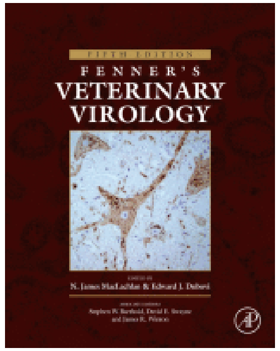
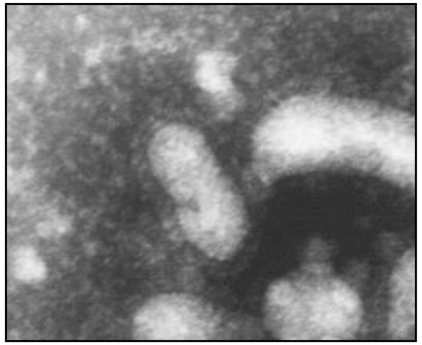
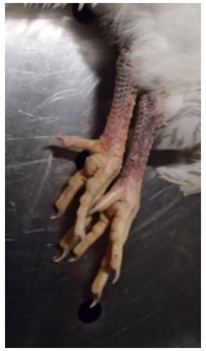
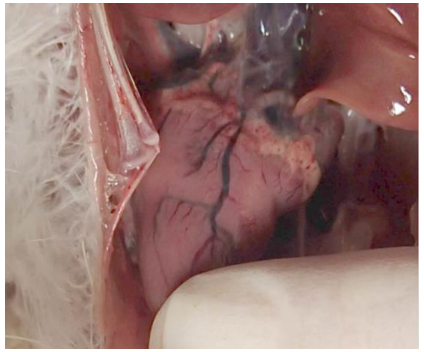
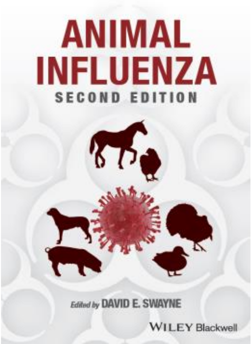
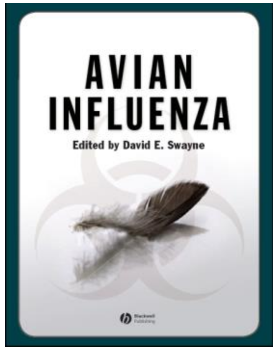




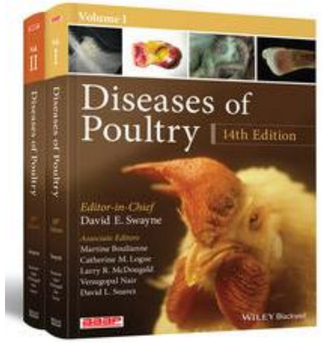








International and National HPAI Status for Poultry and Dairy



David E Swayne, DVM, PhD, dACVP, dACPV

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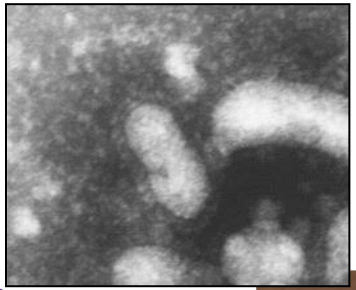
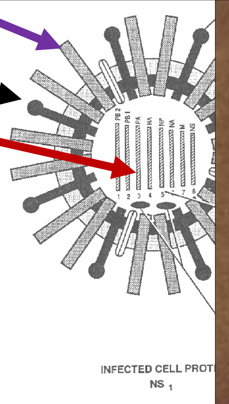
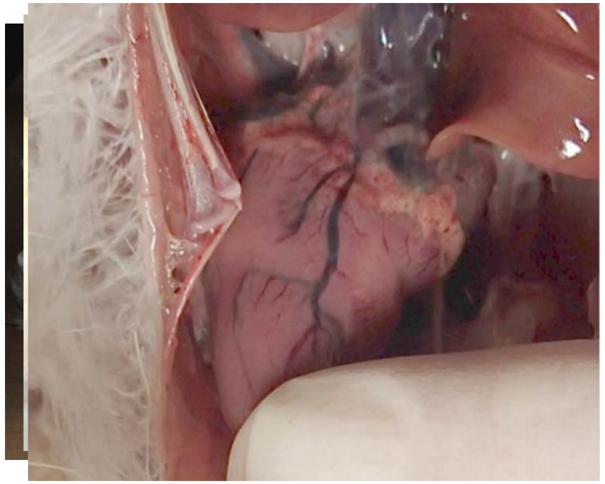
Disclaimer: This presentation is based on current scientific data and is not an endorsement of any specific product or company

Avian Influenza and the Viral Cause

- Small Virus (Orthomyxovirus) with protein projections on the surface:
  - 17 hemagglutinin subtypes (i.e., H1-H16, H19) - MUTATIONS
  - 9 neuraminidase subtypes (i.e., N1-N9)
- 8 gene segments: Can REASSORT between different LP & HP AIVs
- Vary in disease production (chickens):
  - Low pathogenicity (LPAIV): local replication - mild respiratory disease and egg drop; e.g. H9N2 LPAIV but can be any H1-16 or H19
  - High pathogenicity (HPAIV): systemic - deadly disease (some H5 & H7); e.g., H5N1 HPAIV
- Can infect a variety of poultry and wild birds, depending on virus strain and species (severity)
- Migratory aquatic birds are the reservoir of LPAIV but historically not HPAIV
- AVIAN INFLUENZA VIRUSES CHANGE!!!







High Pathogenicity Avian Influenza Events

1. 1959: Scotland, H5N1
2. 1961: S. Africa, H5N3
3. 1963: England, H7N3
4. 1966: Canada, H5N9
5. 1975: Australia, H7N7
6. 1979: Germany, H7N7
7. 1979: England, H7N7
8. 1983-84: USA, H5N2
9. 1983: Ireland, H5N8
10. 1985: Australia, H7N7
11. 1991: England, H5N1
12. 1992: Australia, H7N3
13. 1994: Australia, H7N3

§ 14. 1994-5: Mexico, H5N2 LPAIV persist

§ 15. 1995 & 2004: Pakistan, H7N3

16. 1997: Australia, H7N4
17. 1997: Italy, H5N2

§ 18. 1996-present: Asia/Europe/Africa/N. & S. America, H5Nx (including N1, 2, 3, 5, 6, 8 reassortants) – Gs/GD Eurasian lineage

19. 1999-2000: Italy, H7N1
20. 2002: Chile, H7N3
21. 2003: Netherlands (BEL, GRM), H7N7
22. 2004: USA, H5N2
23. 2004: Canada, H7N3
24. 2004: S. Africa, H5N2 (ostriches)
25. 2006: S. Africa, H5N2 (ostriches)

§ 26. 2005: N. Korea, H7N7

27. 2007: Canada, H7N3
28. 2008: England, H7N7
29. 2009: Spain, H7N7
30. 2011-3: S. Africa, H5N2 (Ostriches)
31. 2012: Chinese Taipei, H5N2

§ 32. 2012-present: Mexico, H7N3

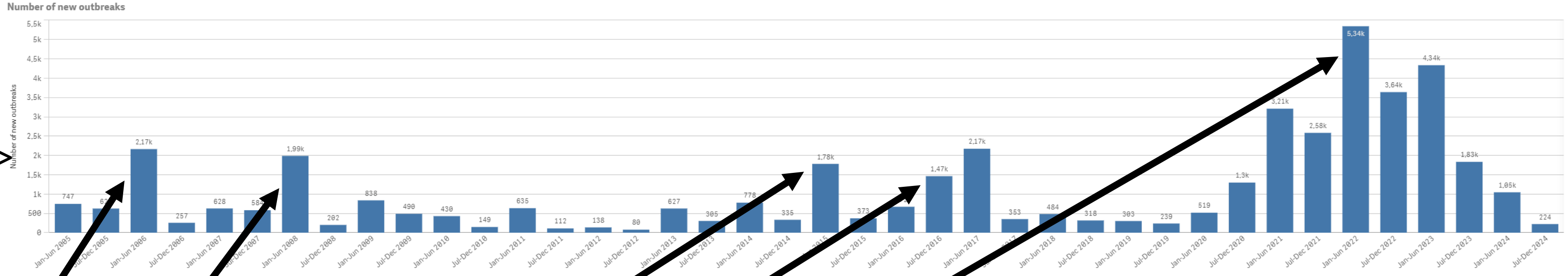
33. 2012: Australia, H7N7
34. 2013: Italy, H7N7
35. 2013: Australia, H7N2
36. 2015: England, H7N7
37. 2015: Germany, H7N7
38. 2015: France, H5Nx
39. 2016: USA (Indiana), H7N8
40. 2016: Italy, H7N7
41. 2017: China, H7N9
42. 2017: USA (Tennessee), H7N9
43. 2020: USA (S. Carolina), H7N3
44. 2020: Australia (Victoria), H7N7
45. 2023: South Africa, H7N6
46. 2024: Australia (Victoria), H7N3
47. 2024: Australia (Victoria), H7N9
48. 2024: Australia (New South Wales), H7N8
49. 2024: Germany, H7N5

§Vaccine used in the control strategy

- H5 & H7 LPAIV → HPAIV
- NOT ALL HPAIV & OUTBREAKS ARE THE SAME!
- 49 HPAI events based on distinct virus hemagglutinin lineages:
  - 46 Emergent (42 eliminated & 4 active)
  - 3 Entrenched
    - H5Nx goose/Guangdong (Gs/GD), especially 2344b clade (global panzootic)
    - H7N3 North American lineage (Mexico)
    - H7N9 Eurasian lineage (China)

Global HPAI: 1-Jan-2005 through 25 October 2024 Status

- Reported outbreaks:
  - Entrenched H5Nx Gs/GD Eurasian lineage >>> H7N9 Eurasian lineage >> H7N3 N. Amer. lineage > H7N6 > emergent H7 > emergent H5



Source: WOAH

- Outbreaks 2005-24: Five main H5Nx Gs/GD lineage peaks
  - 2005-06: 2.2 clade
  - 2007-08: 2.3.2.1 clade
  - 2014-15: 2.3.4.4c clade
  - 2016-17: 2.3.4.4b clade
  - 2020-24: 2.3.4.4b clade

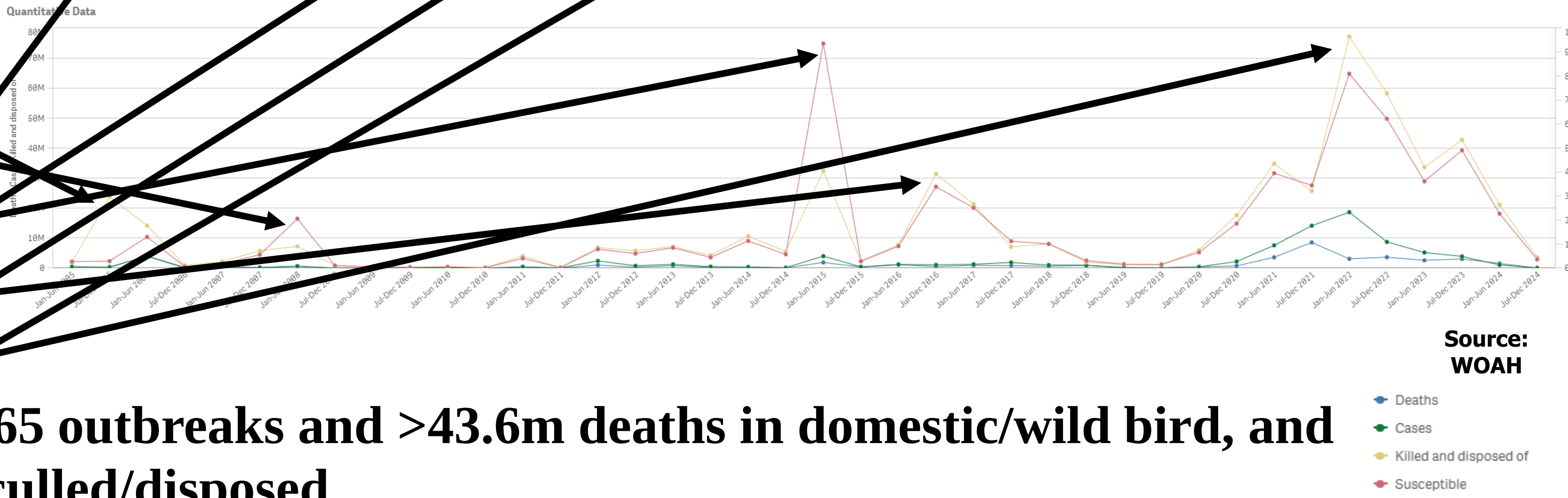
2.2

2.3.2.1
2.3.4

2.3.4.4c
(2.3.4.4A)

2.3.4.4b

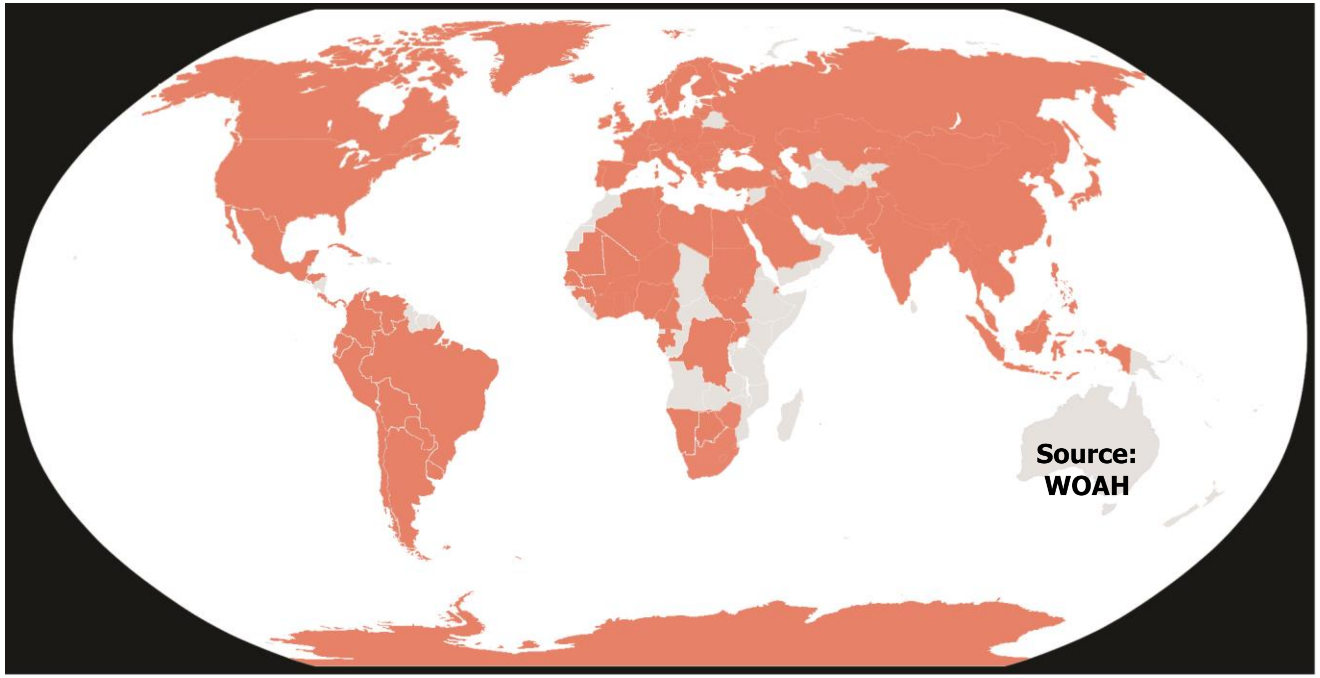
2.3.4.4b

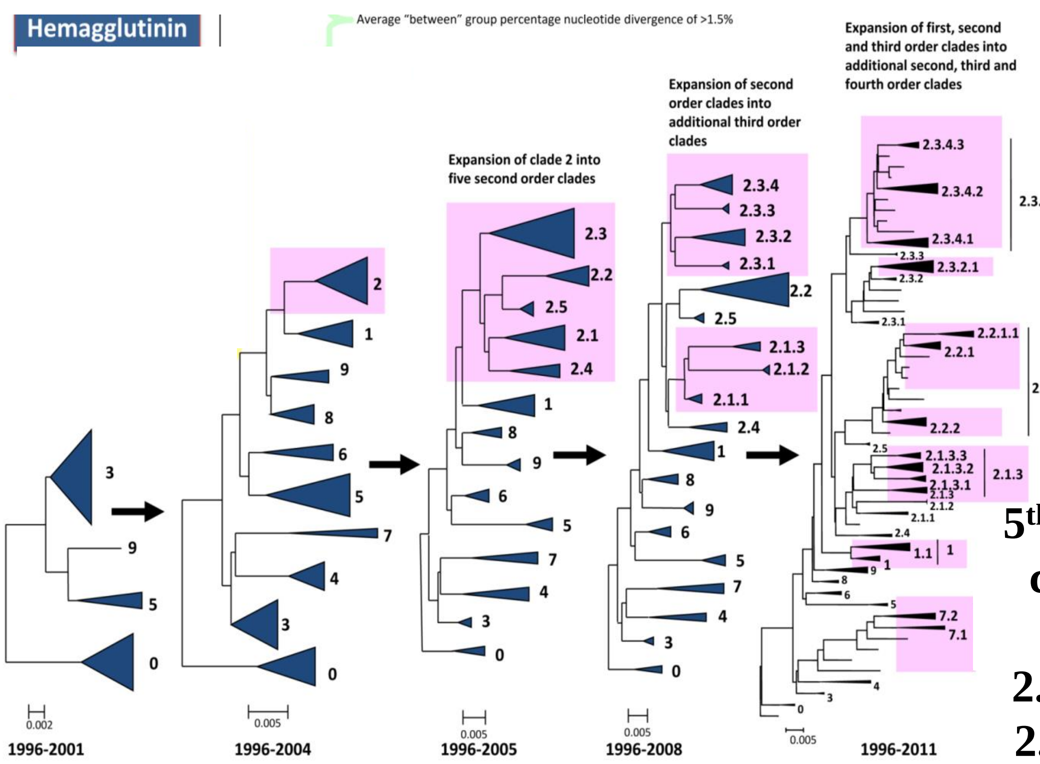


Source: WOAH

Global epizootic: >44,265 outbreaks and >43.6m deaths in domestic/wild bird, and >537m domestic birds culled/disposed

H5Nx Gs/GD Eurasian lineage



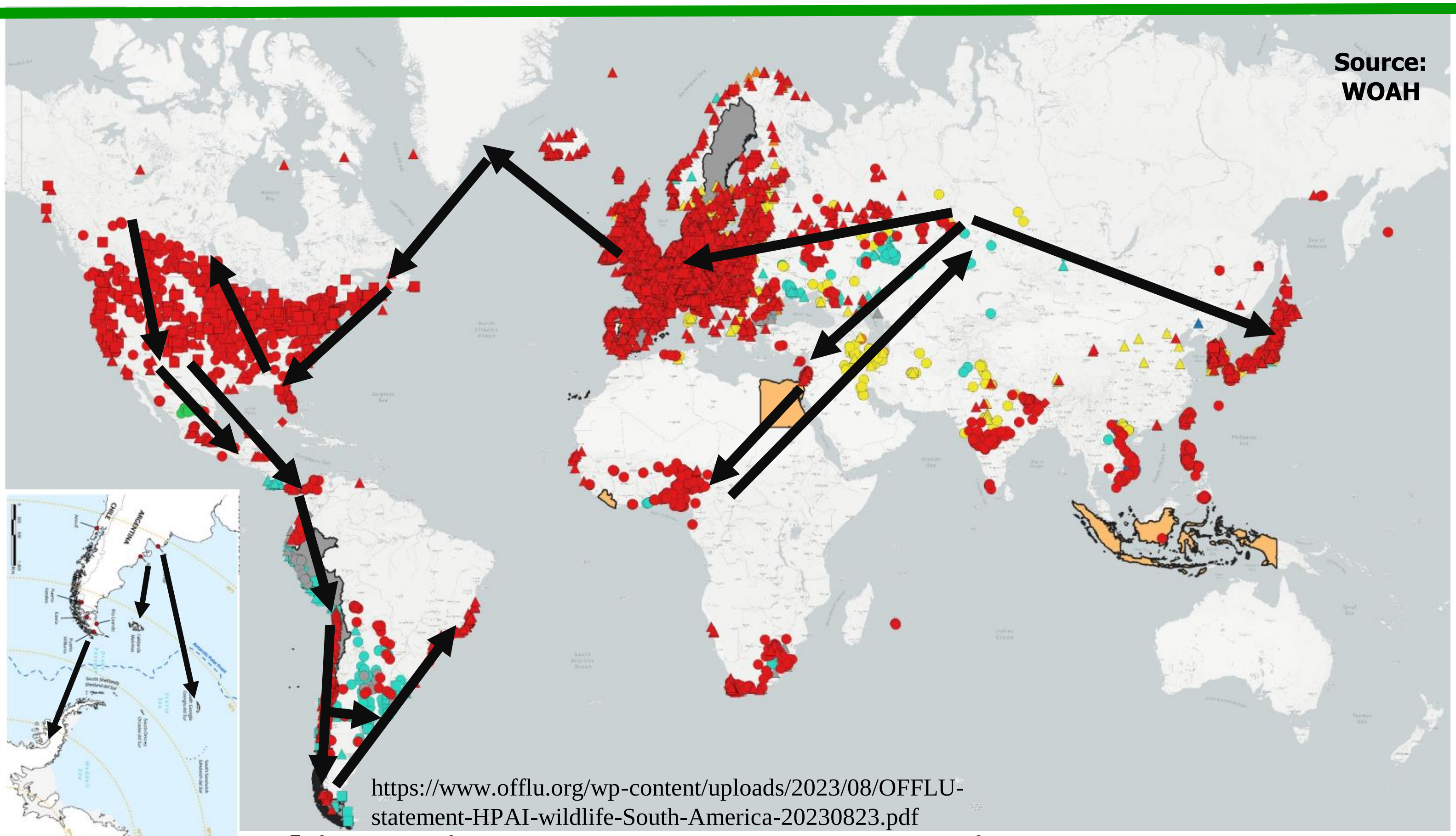


5th order clade: e.g. 2.3.4.4b 2.3.2.1c

- Effected more poultry than the other 48 HPAI disease events combined
- >124 countries in poultry; wild, domestic and captive birds and mammals; and/or humans since 1996
- Largest & longest HPAI outbreak since early 1900's when Fowl Plague ("H7-HPAI") spread across Europe, Asia, Africa, North and South America
- Extensive mutation (drift) in the hemagglutinin and reassortment (shift) of the other 7 gene segments with wild bird LPAIV has impacted the ecology and epidemiology of the epizootic – e.g. generating multiple hemagglutinin clades and subclades (5th order) and genotypes
- Evidence of enzootic ("endemic") reservoir in some wild birds – ecological change (varies from asymptomatic infection to mass die-offs)

H5Nx Gs/GD Eurasian-lineage HPAIV

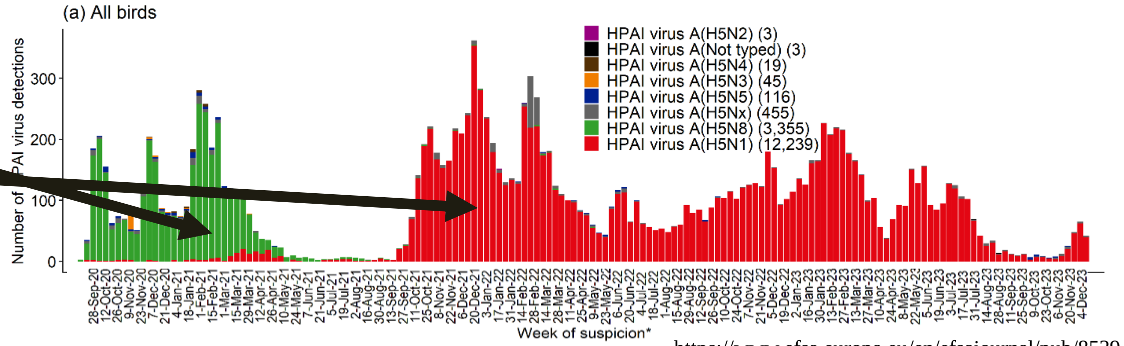
- **Fall 2020, 2.3.4.4b clade moved by migratory aquatic birds from Central Asia to Europe, Eastern Asia, Middle East, and Africa with evidence of bi-directional movement 2021 spring migrations**
- **Spr-Fall 2021, 2.3.4.4b moved to North America and winter 2022 down east coast, spring 2022 northward, late summer 2022 southward**
- **Fall 2022, 2.3.4.4b moved to Central America, Caribbean and northern South America**



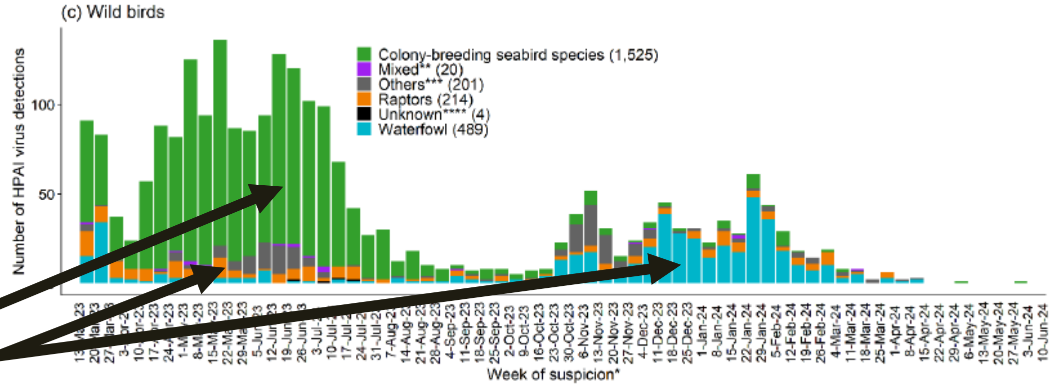
- **Winter 2023, 2344b moved done Pacific Coast and in Spring 2023 across to Argentina & Uruguay, & northward to Brazil**
- **Fall 2023, moved into Falkland Islands (Malvinas) and Antarctic Polar Front (South Georgia Islands)**
- **February 2024, Antarctica**
- **Global (Since Jan 2020): 9456 cases, 27m poultry deaths and 320m poultry culled**

H5N8 2.3.4.4b Gs/GD HPAI wave began Fall 2020 in Central Asia

- **Beginning Fall 2020 as H5N8**
- **Fall 2021, H5N1 reassortant emerged causing infection in diverse wild & domestic bird species (>528 species, 51 families, 25 orders) with illness and death, and continuous cases**
- **Spread by wild birds across large geographic regions: asymptomatic infections in many waterfowl with individual bird deaths to massive die-offs of colony breeding seabirds**
- **In Europe, winter 2023 predominately seabirds, but waterfowl since fall 2023**
- **Spill-over to predatory/scavenger species of wild birds**
- **Spill-over to pets: dogs and cats (predation – wild bird carcasses)**



https://www.efsa.europa.eu/en/efsajournal/pub/8539



EFSA Scientific Reports - https://doi.org/10.2903/j.efsa.2024.8930

Source: Wikipedia

AVIAN DISEASES 68:72–79, 2024

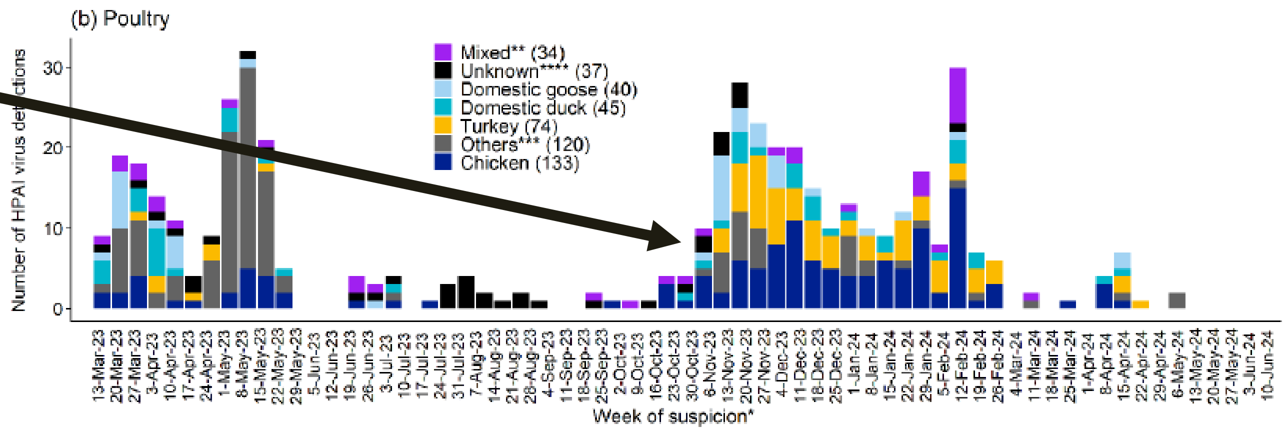
Case Report—

Caught Right on the Spot: Isolation and Characterization of Clade 2.3.4.4b H5N8 High Pathogenicity Avian Influenza Virus from a Common Pochard (*Aythya ferina*) Being Attacked by a Peregrine Falcon (*Falco peregrinus*)

Sun-Hak Lee,[A] Sol Jeong,[B] Andrew Y. Cho,[A] Tae-Hyeon Kim,[A] Yun-Jeong Choi,[A] Heesu Lee,[A] Chang-Seon Song,[AC] Sang-Soep Nahm,[D] David E. Swayne,[E] and Dong-Hun Lee[CFG]

H5N8 2.3.4.4b Gs/GD HPAI wave began Fall 2020 in Central Asia

- **Spill-over into poultry from:**
  - **Direct spread by wild aquatic bird into outdoor reared poultry**
  - **Indirect spread by wild aquatic bird feces contaminating environment around poultry premises and moved into the barn by human activity (clothes, shoes, equipment, water or feed)**
  - **Country specific farm-to-farm spread through human activity**
- **Spill-over to 40 species of terrestrial mammals and 13 species of sea mammals with large die-offs in harbor seals (2022), sea lions (2023) & elephant seals (2023)**
- **Farmed mammals: 1 mink (Spain), 42 fur farms (Finland - fox, sable, mink, raccoon dogs); dairy cattle, goats & alpaca (USA)**
- **Sporadic human cases mostly from direct poultry exposure or exposure to infected dairy cattle**

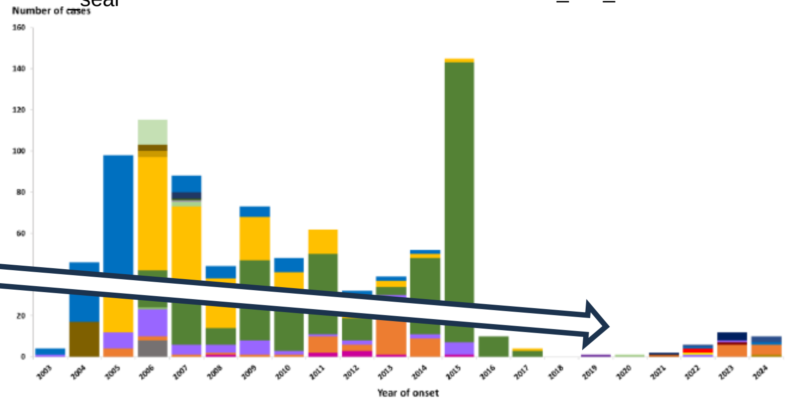


EFSA Scientific Reports - https://doi.org/10.2903/j.efsa.2024.8930

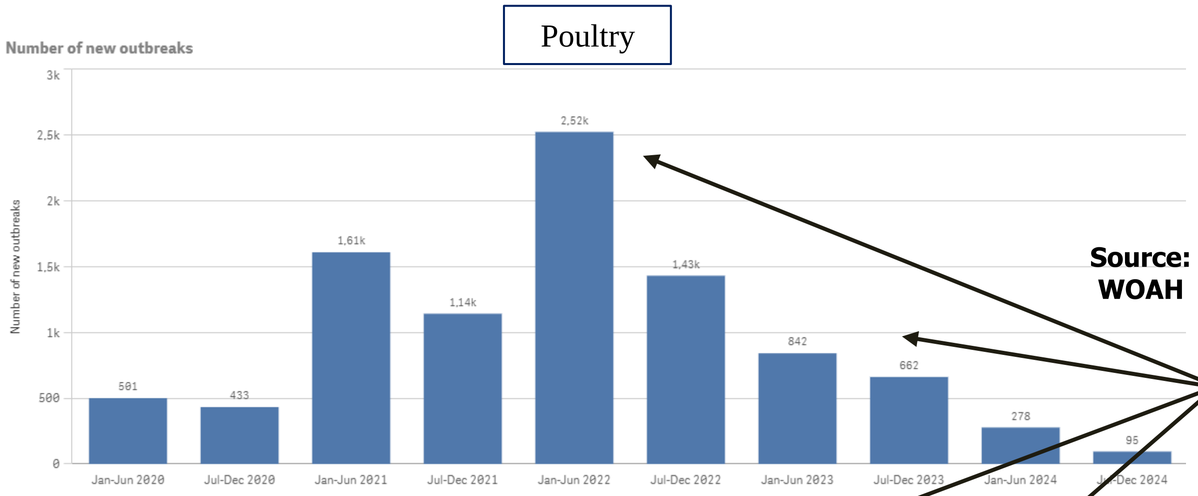
https://en.wikipedia.org/wiki/Red_fox

https://en.wikipedia.org/wiki/Harbor_seal

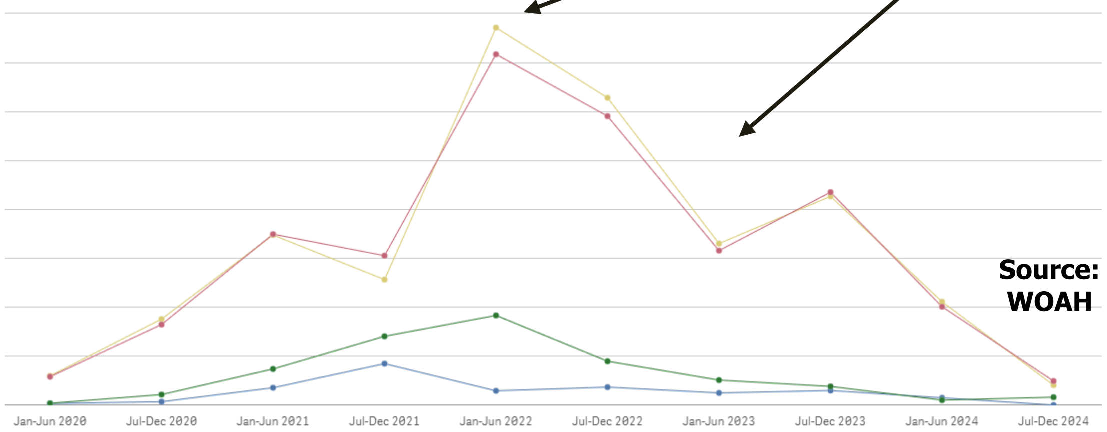
https://en.wikipedia.org/wiki/South_American_sea_lion



Summary Poultry: Global HPAI (1-Jan-20 to 1-Oct-24)



Source: WOAH

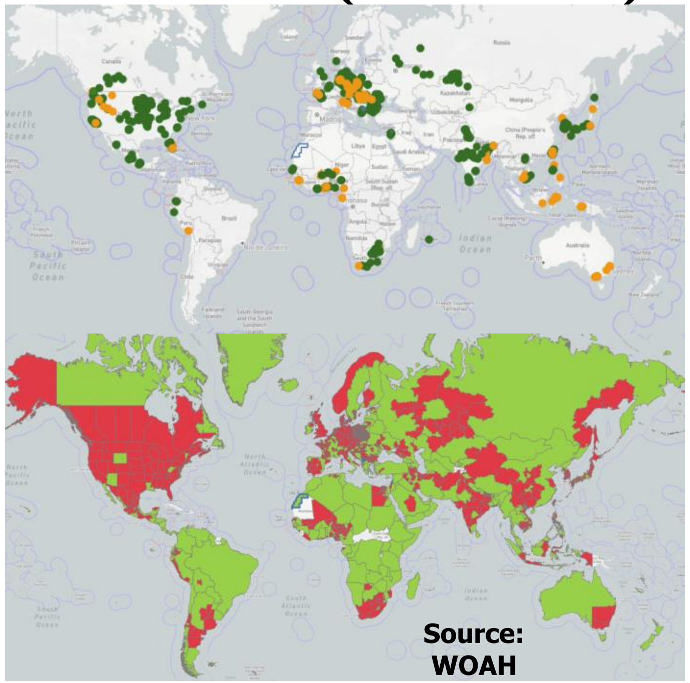


Source: WOAH

- **High Income Countries (HIC) are the primary notifiers to WOAH**
  - **Highly developed & funded poultry and wild bird surveillance and diagnostic programs**
  - **Most transparent – WOAH 2023 Animal Health Forum resolution called for transparency**
- **Jan-Jun 2022 was peak in outbreaks and culling with declines to Oct 2024 (Nov-Dec?)**

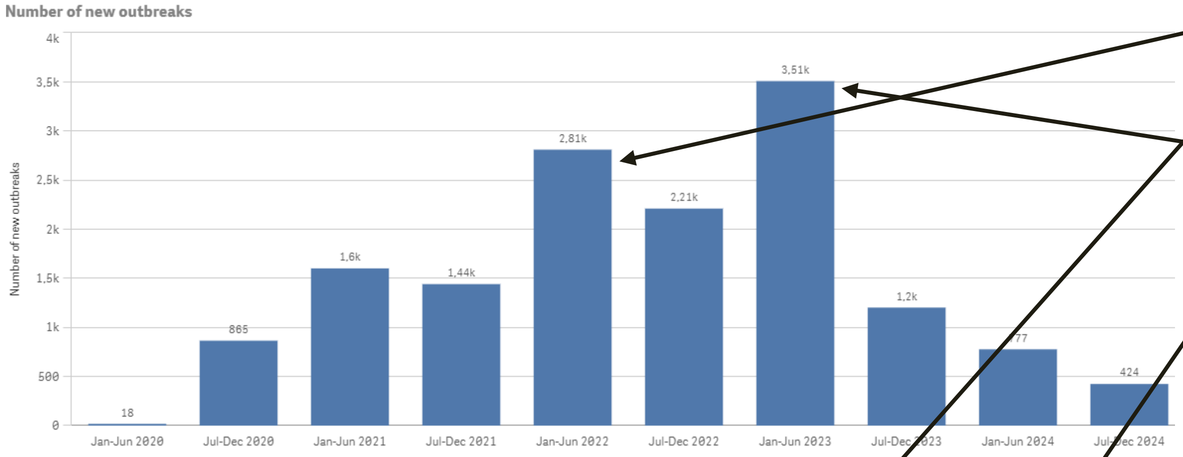
World Organisation for Animal Health
Founded as OIE

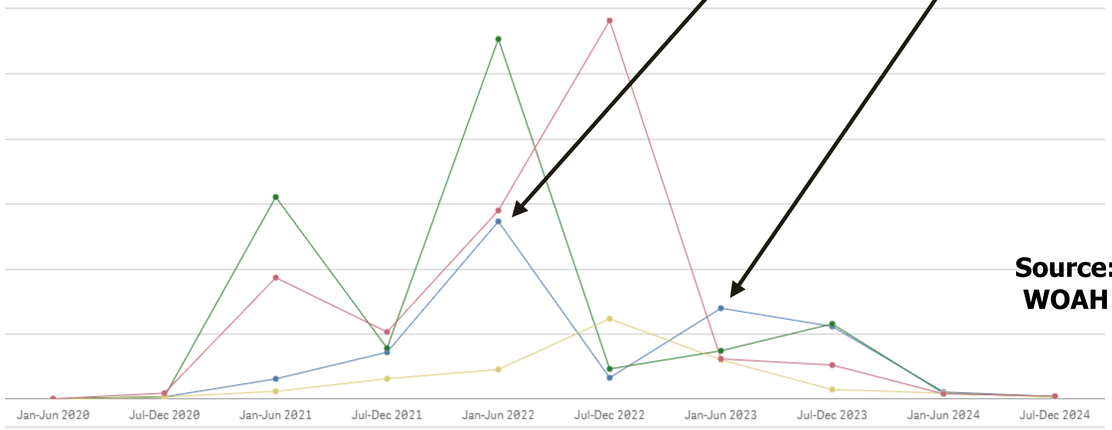
"…Members maintain transparency through timely and comprehensive reporting of avian influenza events to WOAH as described in the Terrestrial Animal Health Code.."



Summary Wild/Domestic Birds: Global HPAI (1-Jan-20 to 1-Oct-24)

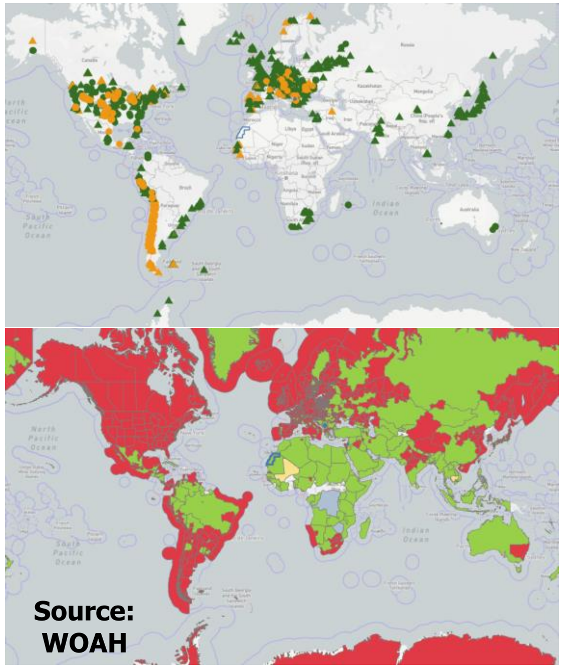
Wild/Domestic Birds





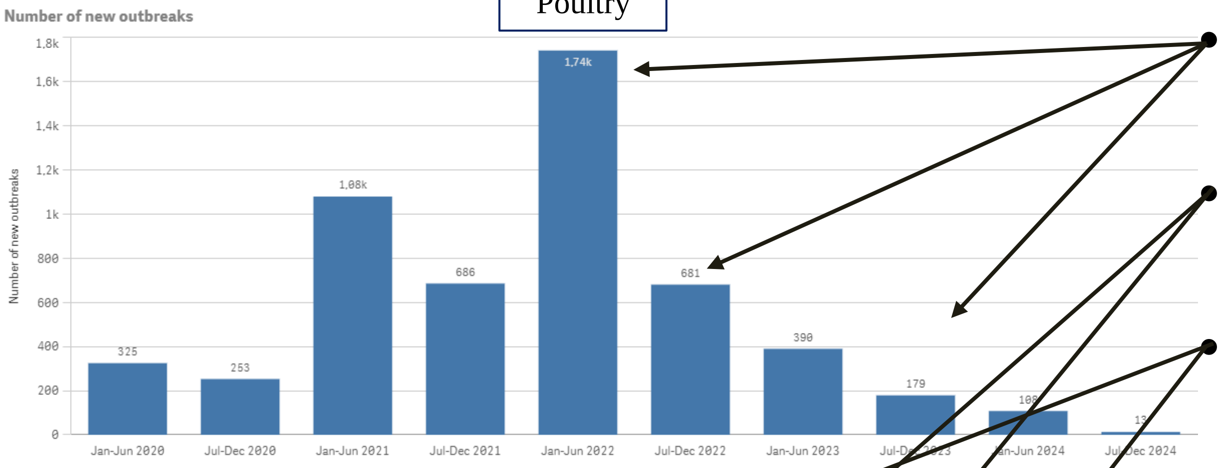
Source: WOAH

- **Two wild bird outbreak and death peaks –**
  - **Jan-Jun 2022: North American and European wild birds**
  - **Jan-Jun 2023 peak – wild birds infections and die-offs in South America and Northern Europe (seabirds)**
- **2 months left of 2024 reporting – could be increase in final numbers with fall waterfowl migration**

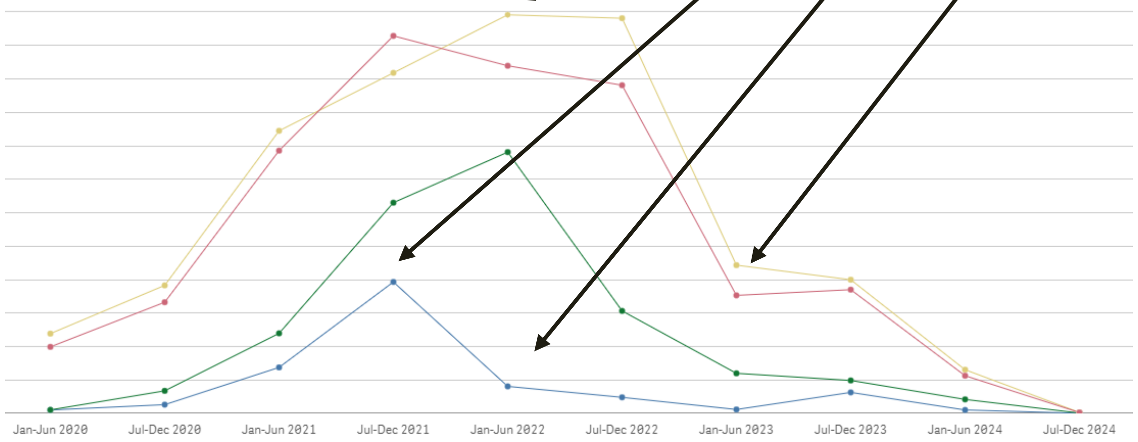


Summary: Europe HPAI (1-Jan-20 to 1-Oct-24)

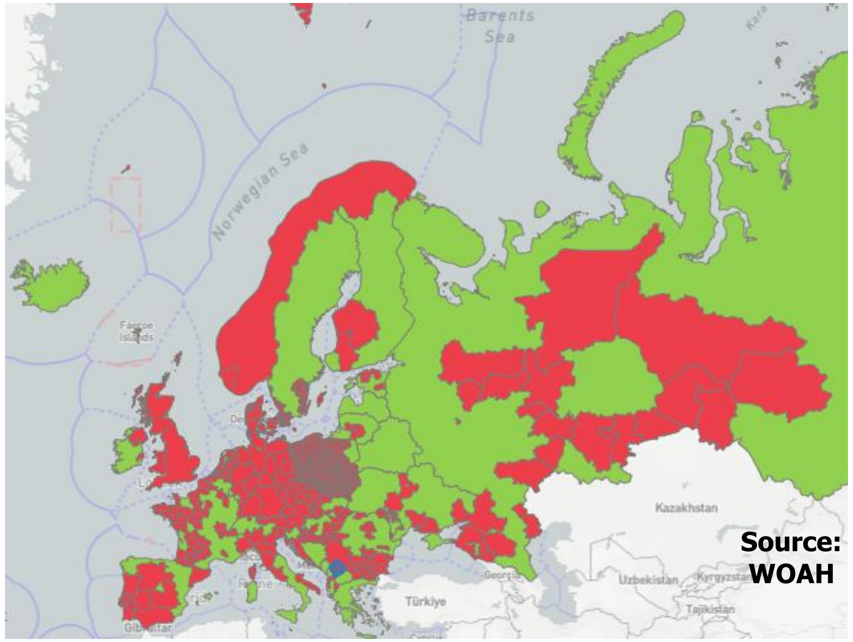
Poultry



- **Jan-Jun 2022 peak poultry outbreaks with steady decline Jul 2022 to Sep 2024**
- **Jul-Dec 2021, peak in poultry deaths with declines since**
- **Jan-Jun 2022 & Jul-Dec 2022, peak in culling with rapid declines Jan-Jun 2022 to Sep 2024**



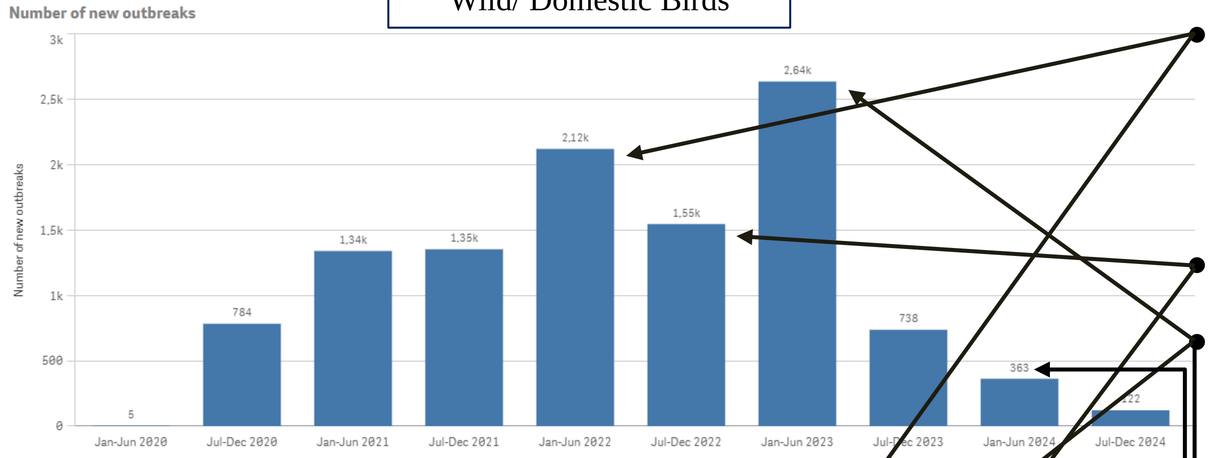
Source: WOAH



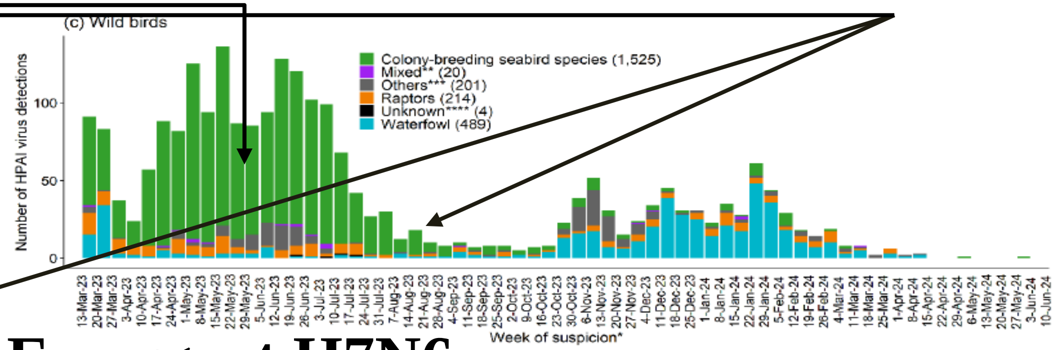
Source: WOAH

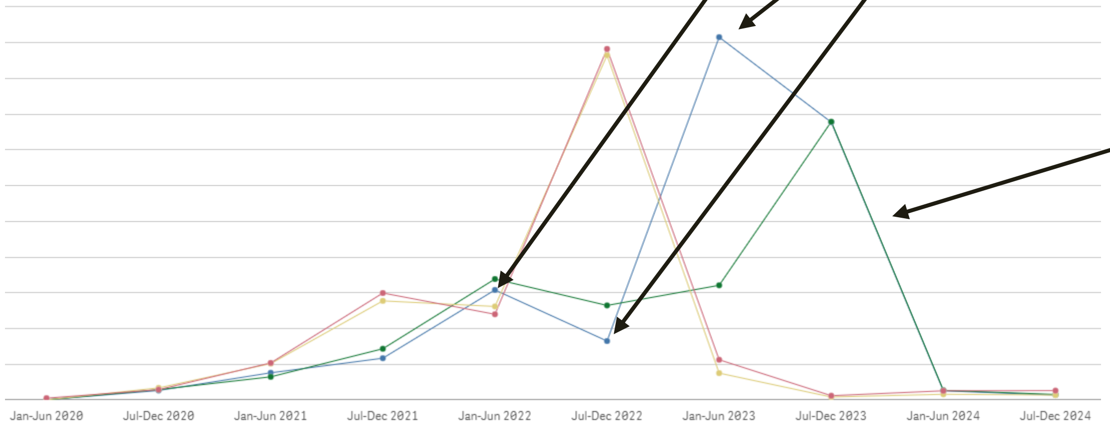
Summary: Europe HPAI (1-Jan-20 to 1-Oct-24)

Wild/ Domestic Birds

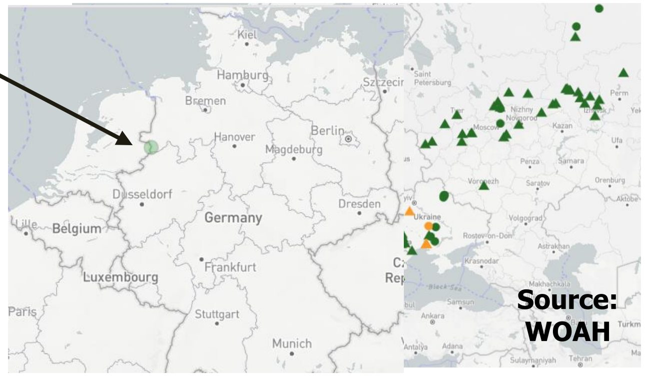


- **Initial peak, Jan-Jun 2022 in wild birds/backyard poultry outbreaks and deaths**
- **Slight decline in Jul-Dec 2022**
- **New peak Jan-Jun 2023 with high mortality in colony seabirds, followed by decline**





- **Emergent H7N6 Germany**
  - **29 June 24, single layer farm, 90,876 birds, outdoor access**
  - **7 Aug 24: Eradicated**

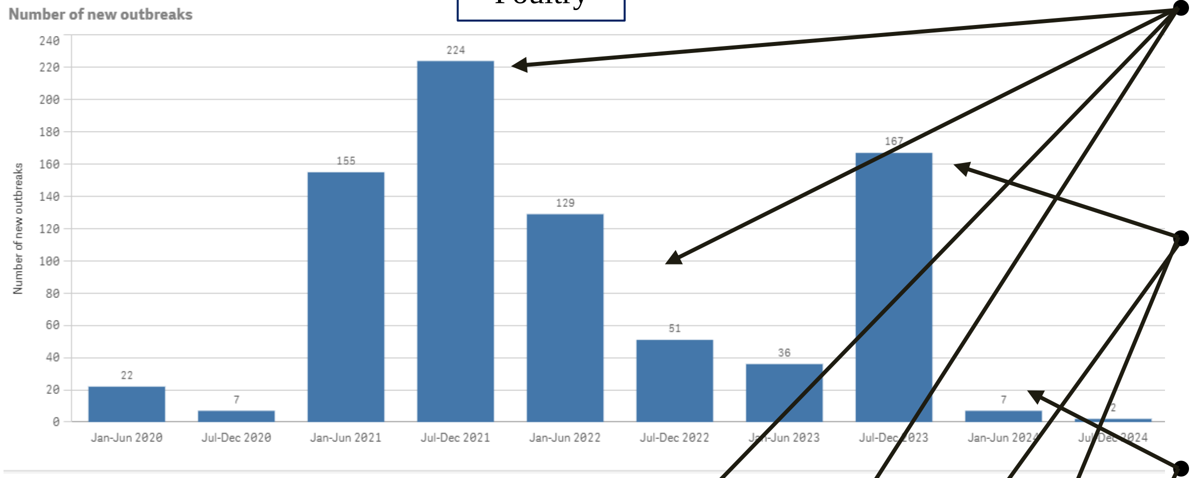


Source: WOAH

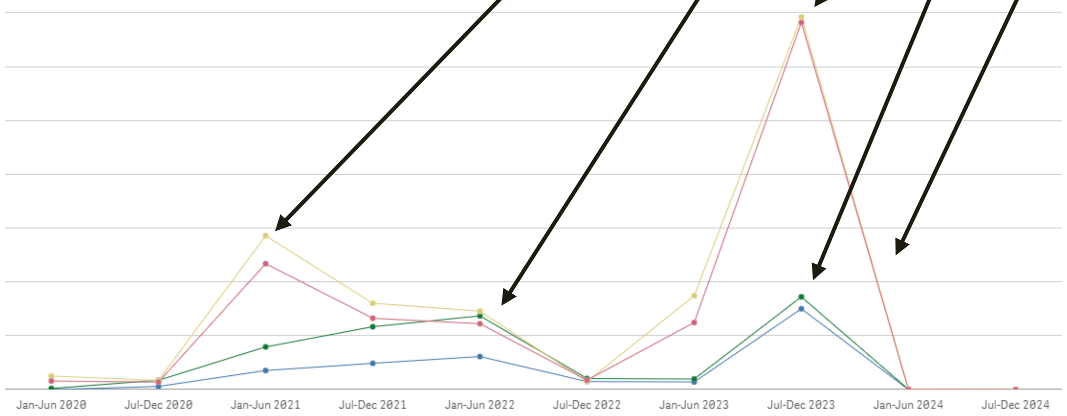
Source: WOAH

Summary: Africa HPAI (1-Jan-20 to 1-Oct-24)

Poultry



- **Jul-Dec 2021 peak H5N1 HPAI in poultry outbreaks and number culled with steady decline Jan-2022 to Jun-2023**
- **Jul-Dec-2023, new peak in poultry outbreaks/deaths and culling from Emergent H7N6 HPAI in S. Africa**
- **Jan-Jun 2024, declines outbreaks, deaths and culling**



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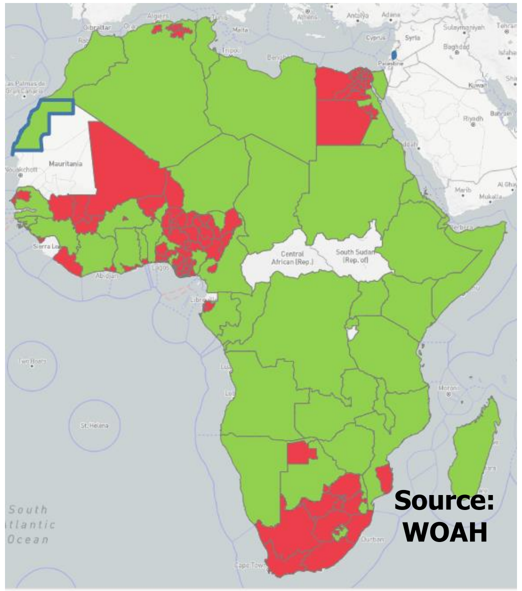
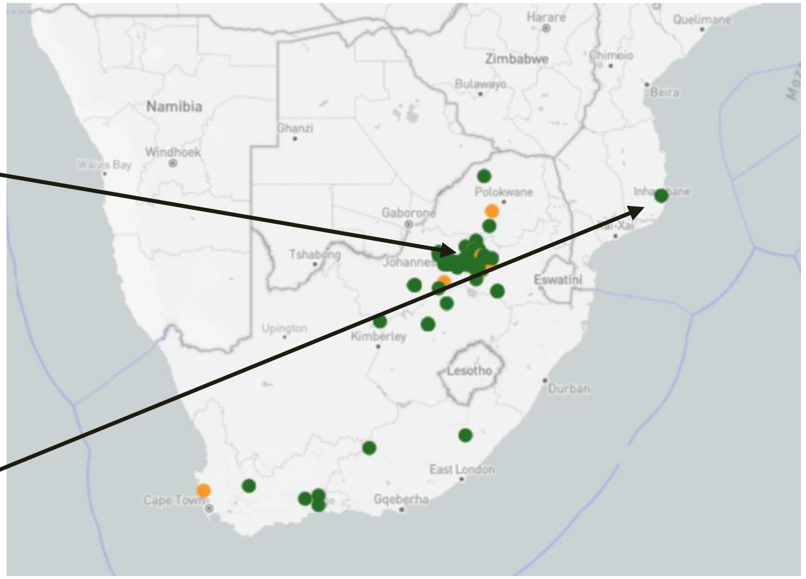
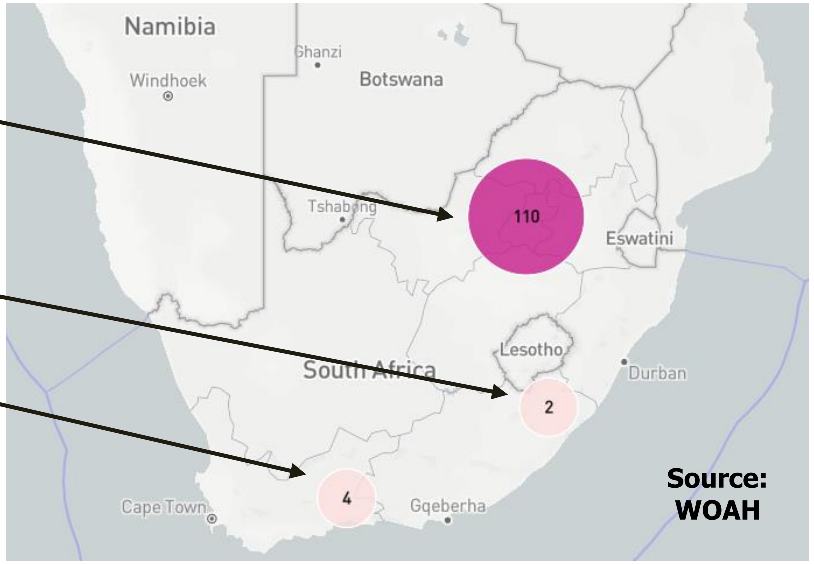


Source: WOAH

South Africa H7N6 HPAI

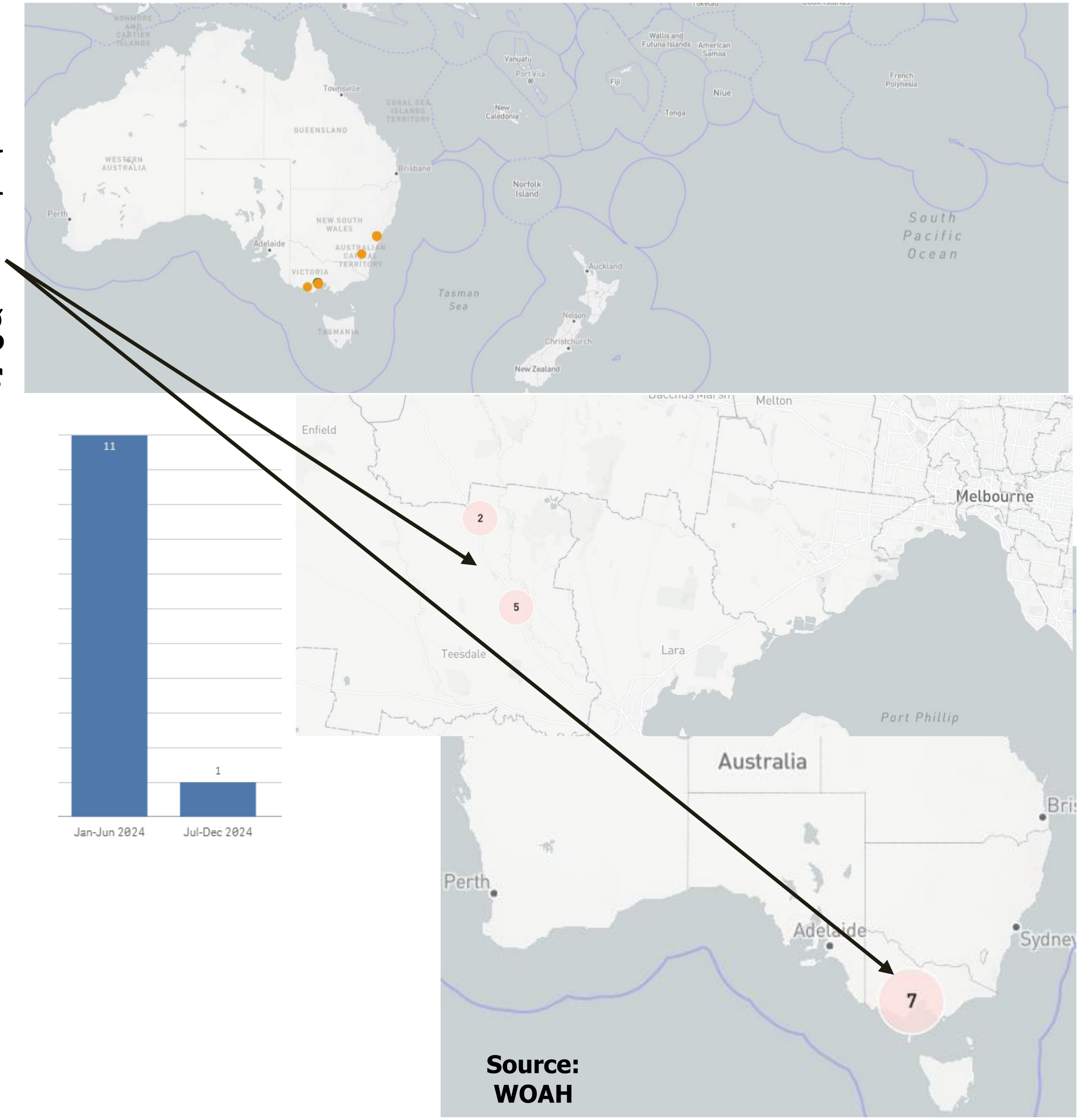
- 29 May 2023 – producer reported increased mortality in layer flock in Gauteng Province
- Sporadic cases in commercial farms in Mpumalanga and the adjacent Gauteng province in June and July 2023
- Outbreaks dramatically increased in August 2023
- Mostly affected layers and broiler breeders
- Spread to Mozambique: 23-30-week-old layer flock that imported spent layers from South Africa (16-Oct-2023)
- 110 premises clustered in and around Gauteng province and six isolated cases in southern and eastern provinces
- Deaths: 1,603,179
- Culled: 7,067,228
- Ongoing analysis with two reported cases September 2024 – Ostriches (serology), but no poultry cases since December 2023





Summary: Oceania (Australia, New Zealand and Pacific Islands:

- **No cases of H5N1 Gs/GD HPAI**
- **Australia: H7 LPAI→emergent HPAI**
  - **22 May 2024 – H7N3 HPAI in a mixed indoor caged and free-range chicken egg layer flock in Victoria, Australia, west of Melbourne**
  - **Stamped-out policy enforced**
  - **Premises: 7 – mostly chicken egg layers, indoor caged and free range; one small flock of layer pullets and a flock of duck egg and meat birds**
  - **Deaths: 3452**
  - **Culled: 1,158,056**



Australia H7N9 HPAI

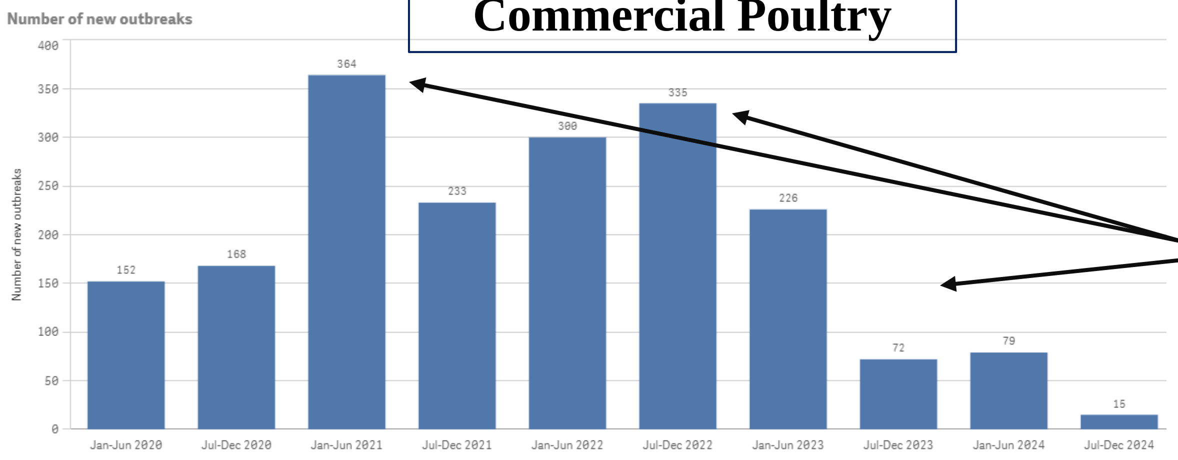
- **24 May 2024 – H7N9 HPAI in a mixed indoor caged and free-range egg layer chickens in Victoria, Australia**
- **Stamped-out policy enforced**
- **Premises: 1**
  - **Deaths: 300**
  - **Culled: 151,894**
- **Management link to a H7N3 affected farm**

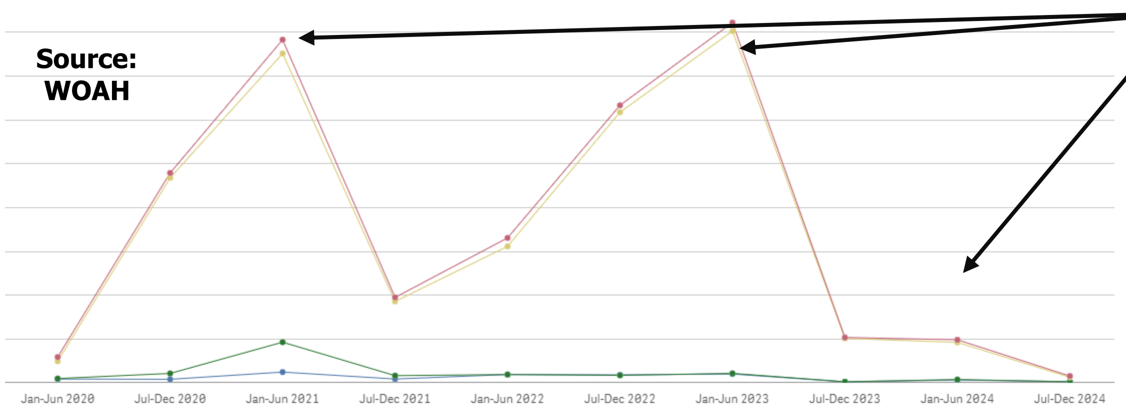
Australia H7N8 HPAI

- 19 June 2024 – H7N8 HPAI in a mixed indoor caged and free-range egg layer chickens in New South Wales, Australia
- Stamped-out policy enforced
- Premises: 4 (3 in NSW and 1 in Australian Capital Territory)
    - Deaths: 127,675
    - Culled: 364,336
- All three H7 HPAIV related to H7 LPAIV strains detected in wild birds of Australia
- Molecular studies are pending to understand if these 3 events were a single hemagglutinin LP→HP mutation followed by 3 neuraminidase gene reassortments, or 3 H7 LPAI neuraminidase reassortments followed by 3 distinct hemagglutinin LP → HP mutations
- Pending final surveillance to confirm eradication

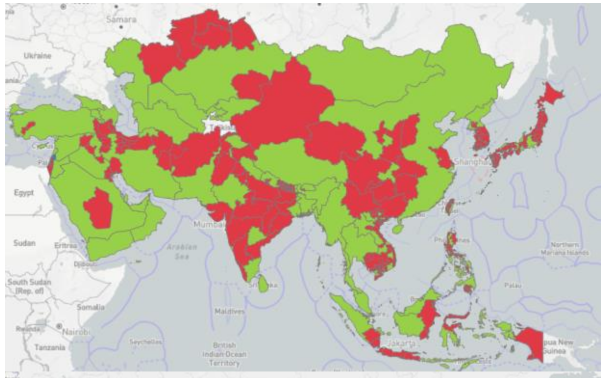
Summary: Asia HPAI (1-Jan-20 to 26-Oct-24)

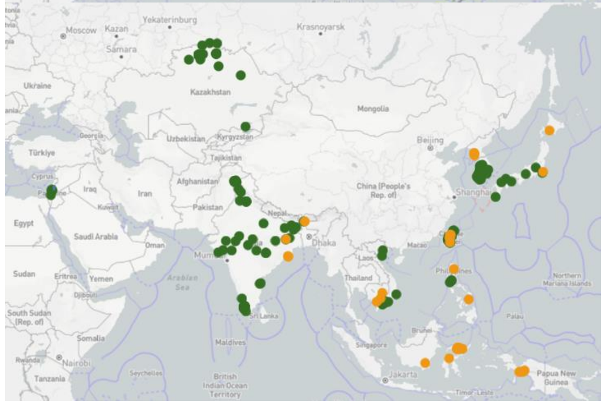
Commercial Poultry





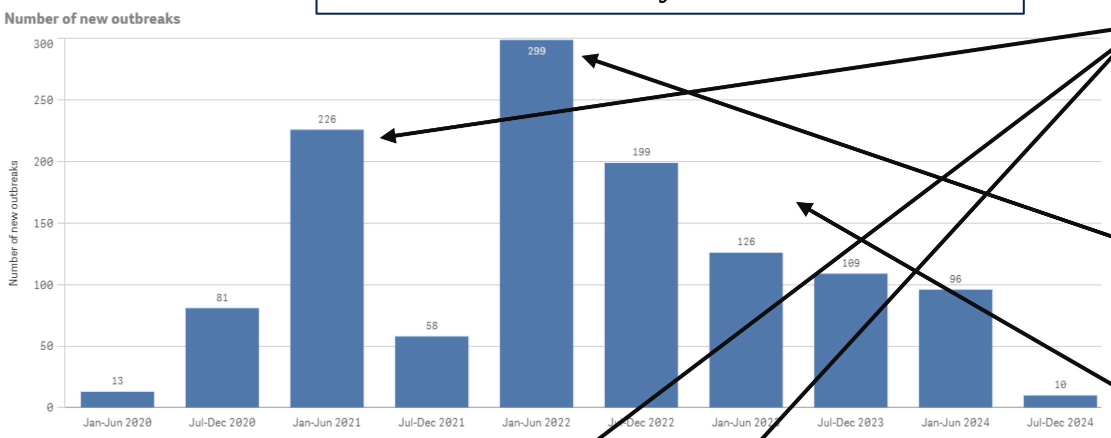
- Majority of poultry and wild/domestic bird reports from Japan & South Korea >> India & Kazakhstan > China & Indonesia
- First peak of outbreaks Jan-Jun 2021 and second peak of outbreaks Jul-Dec 2022 with decline to Oct 2024
- Corresponds to peak culling Jan-Jun 2021 and Jan-Jun 2023 with sharp decline



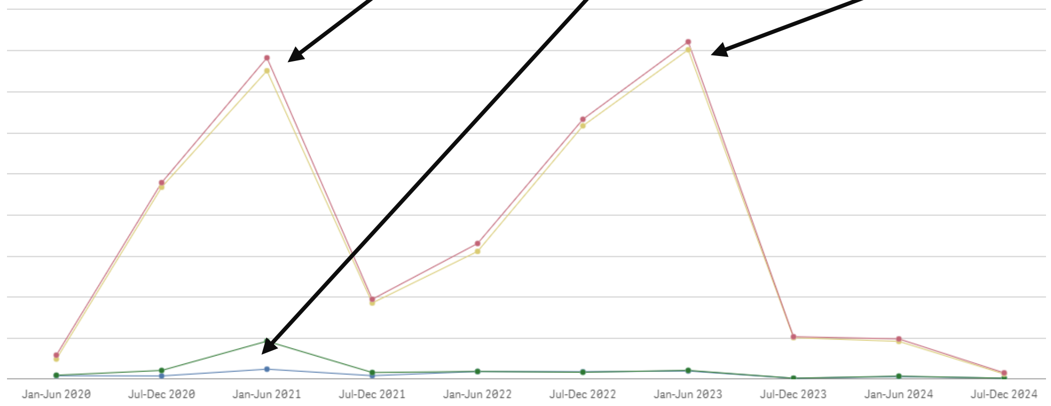


Summary: Asia HPAI (1-Jan-22 to 1-Oct-24)

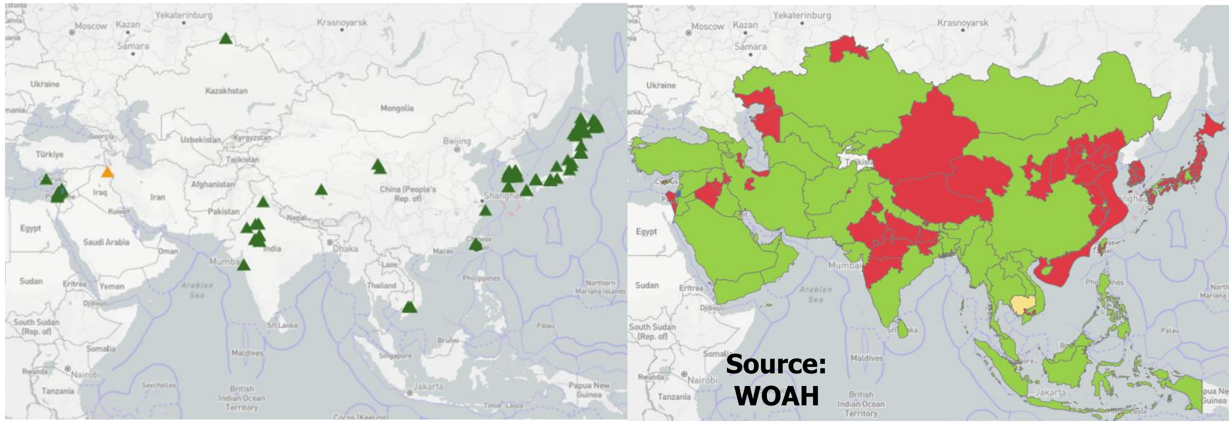
Wild Birds & Backyard Domestic Birds



- **Jan-Jun 2021, first peak wild/domestic bird cases and deaths in Asia, and peak in culling domestic birds**
- **Jan-Jun 2022, second peak wild/domestic bird cases**
- **Jul 2022 to Oct 2024 decline in outbreaks**
- **Jan-Jun 2023, peak in backyard poultry culling with declines to Oct 2024**

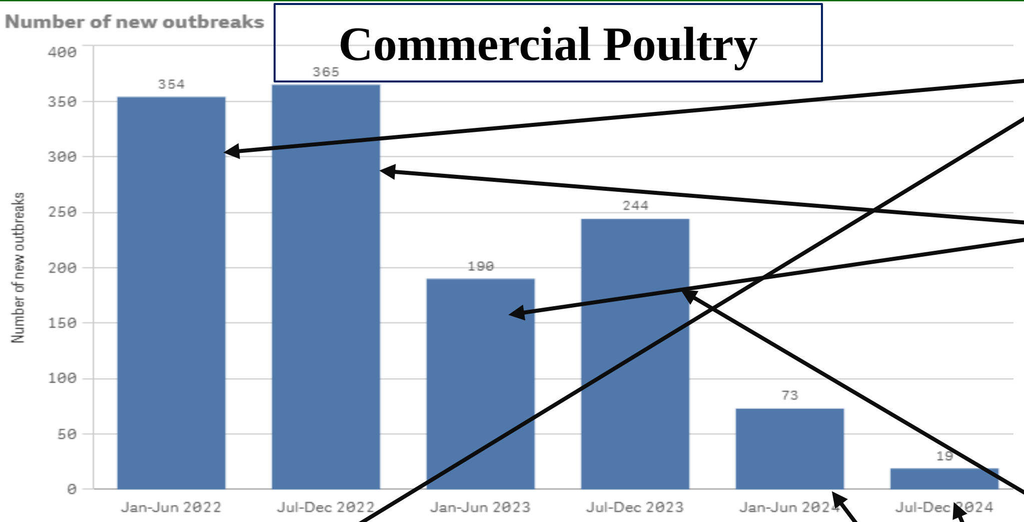


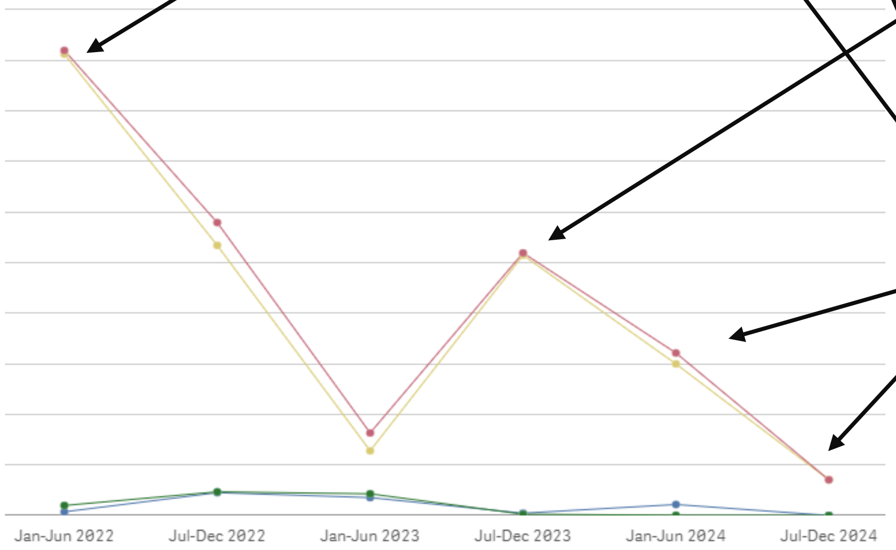
Source: WOAH



Source: WOAH

Summary: Americas HPAI (1-Jan-22 to 1-Oct-24)



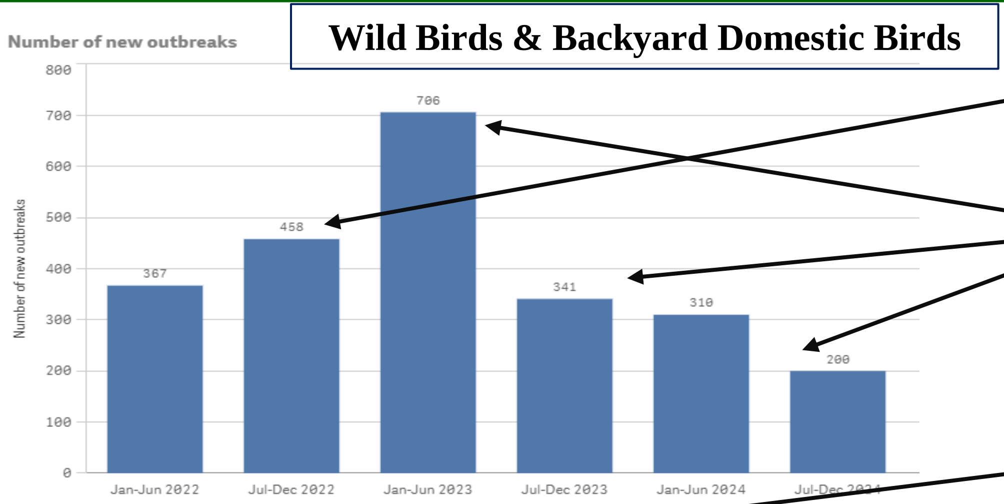


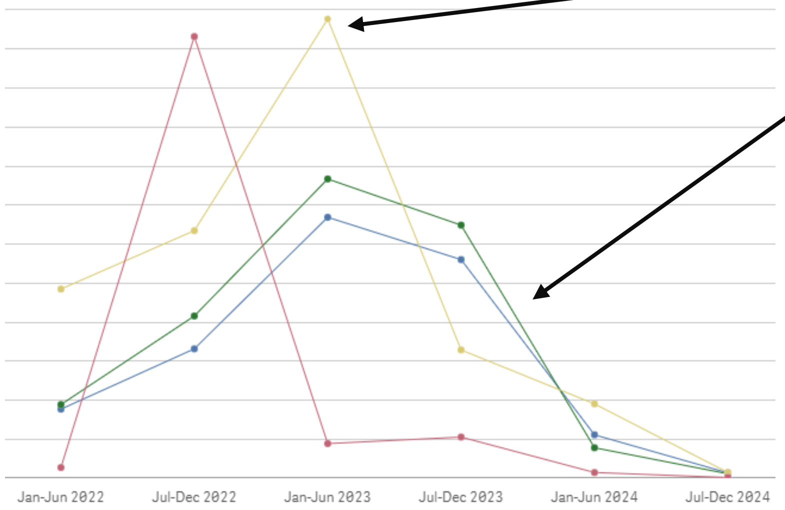
Source:
WOAH

- Jan-Jun 2022 first cases in USA with rapid spread and high cull rates
- Jul-Dec 2022 peak poultry outbreaks with decline Jan-Jul 2023 as started seasonal pattern of infections via primary introduction from wild birds
- Jul-Dec 2023, second peak outbreaks and culling associated with seasonal increase N. America
- Jan-Jun 2024, decline in outbreaks and culling with rapid declines to October 2024
- 2 months left for cases

Source:
WOAH

Summary: Americas HPAI (1-Jan-22 to 1-Oct-24)





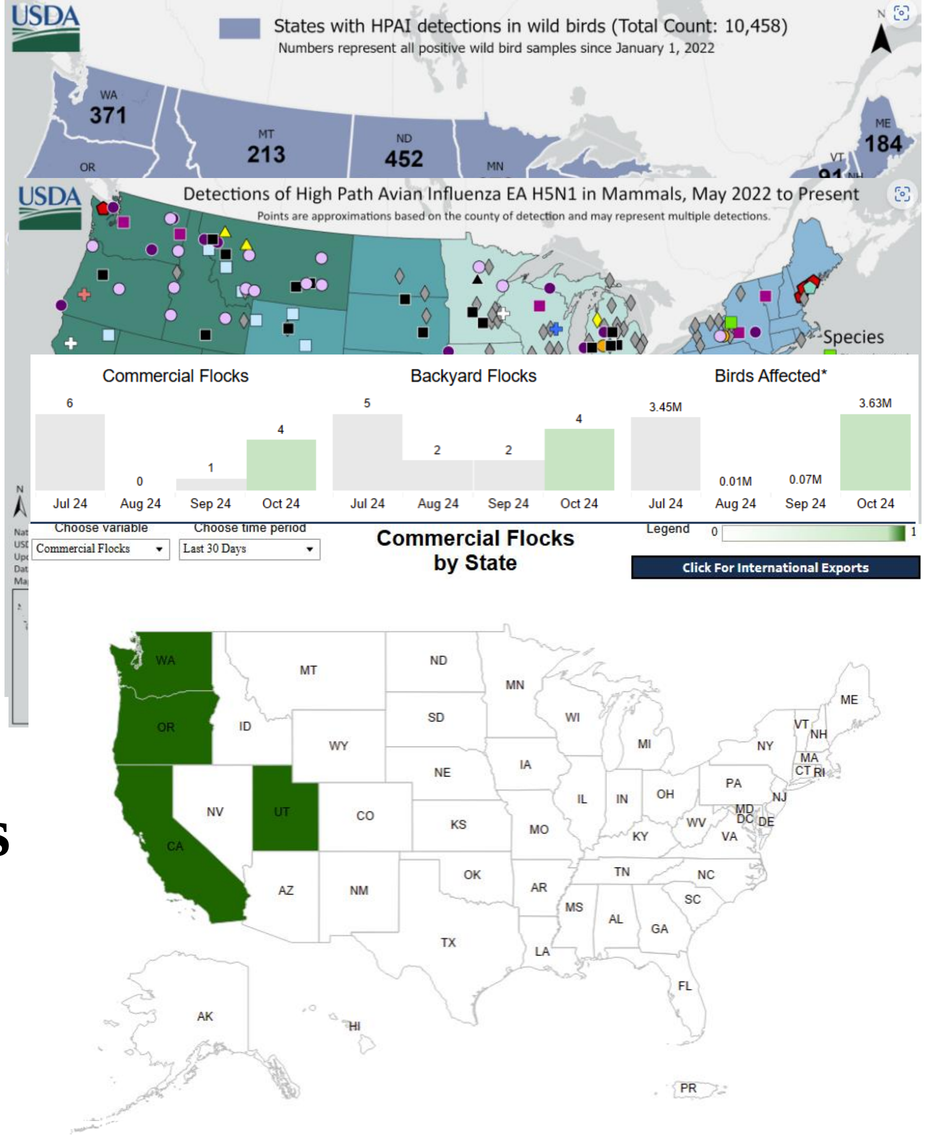
Source: WOAH

- **Jul-Dec 2022 peak wild bird N. American cases**
- **Jan-Jun 2023 peak wild bird and backyard poultry outbreaks driven by S. American and declines Jul 2022 to Sep 2024**
- **Jul-Dec 2022, peak in backyard poultry culling with declines to Oct 2024**

Source: WOAH

USA Situation:

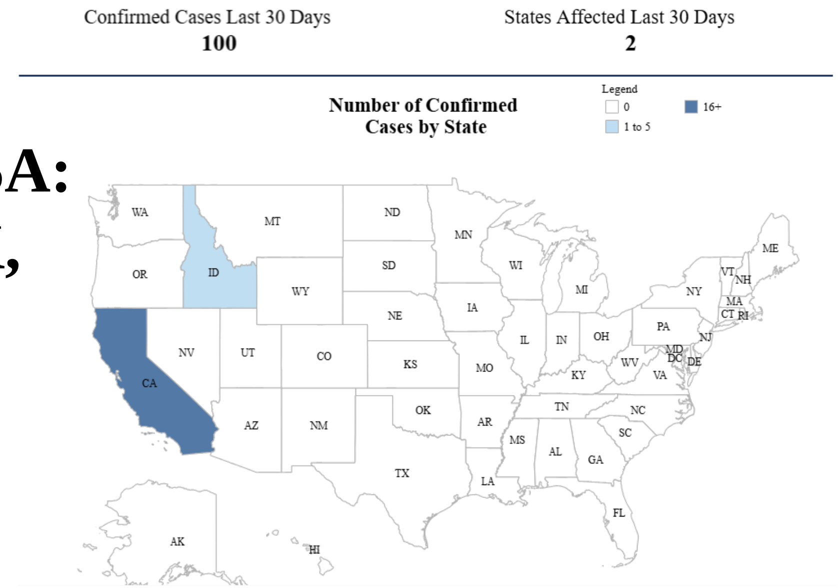
- 01-01-2022 to 10-28-2024: USA
  - Wild Birds: 10,458 (49 states). Waterfowl, shore/seabirds, predatory and scavenger birds and peridomestic birds – decline fall 2024
  - Wild/Feral Mammals: 404 (34 states). 25 species = red fox, striped skunk, raccoon, bobcat, mountain lion, polar bear, harbor seal, domestic cats….dolphin
  - Poultry: 1184 premises (513 commercial and 671 backyard) and >104.4 million birds affected in 48 states
- Decline this summer: most commercial poultry cases associated with Dairy Cattle B3.13 genotype HPAIV
- Past 30d - 3 egg layers (OR, UT & WA), 1 Broiler (CA), and 5 small flocks/LPM (WA, FL, ID)

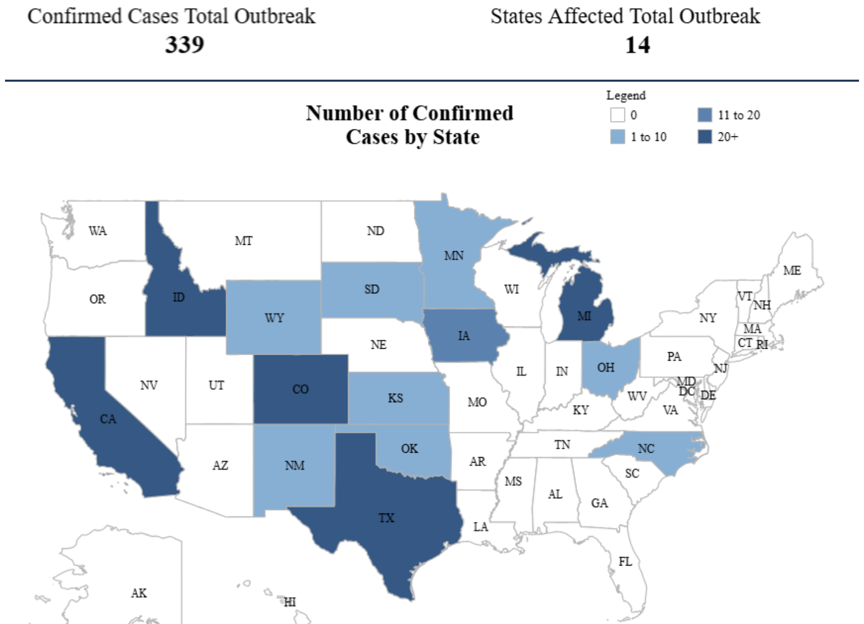


Source: USDA/APHIS: https://www.aphis.usda.gov/livestock-poultry-disease/avian/avian-influenza/hpai-detections

Dairy Cattle

- First diagnosis – 25 March 2024
- As of 27 October 2024 (7 months): 14 states, 339 herds
- Most concerning!
  - Last 30 days – 100 herds
  - Human cases (B3.13 genotype) – 34 confirmed cases
  - Underreported cases in dairy cattle and humans
- No virological or serological evidence of HPAI cattle infections outside USA: Canada, Mexico, UK, Germany, France, others?





https://www.aphis.usda.gov/livestock-poultry-disease/avian/avian-influenza/hpai-detections/livestock

Global Epidemiology: H5N1 2.3.4.4b clade HPAI

- Globally, season peak of cases separate in Northern and Southern hemispheres but changes yearly
- Most cases in North America and Europe in poultry and domestic birds are associated with bidirectional migratory periods of aquatic birds (e.g. waterfowl or seabirds)
- Source of virus
  - Primarily from wild bird reservoir (migratory or resident peridomestic) or their contaminated environment – minority from onward spread between premises
  - Exceptions (e.g. premise-to-premise):
    - LIC and MIC countries: Live Poultry Market systems
    - HIC: Highly susceptible species (domestic ducks and geese) and in areas of high poultry density
    - USA: Since April 2024, dairy cow B3.13 virus via indirect epidemiological links to poultry farms

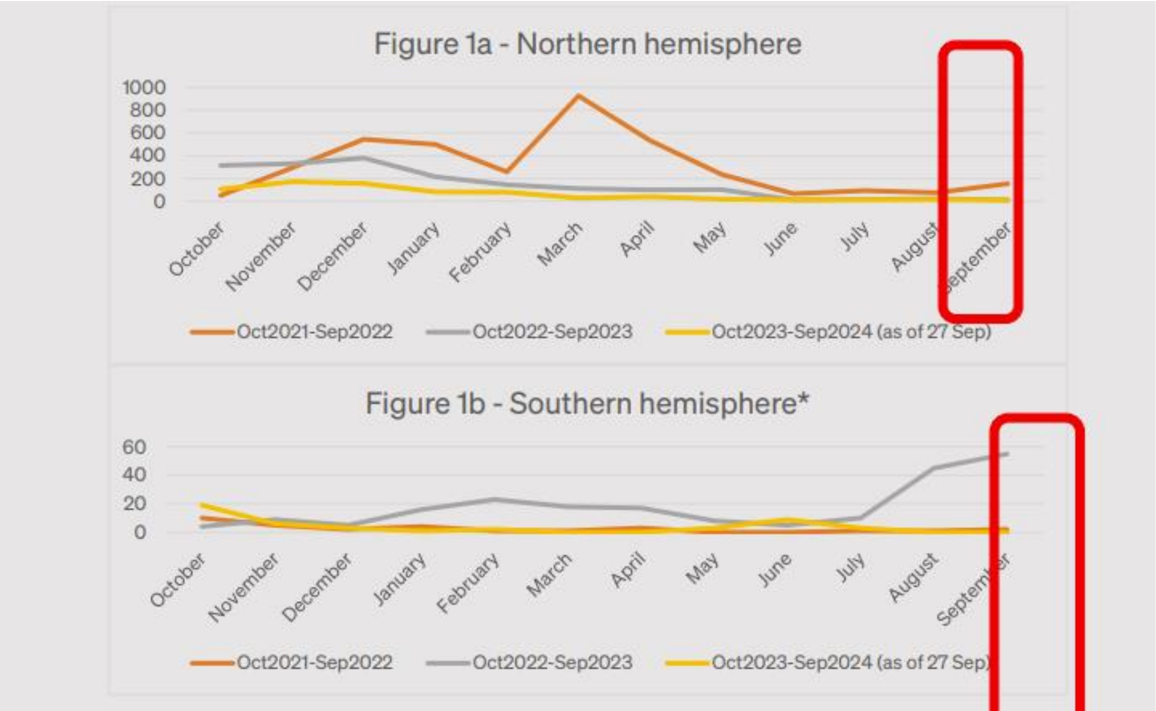


Figure 1. Number of HPAI outbreaks in poultry reported to WOAH the seasonal wave which is now coming to an end (October 2023 to September 2024), as well as the two previous waves for comparison. Data is presented by month and by hemisphere.

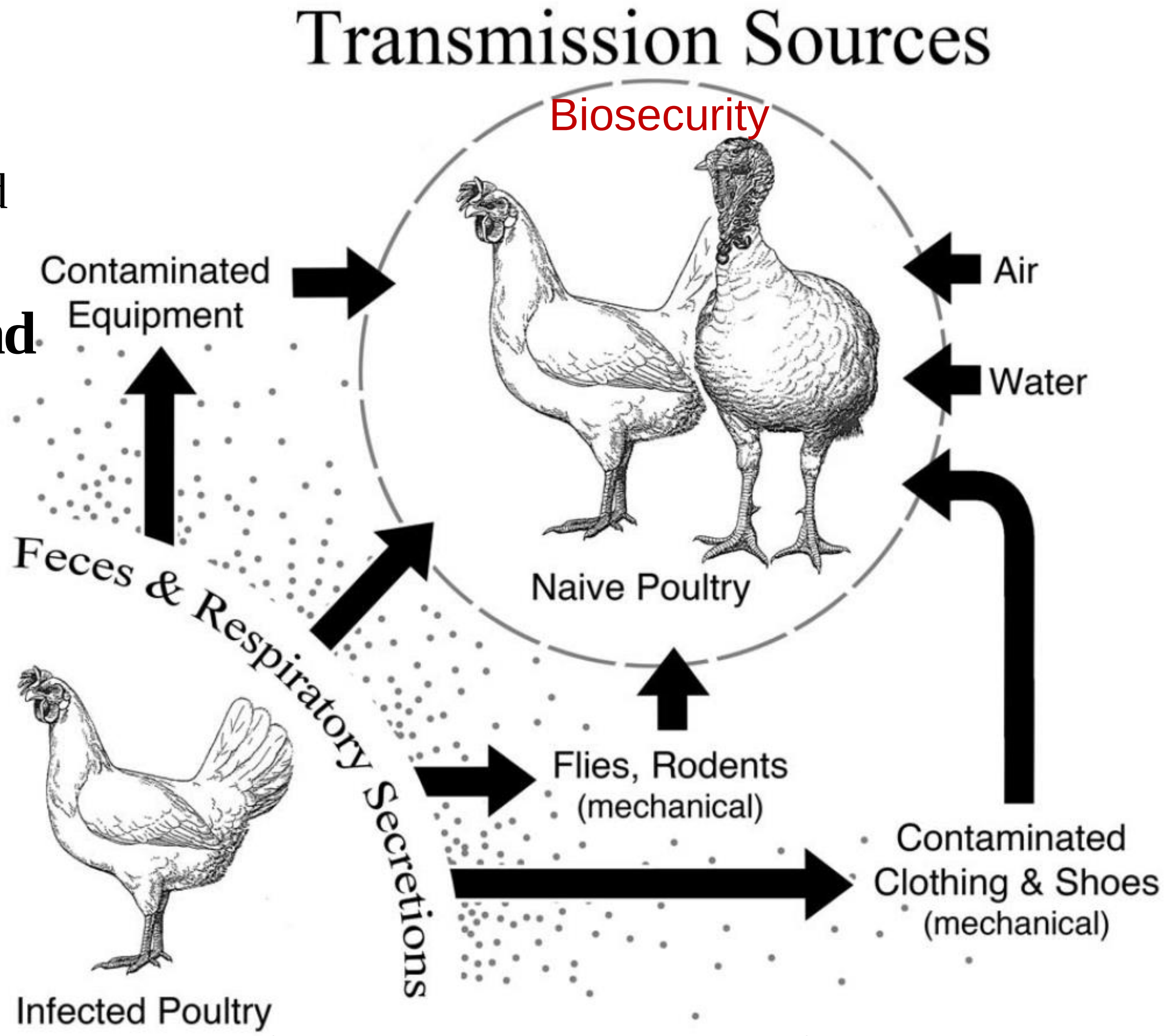
Source: WOAH

Global HPAI Prevention and Control Strategies for Poultry

1. **Biosecurity: to keep the HPAI virus out of naïve flocks and contain the HPAI virus in affected flocks**
2. **Surveillance: to determine HPAI virus status of the flock → data collectively used to declare HPAI-free country, zone and/or compartment (USA-NPIP program)**
3. **Stamping-out: to prevent lateral spread (diagnose, quarantine with movement controls, depopulate & dispose, clean & disinfect, repopulate). #1, 2 & 3 are sufficient for detection and eradication of emergent HPAIV lineages**
4. **Vaccination – some countries use in addition to 1, 2 and/or 3 to increase resistance of *at-risk* poultry to HPAI virus infection, especially for H5Nx Gs/GD and other 2 entrenched lineages**

1. Biosecurity for Poultry: Frontline Defense

- **In simple terms, biosecurity is informed common sense:**
  - Keep “invisible” pathogens away from poultry and
  - Poultry away from pathogens
- **Components: total of all structural barriers and procedures that keep pathogens out of naive flocks or from leaving infected flocks**
- **But why in modern poultry production do we still have outbreaks? Biosecurity reduces but does not eliminate risks**
- **Practice of Biosecurity takes dedication, consistency and all-in-approach**
- **Need a comprehensive farm plan that is audited to find and correct the “weak” links**



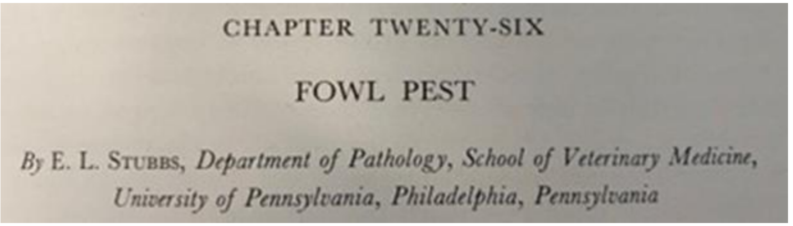
Example: Avian influenza virus (Swayne, D.E., Avian Influenza, Blackwell, 2008)

2. Surveillance

- **WOAH Guidelines:**
  - **Terrestrial Animal Health Code – chapter 10.4.**
  - **Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2022 - Chapter 3.3.4.**
- **Outcome- and risk-based provisions to control & prevent the spread of HPAI through international trade while avoiding unjustified restrictions**
- ***Article 10.4.3. A country or zone may be considered free from HPAI when:***
  - ***infection with HPAIV is a notifiable disease in the entire country***
  - ***an ongoing awareness programme is in place to encourage reporting of suspicions of HPAI***
  - ***absence of infection with HPAIV, based on surveillance, in the country or zone for the past 12 months;***
  - ***an awareness programme is in place related to AIV risks and the specific biosecurity and management measures to address them;***

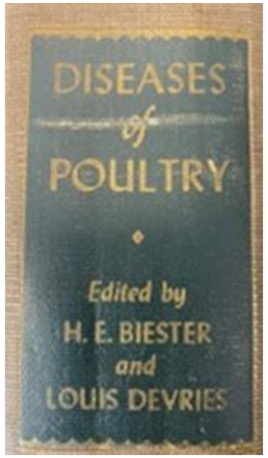
3. Stamping-out:

REACTIVE:


CHAPTER TWENTY-SIX

FOWL PEST

By E. L. STUBBS, *Department of Pathology, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania*



- E.L. Stubbs (1926):
  - "Capable of causing such destruction of the poultry population as to be of economic importance in diminishing the food supply"
  - "Dangerous character of the disease warranted the radical methods for complete eradication within a few months"
- Control since 1920's: Stamping-out programs (diagnose, quarantine with movement controls, depopulate & dispose (preferred on site), clean & disinfect, repopulate)
- What was depopulated: infected flocks, dangerous contacts, contiguous properties or geographic control zones (1-3 km)
- Followed the methods used globally for livestock diseases, e.g. Rinderpest in cattle, since 1711

World Organisation for Animal Health
Founded as OIE

4. HPAI Vaccination

OIE

WOAH Guidelines:

- The Code and Manual support vaccination as a control tool
- Supports trade in vaccinated poultry in the presence of appropriate surveillance to demonstrate freedom of HPAIV infection
- WOAH Policy Brief on HPAI Vaccination (29 Dec 2023):

…. stricter biosecurity measures and mass culling of poultry may no longer be sufficient to control the disease

- ….poultry vaccination can no longer be excluded from the available alternatives and should be considered a complementary tool

- What are the principal barriers:
  - Potential non-tariff trade barriers by importing countries
  - Defining "appropriate" surveillance needed to demonstrate freedom from infection

4. Advantages of HPAI Vaccination

Increase resistance to AIV infection (10^{3-4} higher exposure dose to infect)

Reduce AIV replication in respiratory & GI tract which reduces shedding (10^{2-5})

Prevent disease and death in poultry

↓

Reduced environmental contamination

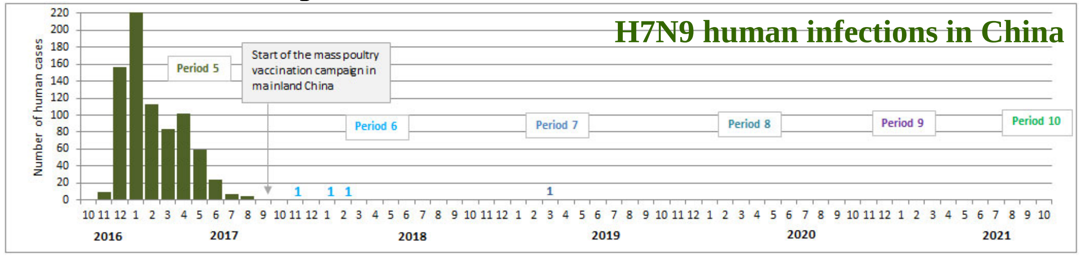
Reduced transmission to birds within premise

Reduce spread between barns and premises

Maintained livelihood of growers and food security of consumers

Improves animal welfare

Prevent human infections



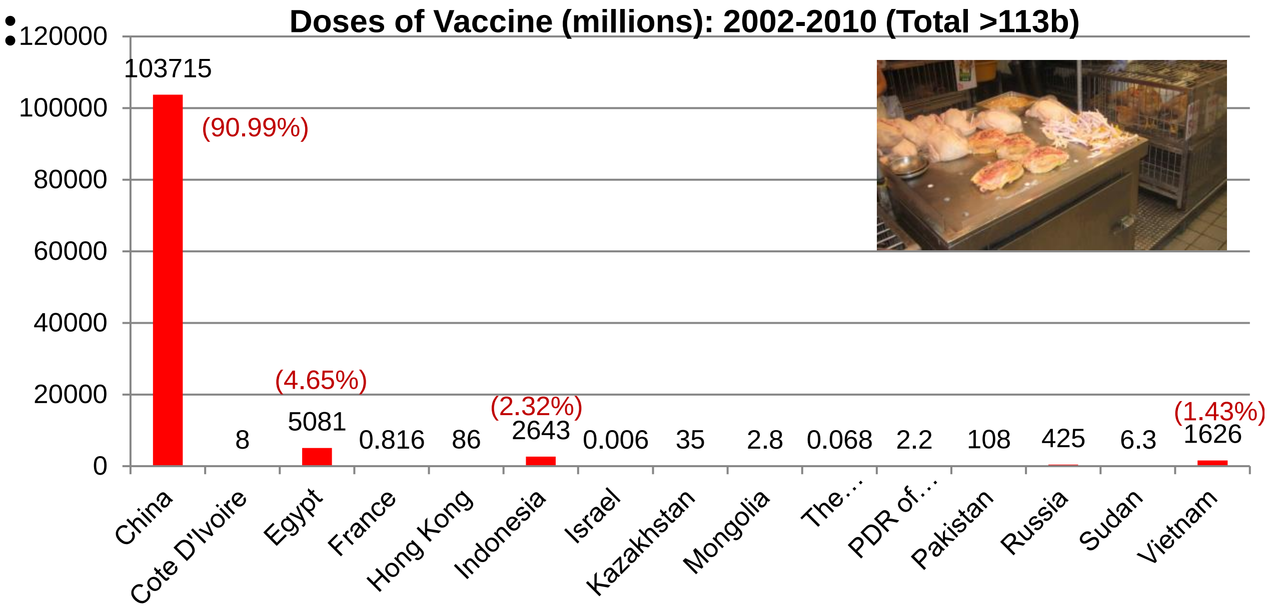
Vaccination adds an additional layer of protection on top of biosecurity measures and stamping-out but does not replace them

Vaccination should be risk based to the most susceptible species and geographic areas

Practice Avian Influenza Vaccine Stewardship

4. Global HPAI Vaccination Programs:
National-focused, Blanket Systematic Vaccination

- **After HPAI become entrenched in poultry → vaccination used for food security and prevent human infection (H5 Gs/GD)**
  - **H5Nx Gs/GD Eurasian lineage (2002-): China (~300B doses), Indonesia, Vietnam, Egypt, Bangladesh**
  - **H7N3 N. American lineage (2012-): Mexico, Guatemala**
  - **H7N9 Eurasian lineage (2017-): China**
  - **Surveillance is not adequate for trade purposes in countries having endemic HPAI in poultry with or without vaccination**



Swayne et al., OIE Sci Tech Rev 30(3):839-870, 2011

  - **Additional countries that notified WOAH (2005-2022)of more limited vaccine use for AI prevention/control - Armenia, Belarus, El Salvador, Jordan, North Korea, Kuwait, Laos, Niger, and Turkmenistan**

4. Global HPAI Vaccination Programs: Emergency Vaccination

- **Prevention in the Americas for H5N1 Gs/GD HPAI in 2023 & 2024: six Latin American countries**
  - **Mexico (197.5M and 66.5M) and Guatemala: added emergency H5 Eurasian vaccines plus ongoing vaccination with H5N2 LPAI and H7N3 HPAI N. American strains**
  - **Ecuador (14 million doses) and Bolivia (10 million doses): vaccination of long-lived poultry**
  - **Peru: vaccinated egg layers and pullets (28M), light breeders (1.5M), heavy breeders (7.2M) and turkey breeders and meat turkeys**
  - **Uruguay – 14.6 million doses in chickens**
- **Individual country assessments are underway to determine if they will stop or continue emergency vaccination**
- **France: vaccinated 60.5M ducks (141M doses) in 2023/24, continuing a second year**

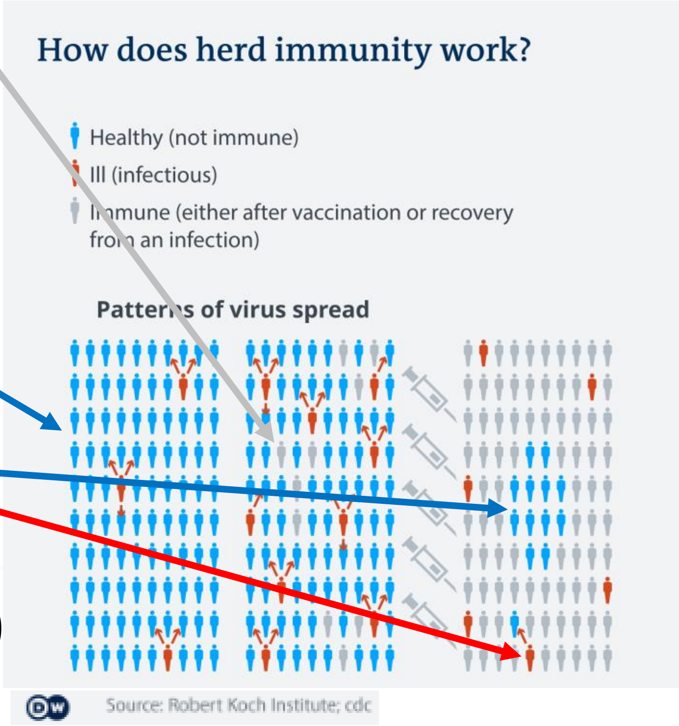
Source: WOAH

Proposed HPAI Prevention and Control Strategies for Dairy Cattle

1. **Biosecurity – keep the HPAI virus out of naïve herds and keep the virus in affected herds**
2. **Surveillance – determine where the virus is located so appropriate action can be taken**
3. **Movement controls - to prevent lateral spread of the HPAI virus between herds**
4. **Vaccination – increase resistance of cattle to HPAI infection and assure uniform immunity within the herd**

4. Why vaccination of dairy cattle will be needed

- **Basic pathogen spread in a population**
  - **Acute phase of infection – highly susceptible population – initially the spread is rapid**
  - **Infection and shedding period 7-21 days for individual animals without high mortality → individuals recover with antibodies in serum and milk. In dairy cattle, the H5N1 B3.13 HPAIV has a LP phenotype.**
  - **As infection process proceeds - # of susceptible animals decline but in large population, you will not reach 100% infection → 100% immunity as spread slows. Complicated by introduction of naïve animals of ~1/3 a year; i.e will not reach herd immunity without vaccination**
- **H7N2 LPAI in large chicken layer operations in PA (1997-1998)**
  - **One closed flock (500,000 birds) under movement restrictions and no vaccination → 6 months later reisolated virus from the daily mortality of the flock**



https://www.dw.com/image/54430714_7.png

Global Solutions for HPAI Vaccination of Poultry: Conclusions & Recommendations

IABS
International Alliance for Biological Standardization

World Organisation for Animal Health
Founded as OIE

Vaccination and Surveillance for
High Pathogenicity Avian Influenza in poultry:
Current Situation and Perspectives

October 22-23, 2024
WOAH, Paris
Hybrid meeting

- **Flip the narrative – Vaccination should help trade by decreasing the risk of HPAI in poultry and poultry products**
- **Trade policy should be based on science and not politics**
- **Appropriate surveillance of vaccinated poultry should be risk-based, multi-layered and primarily virological in nature; i.e. find active infections**
  - **Bucket surveillance: dead birds, but if not available use clinically ill with specific signs > clinically ill with non-specific signs**
  - **Supplemented by specific environmental samples with validation**
  - **Lack of general utility of sampling healthy chickens but some potential use for ducks**
  - **Limited use of serosurveillance (“DIVA”) to find infected flocks, e.g. vaccine reassessment**
  - **Surveillance must be cost-effective and efficient**
- **Vaccines, especially inactivated, should match the field viruses to assure protection and be updated based on genomic and antigenic analysis of field viruses**
- **Compartmentalization:**
  - **WOAH Code: define HPAI-free compartments for export of genetic resources**
  - **Explore potential to create vaccination “compartments” separate from non-vaccinated zone or compartment**

Global Conclusions:

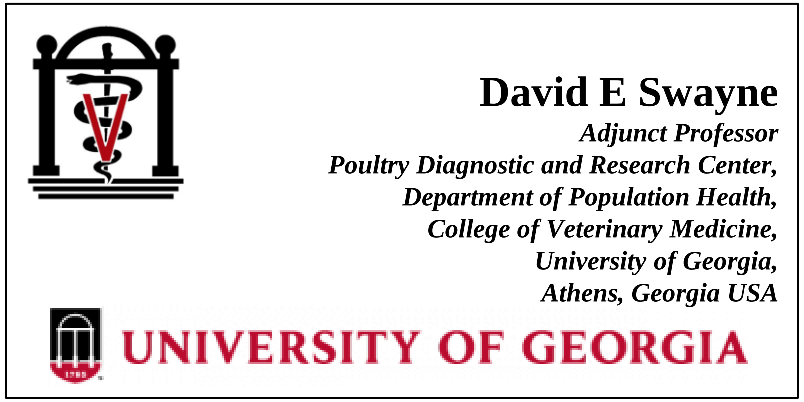
- **The changed epidemiology of H5Nx Gs/GD HPAI has created a global panzootic with devastating infections not only of poultry, but diverse wild birds and mammals, domestic birds and mammals, and humans on six continents**
- **In 2024, the world has experienced declining number of poultry, domestic bird and wild bird outbreaks, deaths and culling**
- **Primary source to commercial poultry has been introductions from the environmental reservoir (migratory and resident wild birds) with seasonal peaks following the migratory waterfowl and shorebird season, but with changing seasonal peak periods**
- **Expansion of H5N1 HPAI into livestock in USA, with dairy cattle becoming a new source of the virus for onward spread to poultry, other domestic mammals, wild birds and mammals, and humans; i.e. new reservoir, but there have been no cattle cases in other countries**
- **Biosecurity, surveillance and stamping-out have been inadequate against H5Nx Gs/GD HPAI, but vaccination can be a complementary tool to prevent and control HPAI**
- **WOAH supports poultry vaccination as a tool if used with appropriate surveillance**

Global Conclusions:

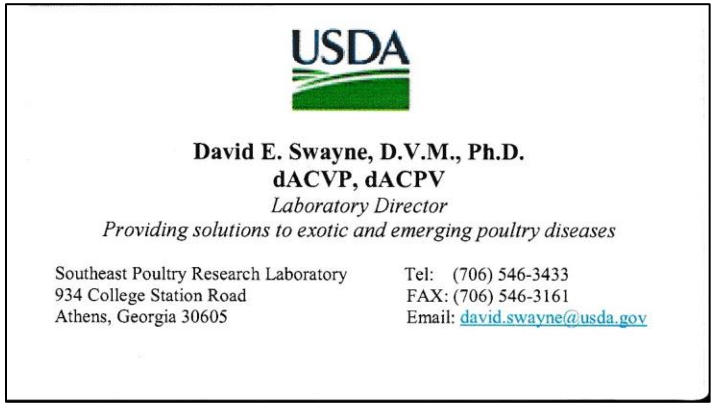
- **Primary reasons for not vaccinating - non-tariff trade barriers and lack of agreement on appropriate surveillance**
- **From the IABS Workshop, surveillance in vaccinated poultry flocks should be reasonable, affordable and sustainable**
  - **Risked-based virological surveillance is superior in assuring vaccination success in preventing infections, primarily through samples of daily mortality or clinically ill birds (targeted samples), supplemented by environmental samples**
  - **Samples of random health birds are ineffective and serosurveillance has limited use**
  - **Virological surveillance provides viruses to examine for antigenic changes and their use for reassessing the vaccines for protection and any needed updates to inactivated vaccine seed strains**
- **Vaccination can be a critical part of a HPAI prevention and control program in dairy cattle, alongside biosecurity enhancements, surveillance and movement controls. Needs:**
  - **Vaccine efficacy challenge model and effectiveness studies for dairy cattle**
  - **Licensed vaccines**
  - **Virological surveillance and movement controls**
  - **Sero-monitoring programs (monitoring for protection and assessing herd immunity)**

Thank you for your attention!

2023 - present

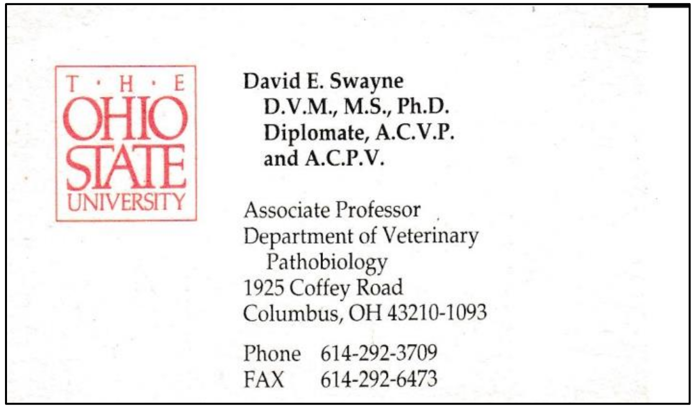


2023 - present



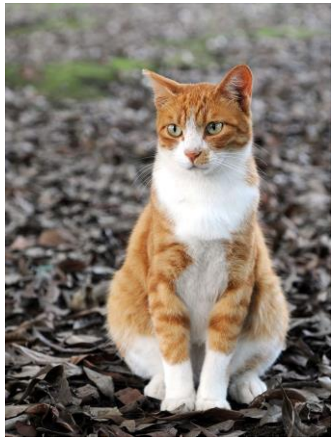
1994 - 2022

2010 – 2011 (Sabbatical)



1987 - 1994

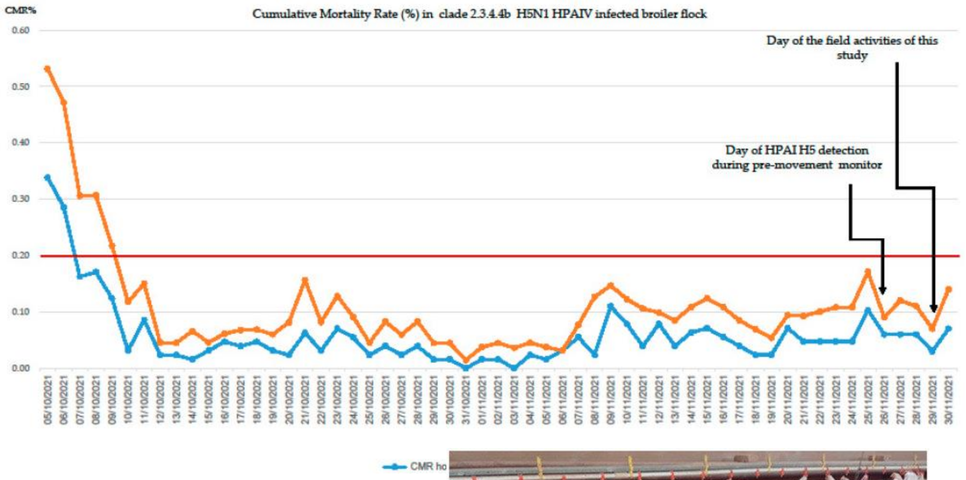
HPAI Trends (Summer 2023)

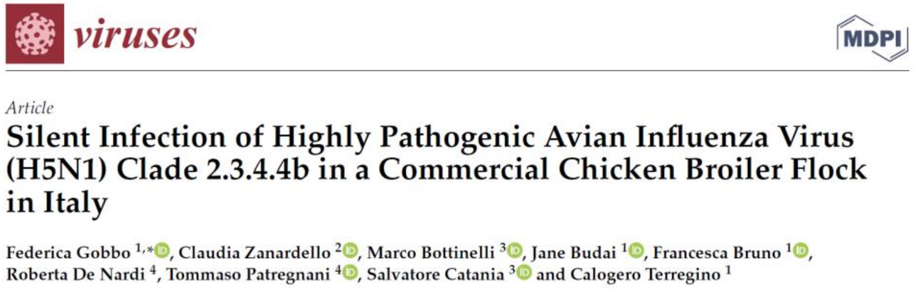


- **Pet Mammals (Domestic cats and dogs):**
  - **Most individual cases from predation on infected wild birds**
  - **Poland (H5N1 - 24 dead domestic cats [across 9 voivodeships/provinces] with molecular analyses suggest infection from similar or common sources. Possible scenario of feeding virus-contaminated raw poultry meat (*https://www.ecdc.europa.eu/sites/default/files/documents/AI-Report%20XXV_final.pdf*)**
  - **South Korea (H5N1 in 2 of 38 feral domestic cats that died in a shelter) – linked to feeding commercial freeze-dried uncooked duck meat product**

H5 Gs/GD Eurasian-lineage HPAIV: Europe

- **Broiler cases in northern Italy (Veneto) – H5N1 2344b HPAI - October 2021 – initial infections in turkeys – spread to other poultry types**
  - **Delayed depopulation of turkeys overwhelming # affected farms**
  - **“Silent infections” in pre-slaughter movement broilers**
    - **Absence of signif. mortality, abnormal production (feed and water consumption), or signif. clin. signs**
    - **Sampling clinically ill and normal mortality – 15/961 flocks HPAI positive – 7+ only on deads**
    - **Closer examination – mild resp signs and drooping wings with curled feathers**
    - **8 days after HPAIV detection – before mortality exceeded 0.2% per day**
    - **ELISA serology negative**
- **Conclusion: Broilers are the most resistant of poultry species – slow spreading**




viruses MDPI

Article

Silent Infection of Highly Pathogenic Avian Influenza Virus (H5N1) Clade 2.3.4.4b in a Commercial Chicken Broiler Flock in Italy

Federica Gobbo [1,*], Claudia Zanardello [2], Marco Bottinelli [3], Jane Budai [1], Francesca Bruno [1], Roberta De Nardi [4], Tommaso Patregnani [4], Salvatore Catania [3] and Calogero Terregino [1]

Viruses **2022**, *14*(8), 1600; https://doi.org/10.3390/v14081600 (registering DOI)

“AI Vaccine Stewardship”

Concepts of Les Sims

@FAO/Mohamed Moussa

Best practices, transparency, rigor, responsibly…

Some similarities to “Antimicrobial Stewardship”

(FAO Virtual Learning Course – launched June 2024)

1. **Vaccines should not be used as a replacement/substitute for other methods of disease prevention but to add an additional layer of protection ***
2. **The decision to use vaccine is just the beginning of the process, not the end**
3. **Need to choose appropriate vaccines that provide protection against circulating strains**
4. **Use vaccines in accordance with manufacturer’s recommendation (dose and timing)**
5. **Monitor selected vaccinated flocks to ensure vaccine is producing the desired immune response, to plan timing of boosters (if required) and (if used) to monitor (*surveillance*) for infection ****

*one exception is free-ranging ducks for which few biosecurity measures are feasible at the production level

**may be all flocks if elimination/demonstration of freedom in vaccinated flocks is the target

“AI Vaccine Stewardship”

Concepts of Les Sims

@FAO/Mohamed Moussa

6. Need surveillance for viruses to regularly assess antigenic changes and update vaccines when required
7. Be aware of import (*introduction*) of novel antigenic variants (live bird trade or wild birds)
8. Replace (deregister) vaccines that no longer afford protection from disease and virus shedding
9. Ensure vaccination is done in a manner that does not transmit the virus
10. Regularly re-assess the need for and nature of vaccine programmes and modify programmes accordingly (see AI vaccination cycle)
11. Special attention should be paid to farms or markets where infection occurs or persists, despite appropriate usage of vaccines
12. Examine ways to modify production and selling practices that facilitate transmission and replication of the virus

4. Surveillance of Vaccinated Poultry to Find Infections

DIVA (Detecting Infected among Vaccinated Animals)

Virological Surveillance ('Biosensor')

- Identifies active infection for risk determination for the flock and their products
- Uses identifiable, susceptible population looking for the virus
    - Historically, non-vaccinated sentinel birds that die (logistically very difficult)
    - <u>Daily mortality or sick birds in vaccinated population ("bucket surveillance")</u>
    - Environmental samples – waterers, boot swabs, egg belts, etc. (need validation studies)
- Detection virus by qRT-PCR pooled swabs (USA:pools of up to 11 swabs)

Serosurveillance (Historic 'DIVA')

- Detects antibodies and not the virus – the risk is the active viral infection!!
- Concept applied in 2000-2005 in Italy and predates widespread deployment of highly specific and sensitive qRT-PCR methods to detect virus
- Primary use should be to determine risk under specific circumstances
    - E.g. determine risk before major changes or ending a vaccination program?
    - Can be overused and overinterpreted to support inappropriate non-tariff trade barriers