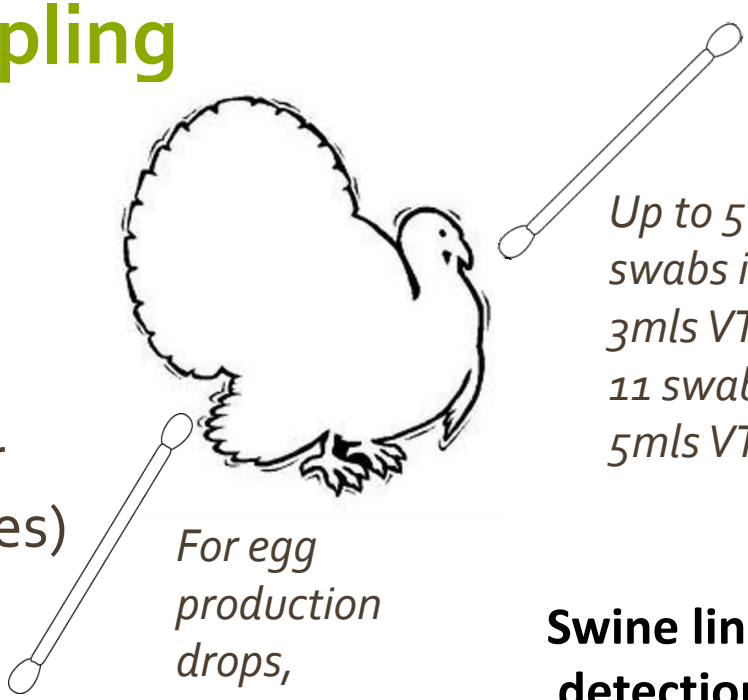
Up to 5 CL swabs in 3mls VTM

If sampling free ranging waterfowl – 1 OP and 1 CL swab in SAME TUBE may be preferred (and is recommended for wild waterfowl)



Alternate Sampling

- OP swabs recommended for routine detection
- For egg production drops (potential for swine lineage viruses) consider additional sampling routes
  - –Cloacal swabs (CL)
  - –Oviduct swabs
  - –Semen



*Up to 5 OP swabs in 3mls VTM or 11 swabs in 5mls VTM**

For egg production drops, collect up to 5 CL swabs in 3mls VTM

Swine lineage H1/H3 detection in turkeys

H1 | H3	2015	2016
H1	MN, NC	AR, MI, MN, MO*
H1/H3	IA	IN, SD
H3	IL	IL

* pH1N1 in 2016

Determine the virus status of the flock *for AGID, ELISA detection in unvaccinated flock or ACIA detection: collect additional swab samples for PCR testing*

For Routine Poultry Surveillance:

FORWARD samples non-negative for fluA (including H5/H7) to NVSL

CONFIRMATION at NVSL (molecular testing)

SEQUENCING for full subtype and LPAI vs HPAI

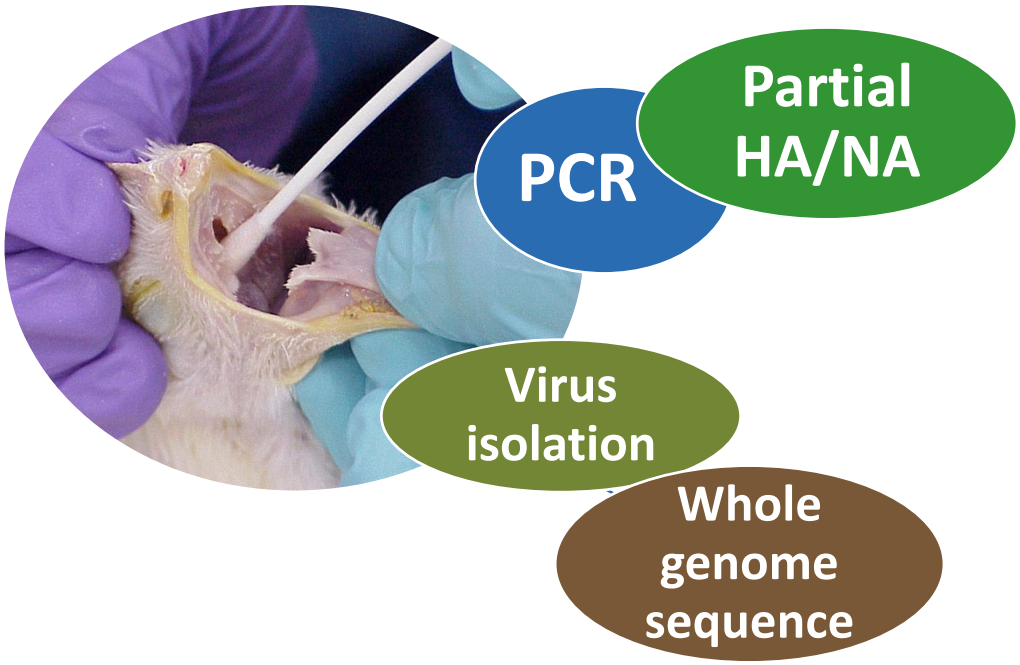
If HPAI Suspected :

Initiate depopulation *and* **forward** samples to NVSL for **confirmation** and **sequencing**

- *WITH:* H5 or H7 **detection** from a flock meeting **HPAI case definition** *AND* **agreement** between state and federal officials

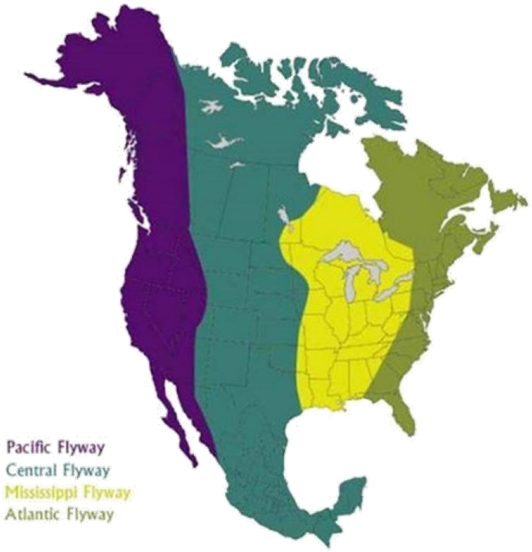
Fastest route for confirmation

Submit duplicate samples



- NVSL leverages the Ct from NAHLN Lab PCR to target samples for rapid subtype/ pathotype by partial sequence *where sufficient RNA is present*

Monitoring influenza A in natural reservoir hosts



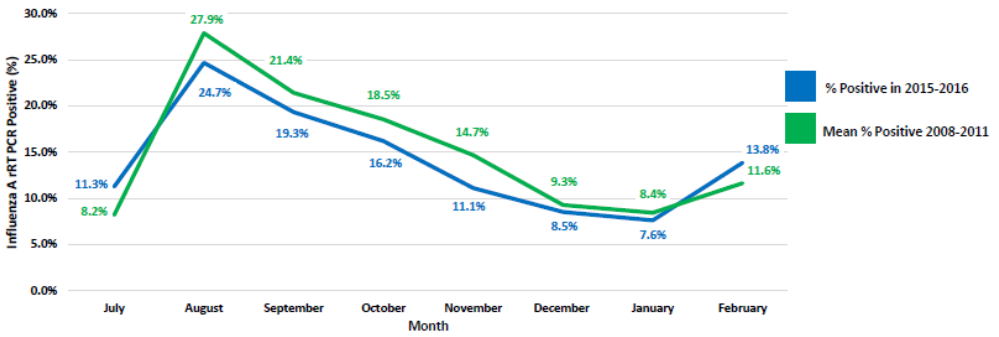
Dr. Tom Deliberto, USDA-WS

USDA United States Department of Agriculture · USGS science for a changing world · NATIONAL FLYWAY COUNCIL Pacific est. 1952 - Central est. 1948 - Mississippi est. 1952 - Atlantic est. 1952

Monthly Summary Data from the National Wild Bird Avian Influenza Surveillance Program:

July 2015 to February 2016 *

Graph 1. Percent of wild duck samples positive for low pathogenic Type A influenza viruses as determined by RT-PCR.



Last updated: 04/20/2016

July 2016 – June 2017
Last Updated: 8/26/2016

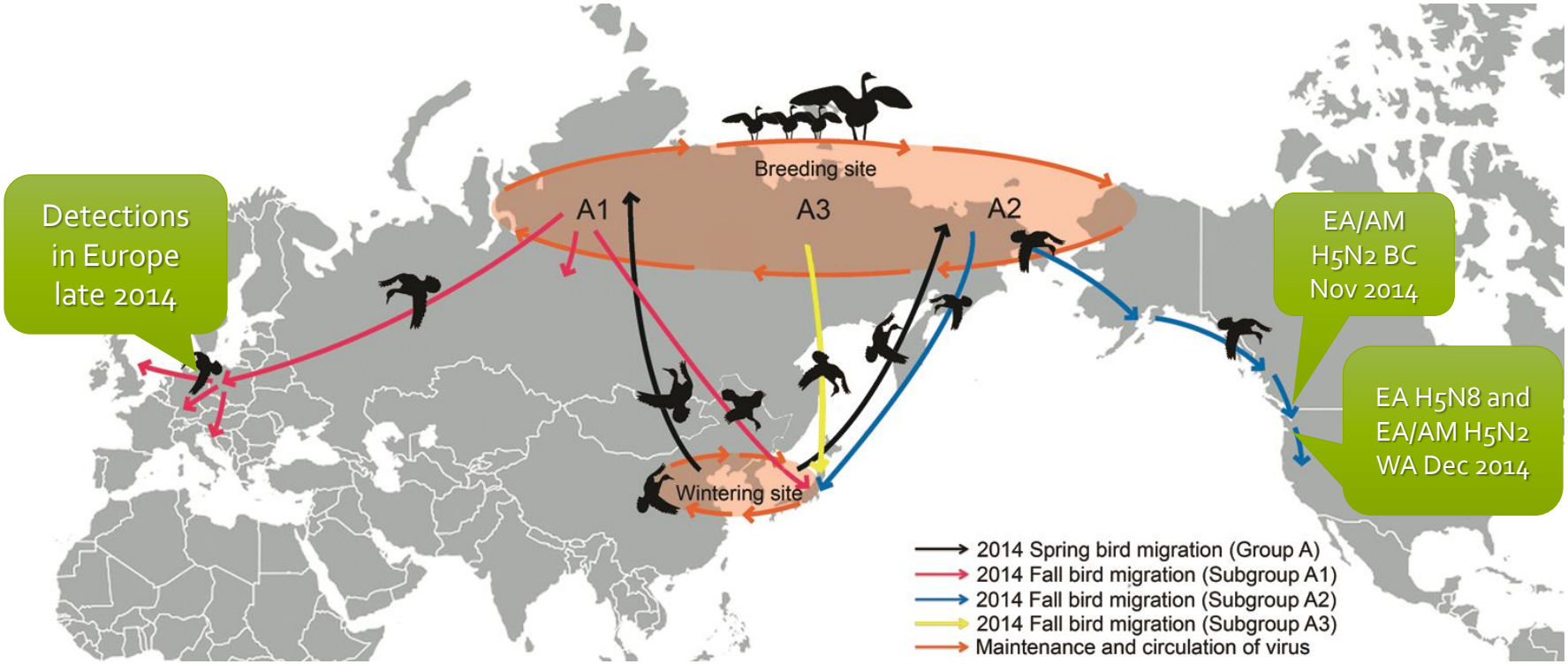
Total birds sampled: 5,339
Total HPAI positive cases (HA gene sequence confirmed): 1
icA molecular detection [d] only (HA gene sequence unsuccessful/no virus isolated) cases: 0

Total birds sampled by flyway
Atlantic: 1,509
Mississippi: 1,707
Central: 485
Pacific: 1,638
American Oceania [f]: 0

WILD BIRD HIGHLY PATHOGENIC AVIAN INFLUENZA CASES IN THE UNITED STATES [a]

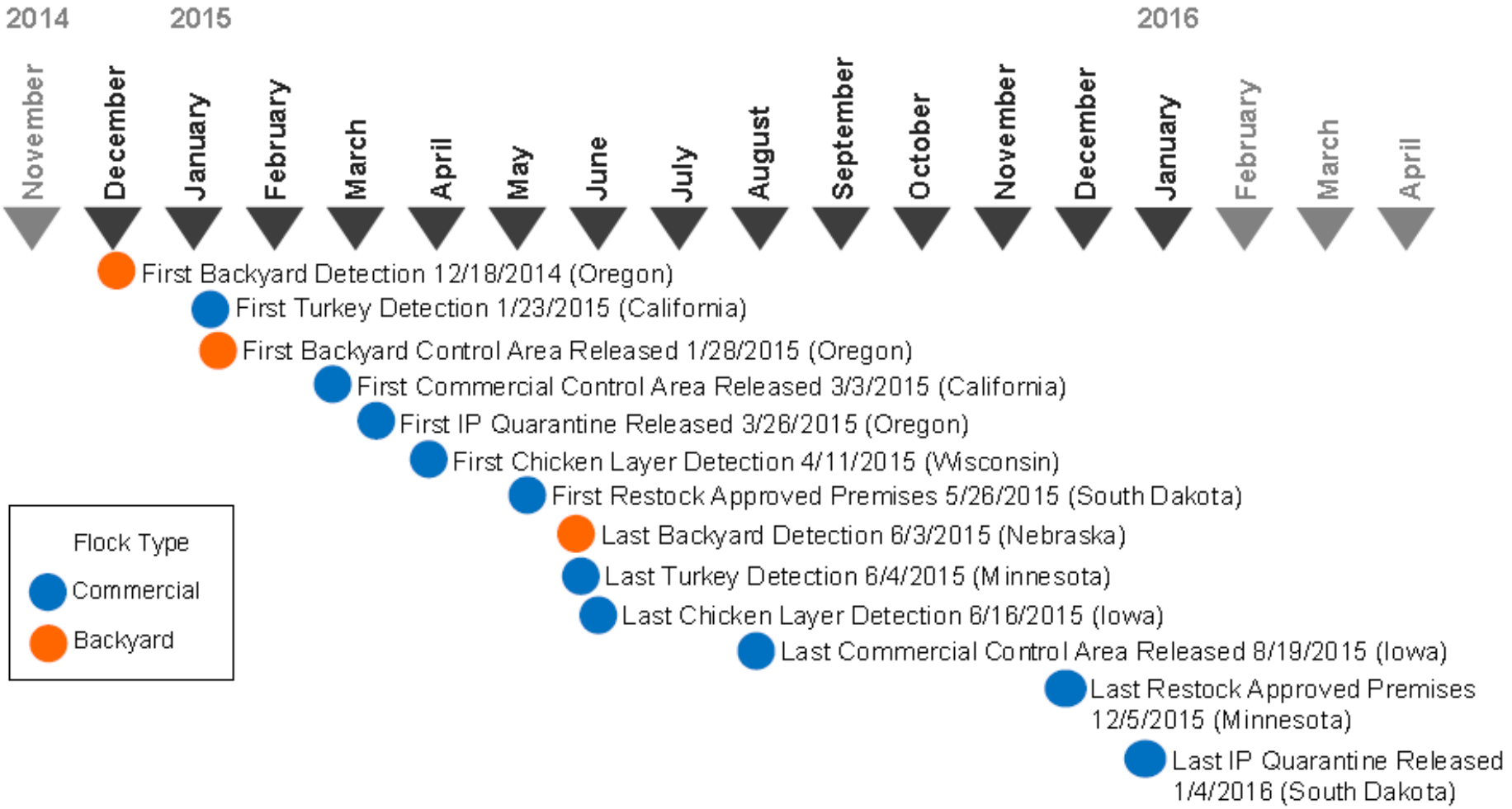
LINE	COLLECTION DATE	SPECIES	COUNTY	STATE	SUBTYPE [b]	CONFIRMATION DATE	COLLECTING AGENCY	COLLECTION STRATEGY [c]
1	8-12-2016 [e]	Mallard	Fairbanks North Star	AK	EA/AM H5N2	8-25-2016	Alaska DFG	L

Introduction of Novel Viruses



Lee DH, Torchetti MK, Winker K, Song CS, Swayne D. *Intercontinental Spread of Asian-origin H5N8 to North America through Beringia by Migratory Birds*
J. Virol. JVI.00728-15; epub ahead of print 8 April 2015, doi:10.1128/JVI.00728-15

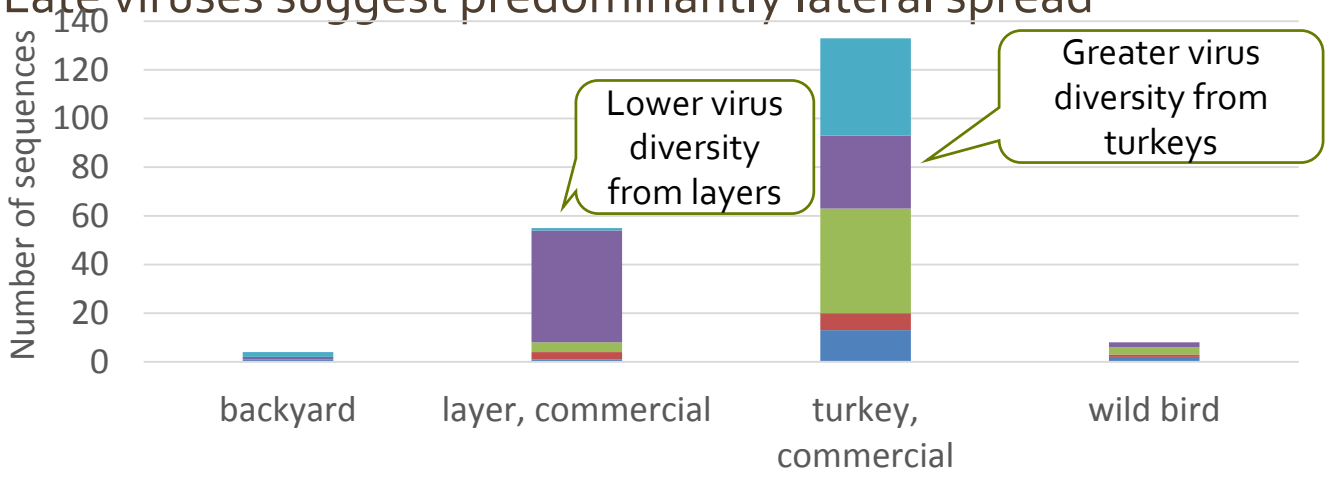
Summary of Key Events during the 2014–2015 HPAI Outbreak



Available at: https://www.aphis.usda.gov/animal_health/emergency_management/downloads/hpai/presentation/finalreport14-15_shortppt.pdf

Midwest EA/AM H5N2 Findings

- The Midwest viruses cluster into different subgroups; wild bird-type viruses present in most – potential to move virus ahead of birds
- Earliest viruses suggestive of point source introductions with limited evidence of lateral spread
- There is evidence for point source introductions and lateral spread concurrently
- Late viruses suggest predominantly lateral spread



Refer to H5 September 2015 Epi and Virus Report

Overview

- More rapid response now possible upon diagnosis with agreement of State and Federal officials.
- Biosecurity remains crucial – tailor program to production type.
- Investigation of whole house pathogen detection continues.

- **To date, the 2016 detections originate from 'native' North American LPAI** and are not related to the 2014-15 Eurasian H5 viruses
- There have been no confirmed Eurasian H5 wild bird or poultry detections since June 2015

IAV Events

Commercial Poultry

H5/H7	2015	2016
AR, IA, MN, ND, NE, SD, WI	H5N2 HPAI	--
CA	H5N8 HPAI	--
MO	H5N2 HPAI	H5N1 LPAI
CA	H7N3 LPAI	--
IN	--	H7N8 HPAI/LPAI

LBM/BYD

	2015	2016
CT, NJ, NY, PA, RI	H2N2	H2N2
NC	H2N2	--
AL	H3N1	--
CA	H3N2 quail	--
PA	H3N9; H1N9	H1N1
ID, KS, MT, OR, WA	H5N2 HPAI	--
IN	H5N8 HPAI	--
NJ	H5N1 LPAI	H5N2 LPAI
NY	--	H5N2 LPAI
PA	--	H5N2 LPAI
PA	H7N7 LPAI	--
CA	--	H9N2 pheasants

2016 H5/H7 Events

- H7N8 HPAI/LPAI of North American wild bird lineage, January 2016 in turkeys; epi and genetic data suggest a single introduction; mutation to HPAI occurred in a single flock.
- H5N1 LPAI of North American wild bird lineage, April 2016 in turkeys; epi and genetic data suggest a single introduction.
- H5N2 LPAI of North American wild bird lineage, June 2016 in LBMs; epi and genetic data suggest a single introduction.

Avian Influenza Summary

- US poultry are free of HPAI
- Wild waterfowl are natural reservoir hosts fluA
  - –Low pathogenicity fluA (non-H5/H7 subtypes) and H5/H7 LPAI
  - –Asian lineage H5 (GsGD) known to circulate in natural reservoir host as HPAI
- Recent outbreaks in the U.S. have stimulated change to policies and procedures
  - –Be aware, know where to find information
  - –Updates to sample collection and testing
  - –Real time use of sequence data and contribution to epidemiologic information
- Efforts to identify opportunities for early detection continue
- AI is of animal and public health significance

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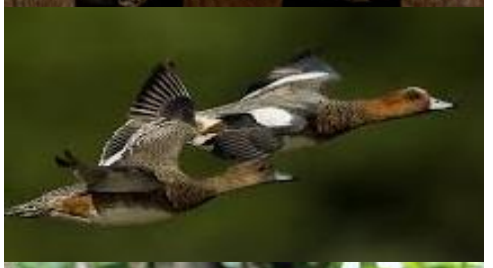
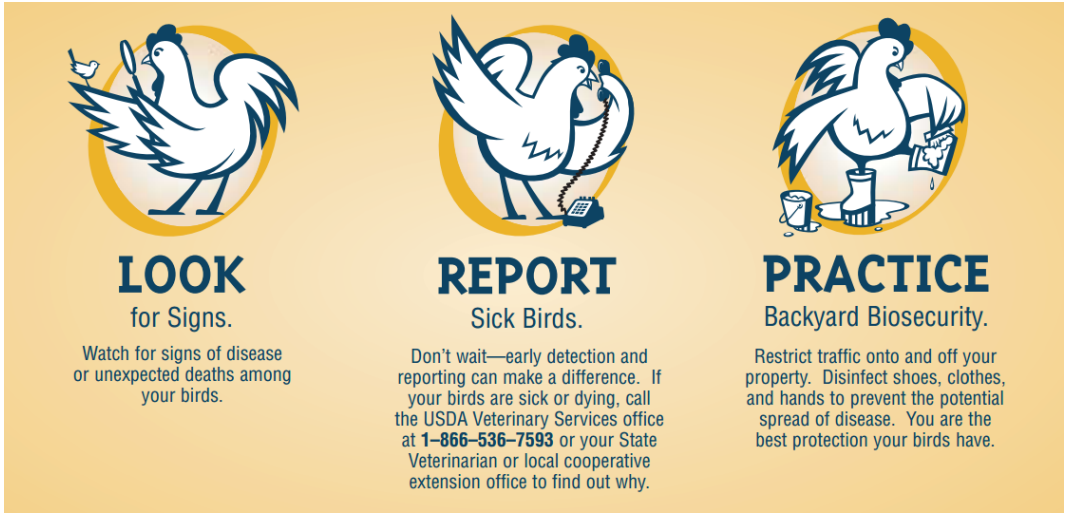
Special thanks to the avian team and our partners!



USGS science for a changing world
Agricultural Research Service
USDA Wildlife Services
APHIS
Veterinary Services
NAHLN National Animal Health Laboratory Network
NPIP
FAO FIAT PANIS
OIE
offlu OIE FAO network on avian influenza

Biosecurity

- USDA Guidance for Hunters
- USDA Guidance - Backyard Biosecurity
- Refer to HPAI FAD-Prep Materials for commercial poultry



Routine Precautions

- Do not handle or consume game animals that are obviously sick or found dead.
- Do not eat, drink or smoke while cleaning game.
- Wear rubber gloves when cleaning game.
- Wash hands with soap and water, or alcohol wipes, immediately after handling game.
- Wash tools and working surfaces with soap and water and then disinfect.
- Keep uncooked game in a separate container, away from cooked or ready-to-eat foods.
- Cook game meat thoroughly; poultry should reach 165°F internally to kill disease organisms and parasites.

Please report sick or dead birds to local wildlife agencies or to 1-866-4USDA-WS.

USDA APHIS VS Guidance Documents

- May supersede NVSL protocols when essential to address outbreak needs. Such changes shall be communicated in a timely manner and documented. Some examples include but are not limited to:
  - HPAI Response Plan: The Red Book
  - HPAI Response Goals
  - Stamping-Out & Depopulation Policy
  - Avian Sample Collection WI-AV-0020
  - Post C&D Environmental Sampling Guide
  - H5/H7 Avian Influenza Case Definition
  - Use of the Antigen Capture Immunoassay