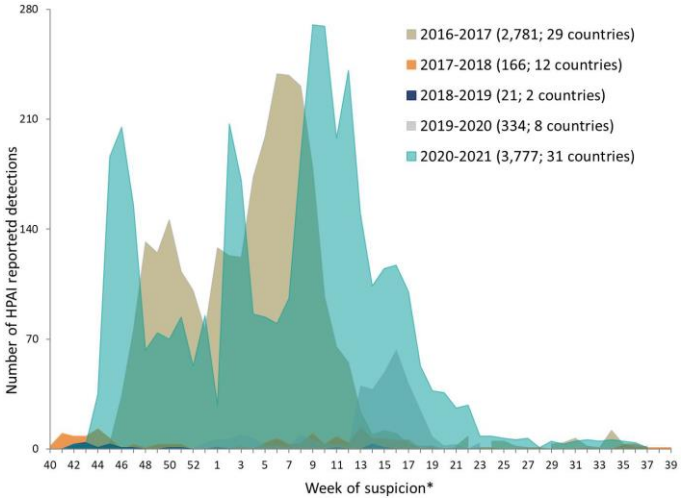
Animal influenza



Timm Harder

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Discontool, 20.10.2021

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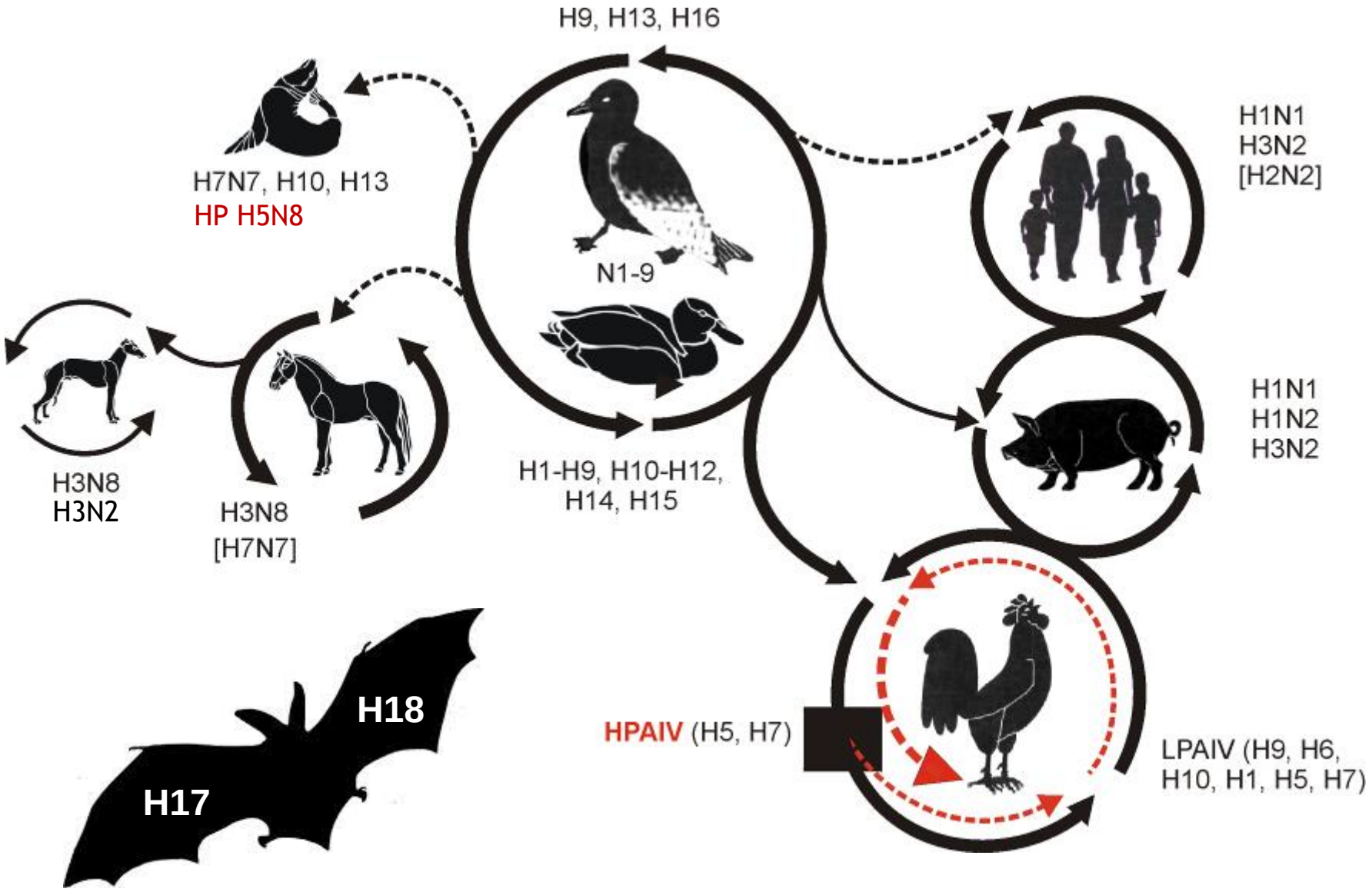
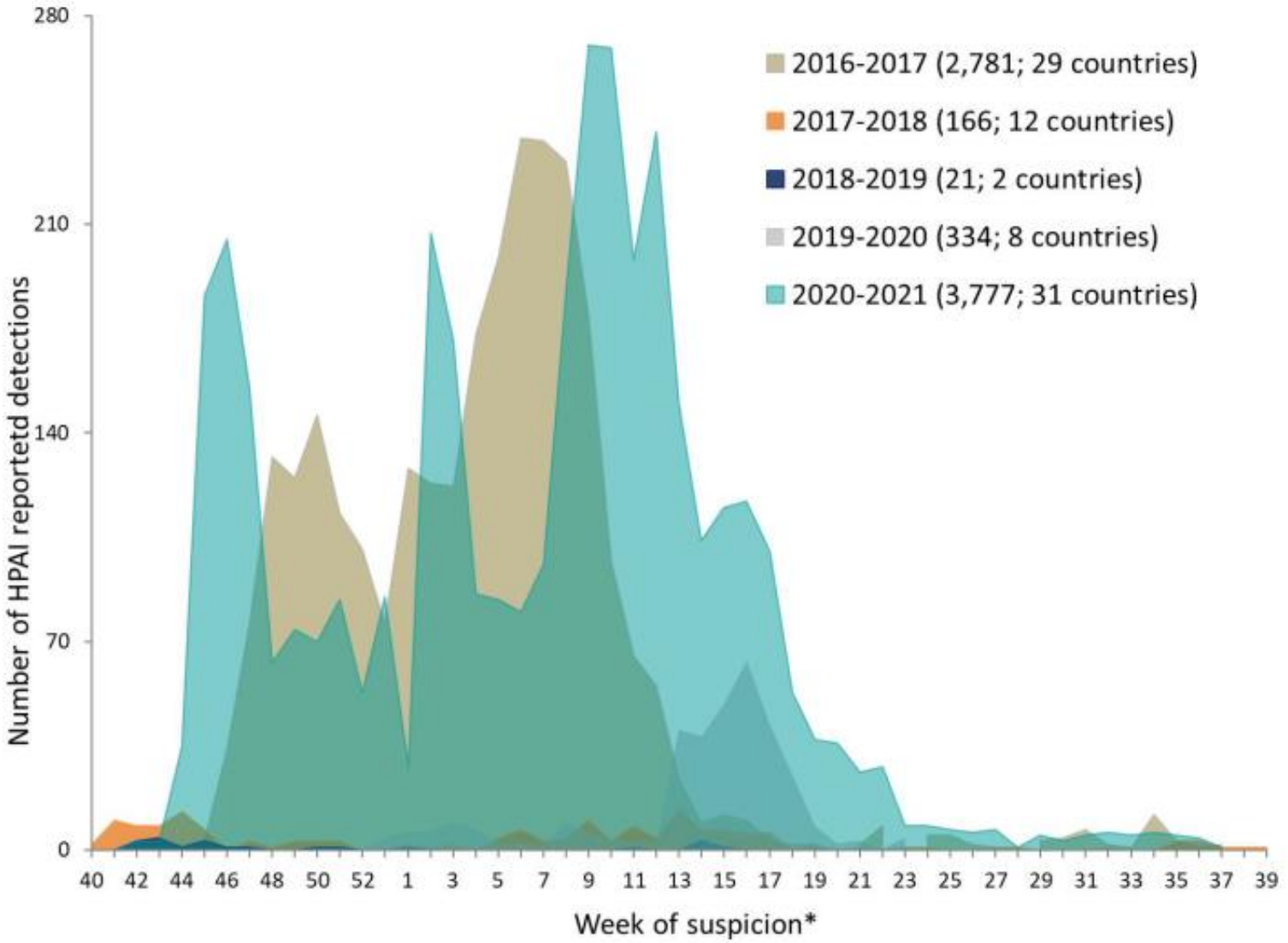
The influenza A virus universe



- Complex interactions
- Host-specific, but adaptable
- Avirulent in natural reservoirs, but able to unfold high pathogenicity

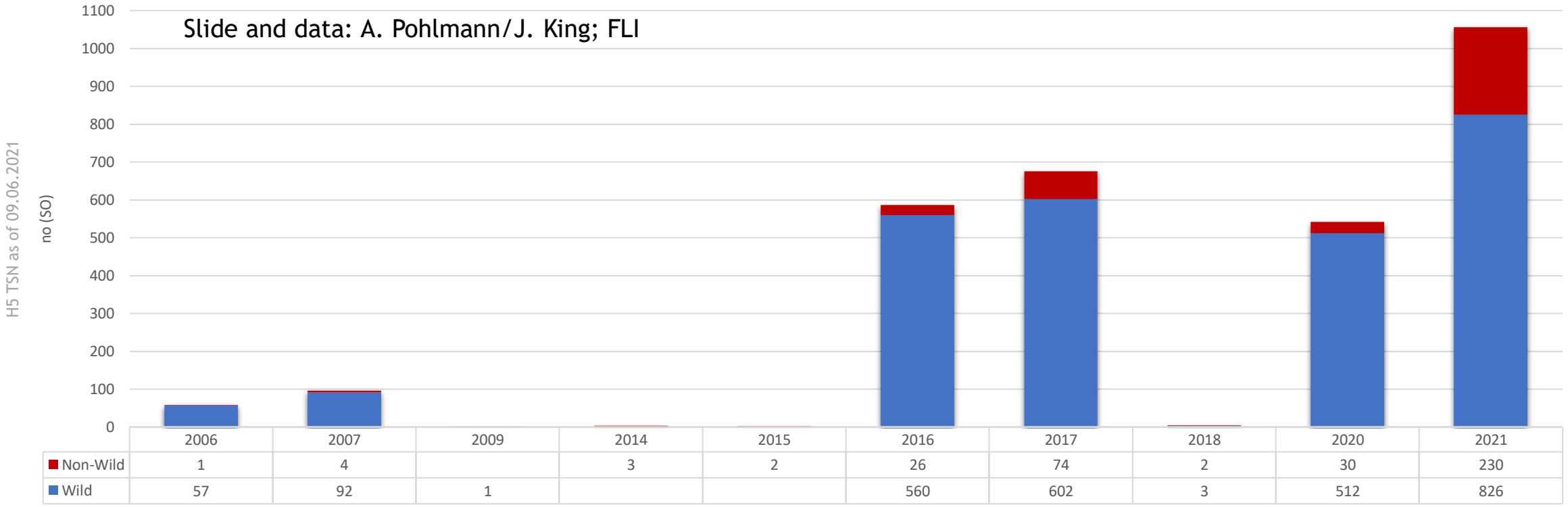
HPAIV – A European winter‘s tale



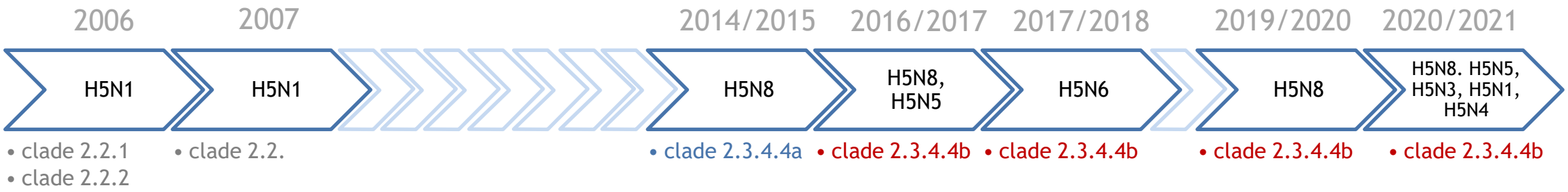
- Since 2006, recurrent seasonal incursions of HPAIV H5 of Asian origin into Europe
- Strains derived from 1996 goose/Guangdong (gs/GD) virus (HP H5N1)
- Increasing economic losses (FR, NL, PL, DE, CZ, HU,…) due to high mortality and associated restrictions (depopulation, trade)

EFSA (European Food Safety Authority), ECDC (European Centre for Disease Prevention and Control), EURL (European Reference Laboratory for Avian Influenza), Adlhoch C, Fusaro A, Gonzales JL, Kuiken T, Marangon S, Niqueux É, Staubach C, Terregino C, Aznar I, Muñoz Guajardo I and Baldinelli F, 2021. Scientific report: Avian influenza overview May – August 2021.

HP AIV H5 in Germany: Expansion of cases



	2006	2007	2009	2014	2015	2016	2017	2018	2020	2021
Non-Wild	1	4		3	2	26	74	2	30	230
Wild	57	92	1			560	602	3	512	826



King, J., T. Harder, F. J. Conraths, M. Beer, and A. Pohlmann. "The Genetics of Highly Pathogenic Avian Influenza Viruses of Subtype H5 in Germany, 2006-2020." *Transbound Emerg Dis (2020).*

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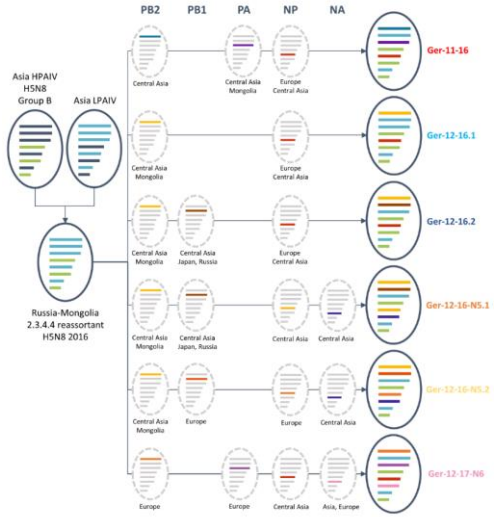
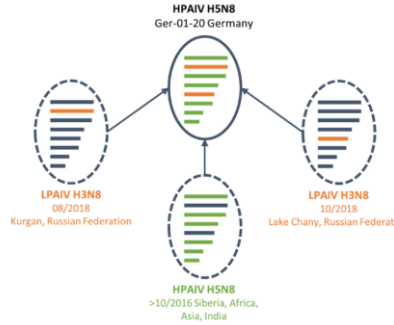
HP AIV H5 in Germany: Expansion of viral variation

2006	2007	2014/2015	2016/2017	2017/2018	2019/2020	2020/2021
H5N1	H5N1	H5N8	H5N8, H5N5	H5N6	H5N8	H5N8, H5N5, H5N3, H5N1, H5N4
• clade 2.2.1 • clade 2.2.2	• clade 2.2.	• clade 2.3.4.4a	• clade 2.3.4.4b •Ger-11-16-N8 •Ger-12-16-N8.1 •Ger-12-16-N8.2 •Ger-12-16-N5.1 •Ger-12-16-N5.2	• clade 2.3.4.4b •Ger-12-17-N6	• clade 2.3.4.4b •Ger-01-20	• clade 2.3.4.4b •Ger-10-20-N8 •Ger-10-20-N5 •Ger-12-20-N3 •Ger-02-21-N1 •Ger-02-21-N4 •Ger-02-21-N8 •Ger-03-21-N8

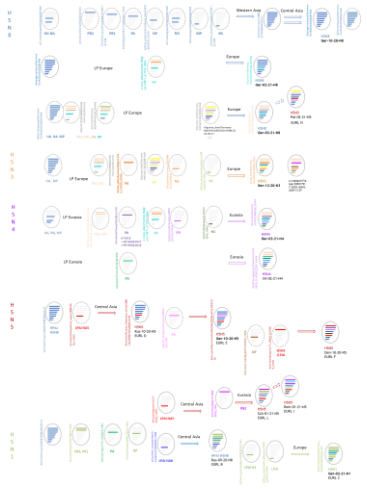
- >90 % H5N8 Ger-10-20-N8: Same reassortant caused 7 human cases in Russia, December 2020.
- Reassortants with five diverse NA subtypes (NA8, NA1, NA5, NA4, NA3)
- H5N8, H5N1, H5N5 detected in poultry; H5N3 restricted to red knots; H5N4 rare (swans, buzzard)
- HA and M segments are constant among all reassortants



2016/17



2019/20



2020/21

King, J., T. Harder, F. J. Conraths, M. Beer, and A. Pohlmann. "The Genetics of Highly Pathogenic Avian Influenza Viruses of Subtype H5 in Germany, 2006-2020." *Transbound Emerg Dis (2020).*

Slide and data: A. Pohlmann/J. King; FLI

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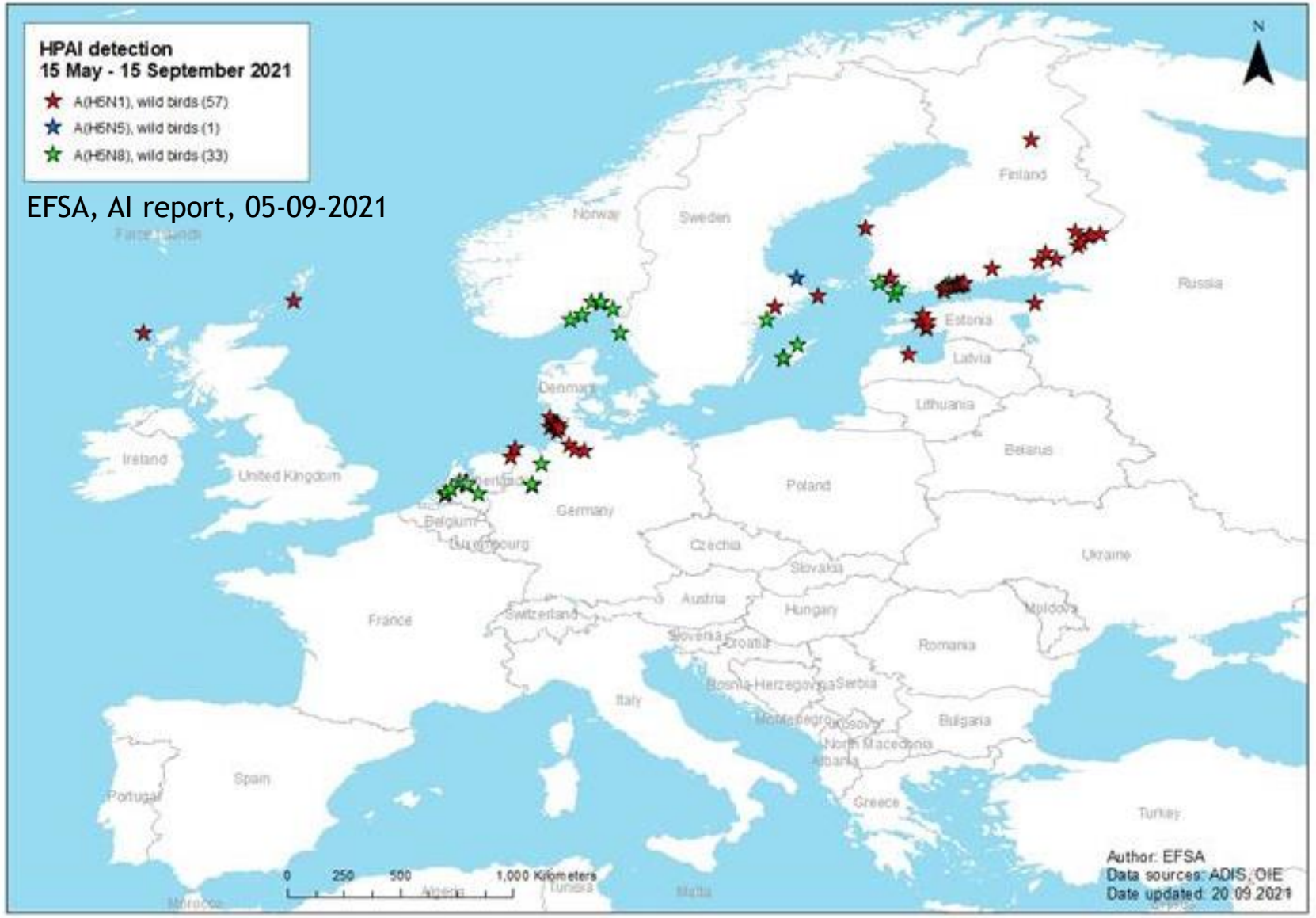
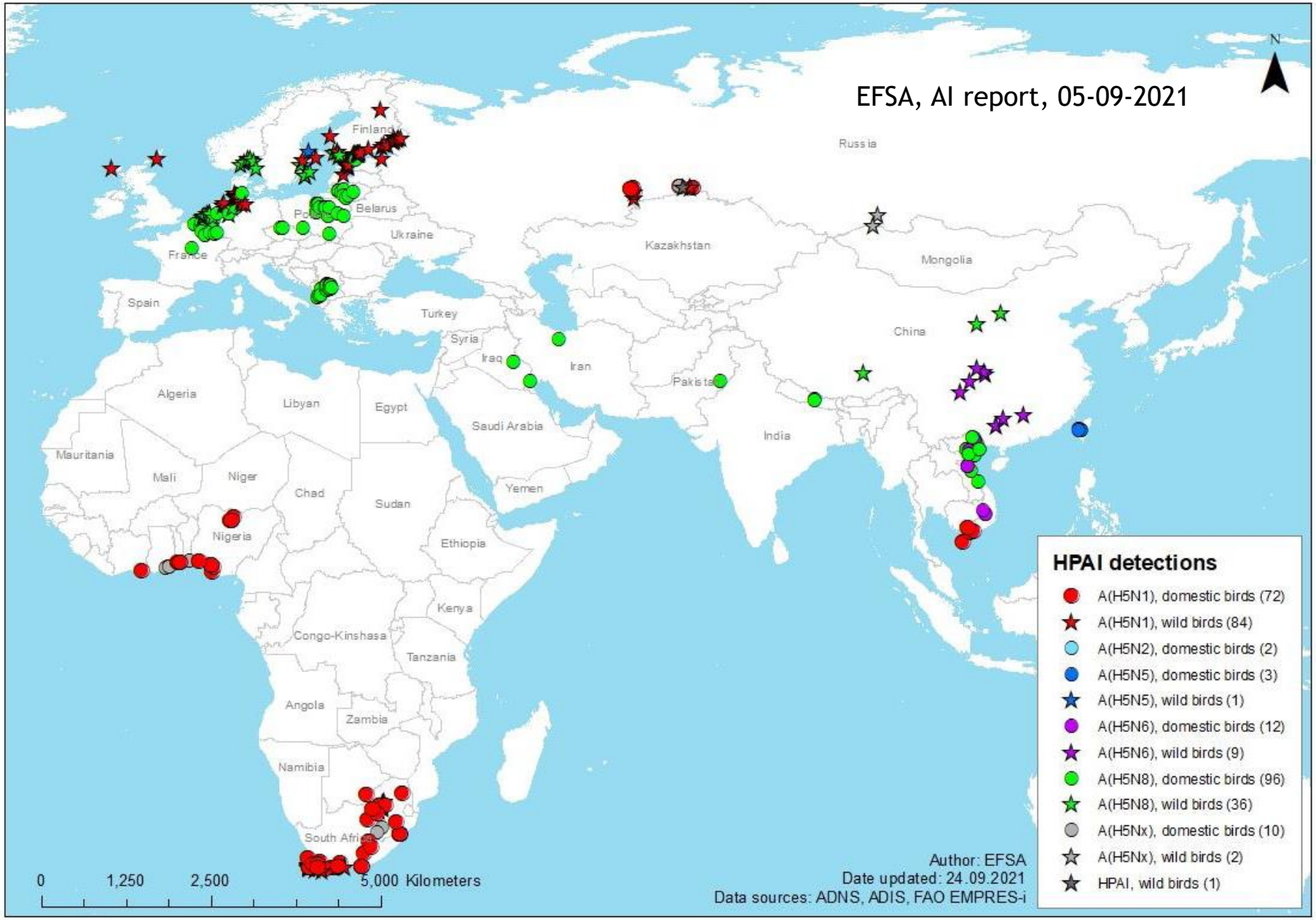
A new quality: On the way to endemic HPAI in Europe?



EFSA, AI report, 05-09-2021

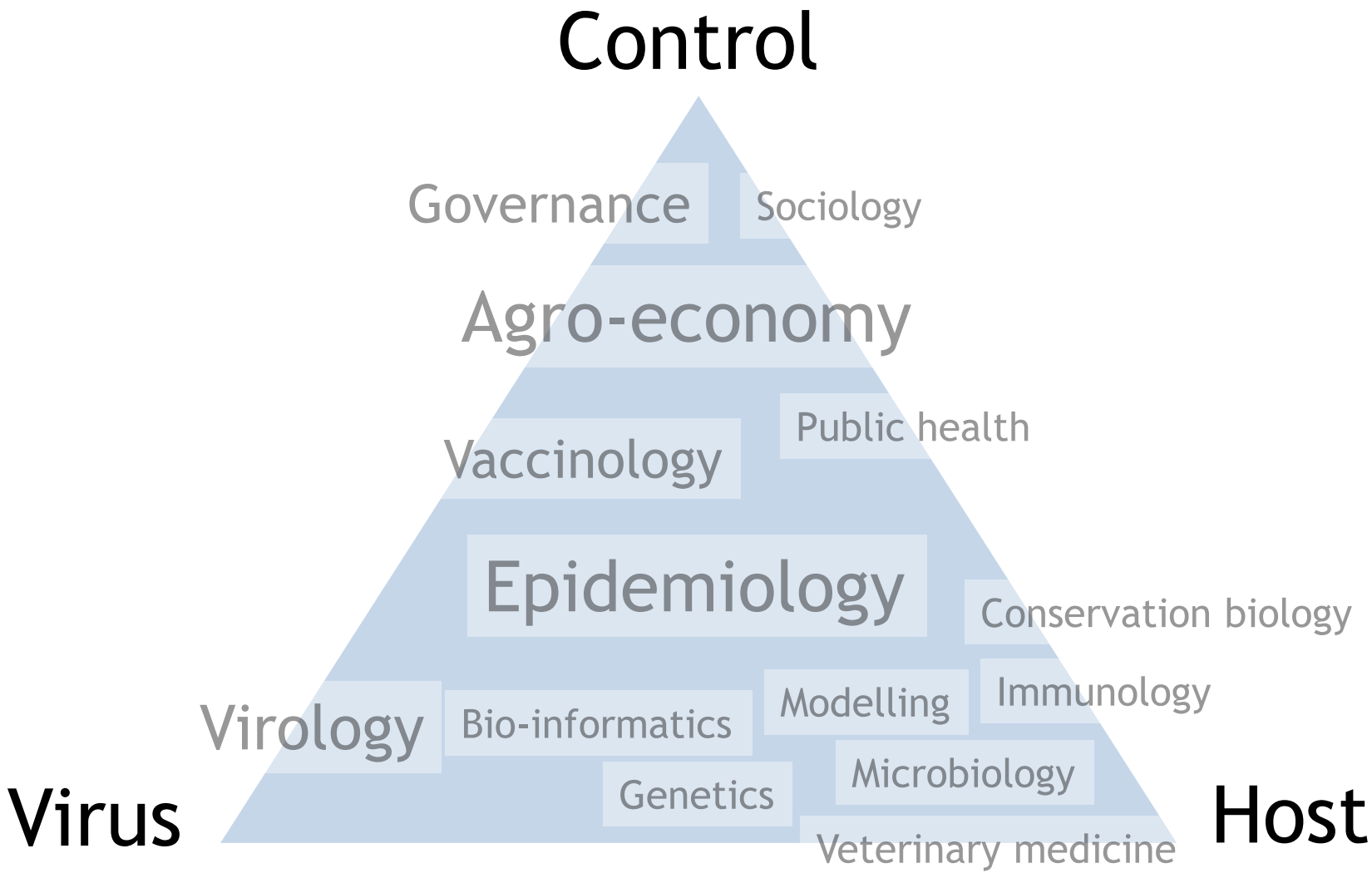
- Pre 2017: No HPAIV detection during summertime
- > 2017: Sporadic HPAI in poultry during summer months
- 2021: Increased HPAI detection rate also in wild birds during summer months
- Coasts of the North Sea and Baltic affected
- At least two subtypes co-circulating: HPAIV H5N8, H5N1 (H5N5); all of gs/GD clade 2.3.4.4b

On-going gs/GD HPAI circulation in Africa and Eurasia

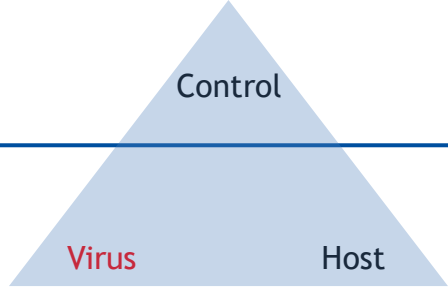


- Evidence for **zoonotic** HPAIV transmissions (China, Russia)
- Evidence for **avian-to-mammalian transmission** in Europe (UK, NL, SE, DE: seals, foxes)

Gaps and answers



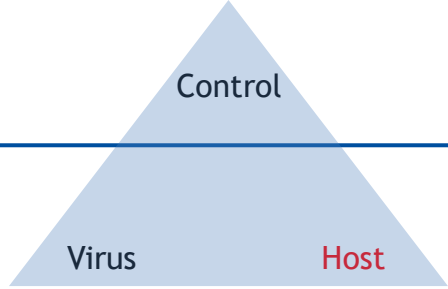
Gaps and answers: Virus



- Identification of viral molecular mechanisms and genetic markers within variable genomic context signaling
  - zoonotic risks and human adaptation of animal influenza viruses,
  - virulence for avian and mammalian species,
  - resassortment propensity (and its sequelae),
  - LP-to-HP mutation likelihood (H5, H7), …

= Improved sequence-to-phenotype prediction

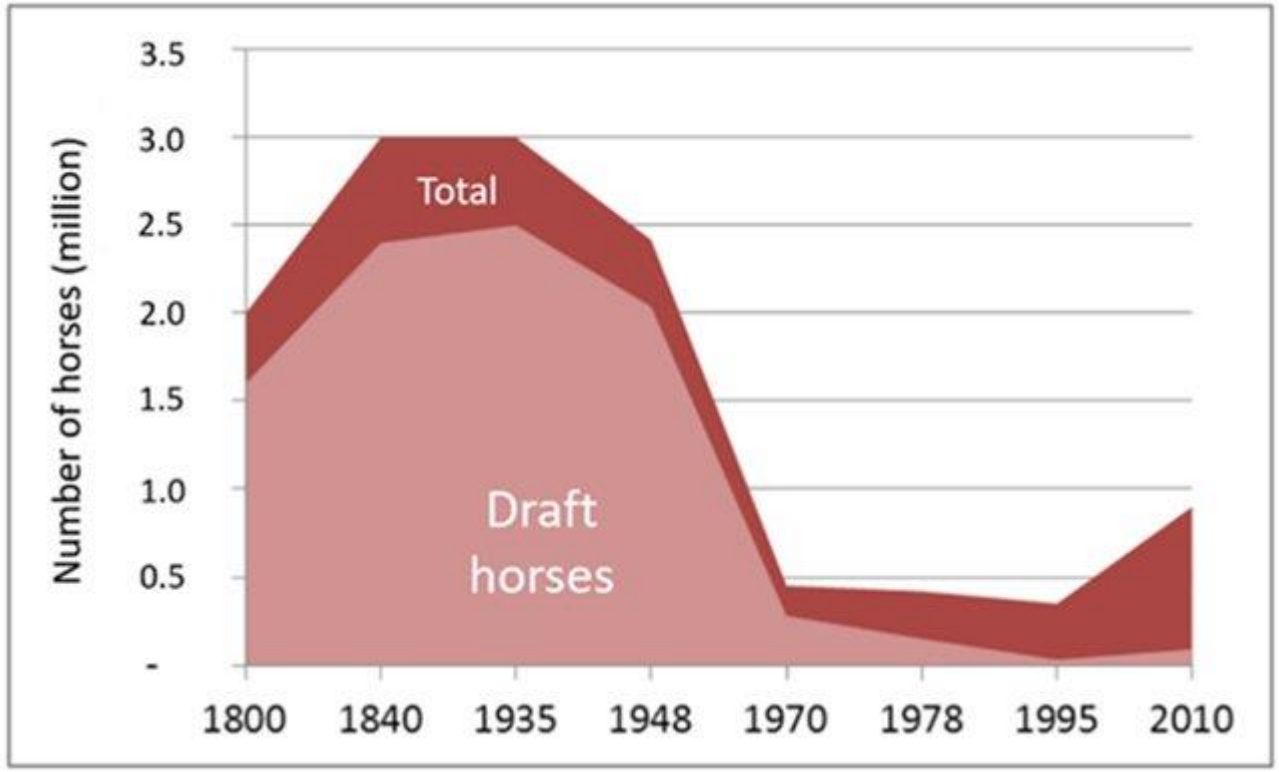
Gaps and answers: Host (populations)



- Genetic markers of susceptibility/resistence
  - Galliform vs anseriform poultry
- Influenza virus maintenance in reservoir species
  - Wild birds (mallards, other dabbling ducks)
  - Swine (endemic virus circulation in large holdings)
- Population and transmission dynamics
  - Wild bird – poultry interface
  - Swine – human interface (zoonotic vs reverse-zoonotic transmission)

= Understand host-specific factors

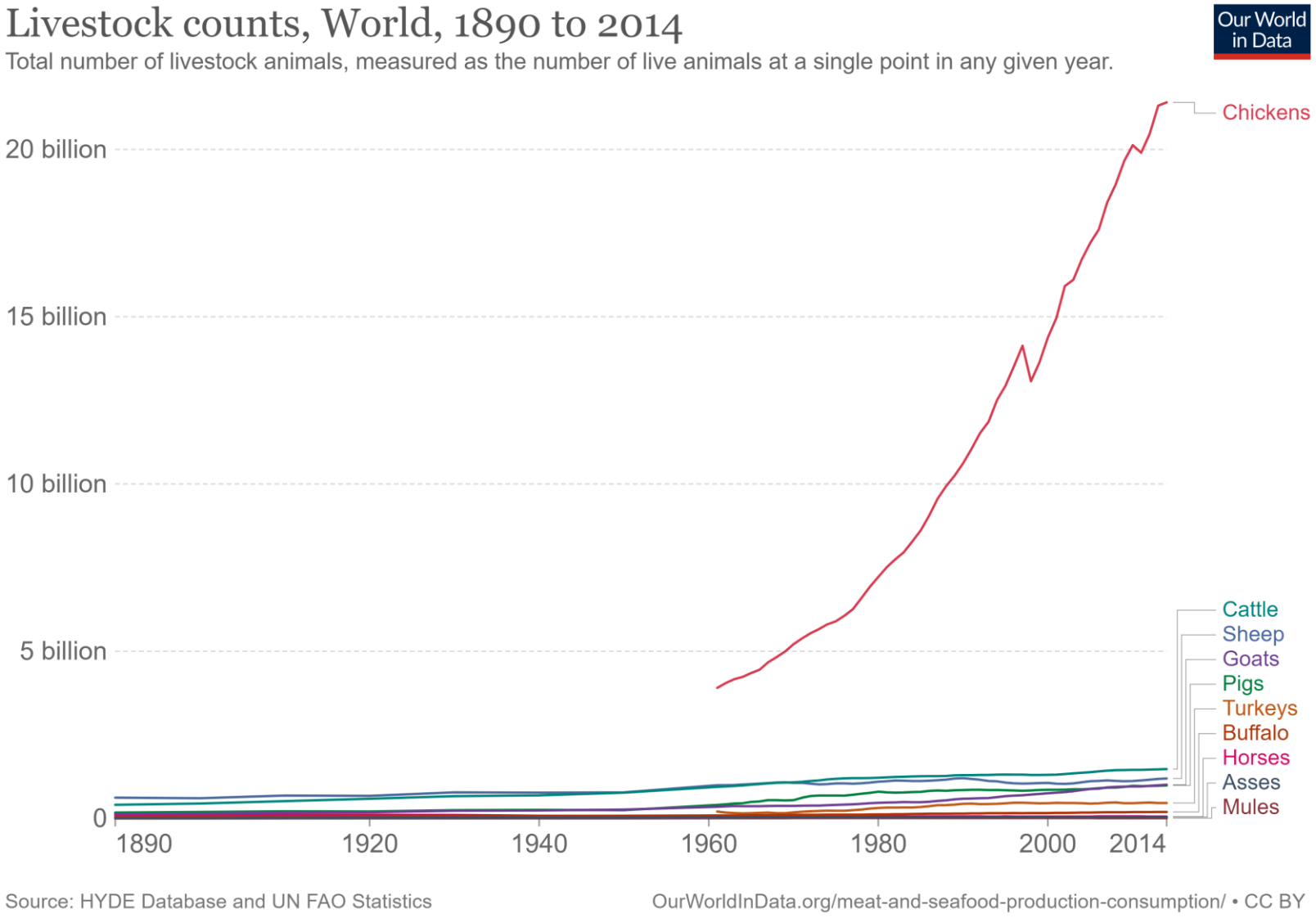
Historic live stock reservoirs



Animals 2020, 10, 106; doi:10.3390/ani10010106

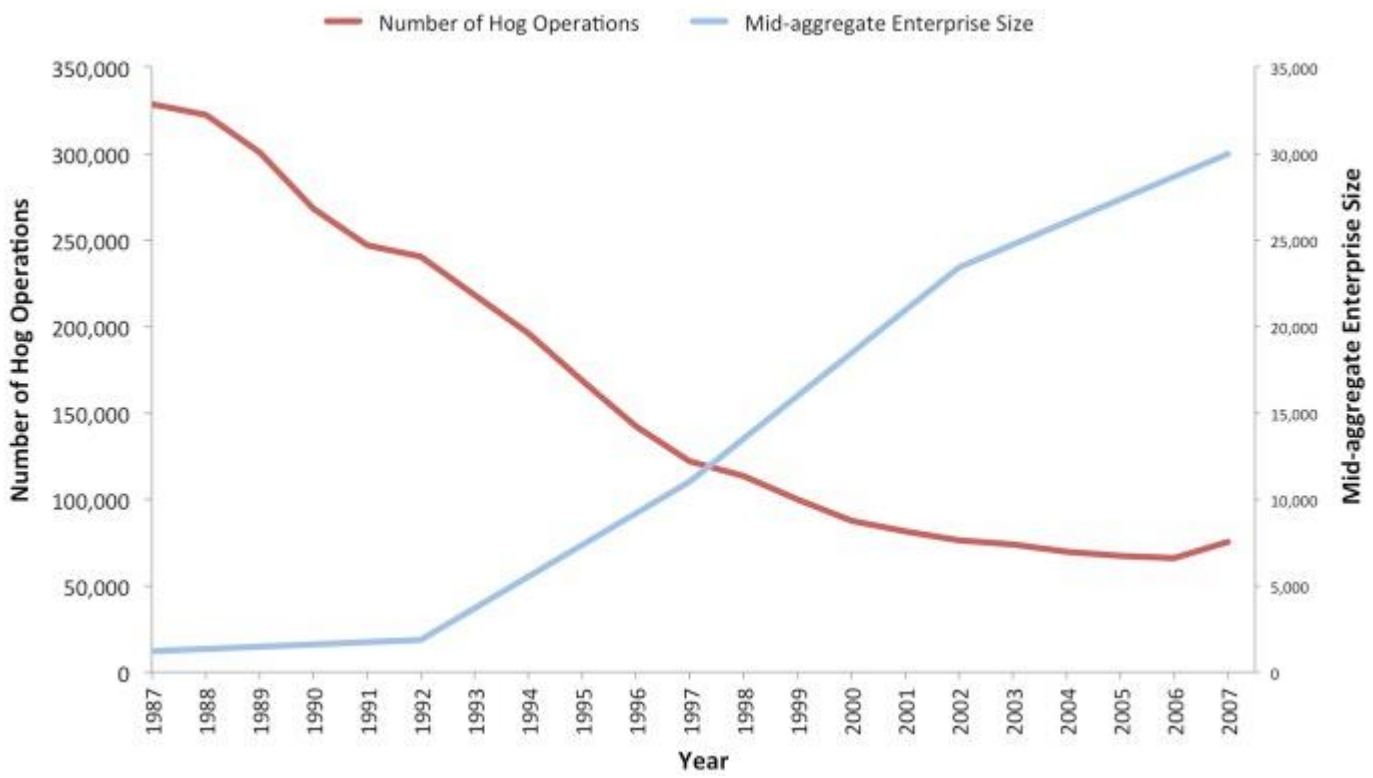
- Pre-1918 human pandemic flu
- Archeo-serologic evidence for equine origin of human pandemic influenza viruses
- Equine populations collapsed following WWII, associated influenza virus populations vanished (H7) or shifted (H3N8)

Current live stock reservoirs of animal influenza viruses



- Increasing chicken populations (Asia, Middle East, …)
- Highly volatile populations (turn-over rates <3 months):
  - Constant re-stocking of susceptible individuals
  - Difficult to protect (by biosecurity or by vaccination)
- Interface to humans highly interlocked

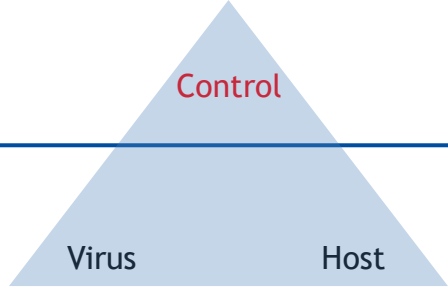
Re-arranged swine populations



DOI: 10.1371/journal.pone.0089870, PlosOne, 2014

- Pig production fairly stable
- Population size and fragmentation shifts:
  - Numbers of swine per holding increase
  - Numbers of holdings decrease
- Transboundary trade with live pigs increases

Gaps and answers: Control



- Incursion routes (the “last mile”)
- Role of environment in transmissions/maintenance (aerosols, wind; surface water, sediments)
- Surveillance for “early warning”: Effective, systematic (orchestrated), sustainable
- Biosecurity: Conflict of goals (outdoor production, live bird markets, …)
- Vaccines: Broad, one-shot, mucosal, needle-free, DIVA

= Understand interaction pathways

Societal changes: The citizen-customer-producer gap

- **Public (“citizen”) demands animal production that**
  - respects animal welfare,
  - is climate-neutral (CO_2/CH_4 emission),
  - generates healthy food (no antibiotics/residual contaminants, no pathogens)
- **Customer demands**
  - “affordable” food products of animal origin
- **Producers demand animal production that**
  - provides sufficient income