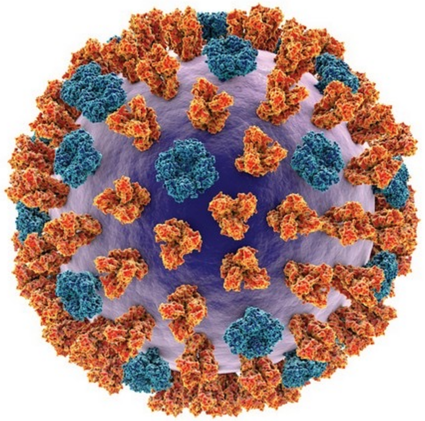
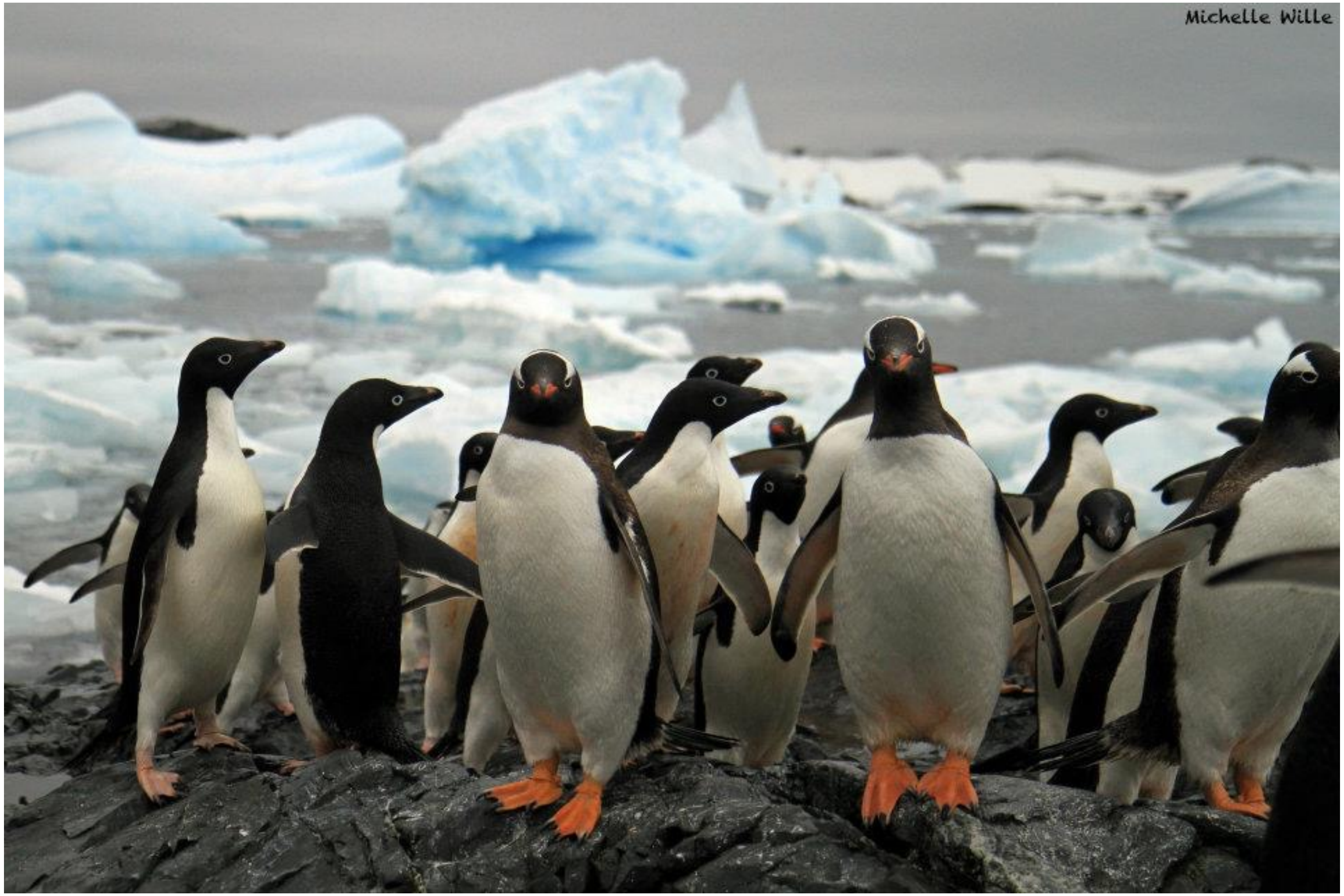
Avian influenza 101



Michelle Wille, PhD



Michelle.wille@unimelb.edu.au

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CENTRE FOR PATHOGEN GENOMICS

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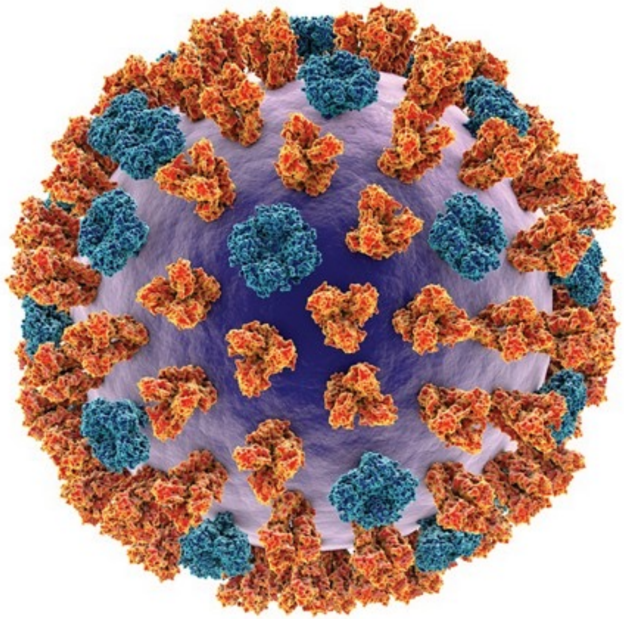
The Royal Melbourne Hospital

A joint venture between The University of Melbourne and The Royal Melbourne Hospital

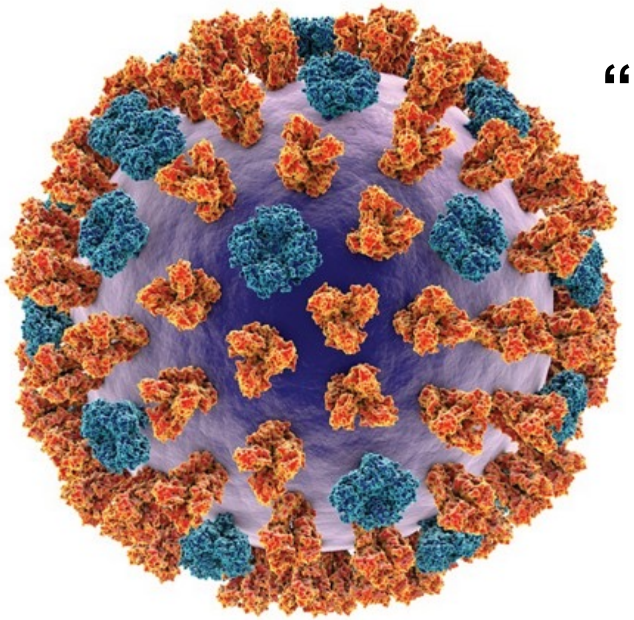
WHO Collaborating Centre for Reference and Research on Influenza VIDRL



Avian influenza 101

“Clade 2.3.4.4 H5N6 HPAI”

“subtype H5N8 (clade 2.3.4.4)”



“Gs/GD clade 2.3.4.4”

“H5 birdflu”

“Clade 2.3.4.4b HPAI H5N1”

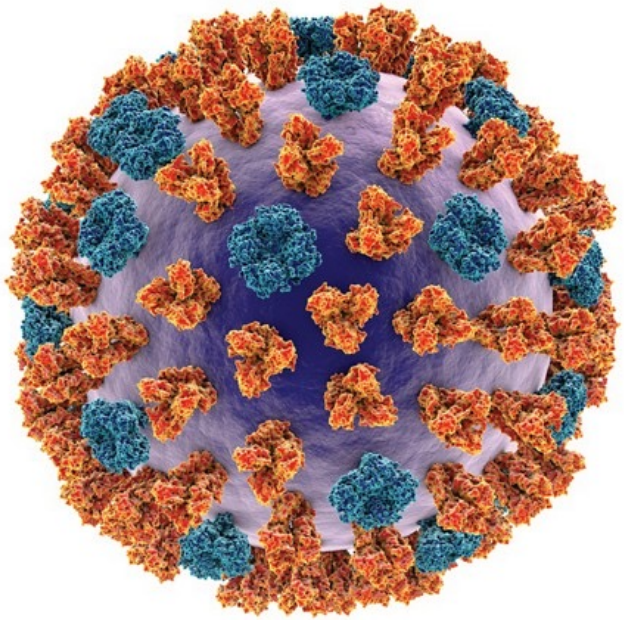
“clade 2.3.4.4 Gs/GD HPAI”

“Clade 2.3.4.4 HPAI H5Nx”

“Clade 2.3.4.4 H5N6 HPAI”

“Gs/GD clade 2.3.4.4”

“subtype H5N8 (clade 2.3.4.4)”



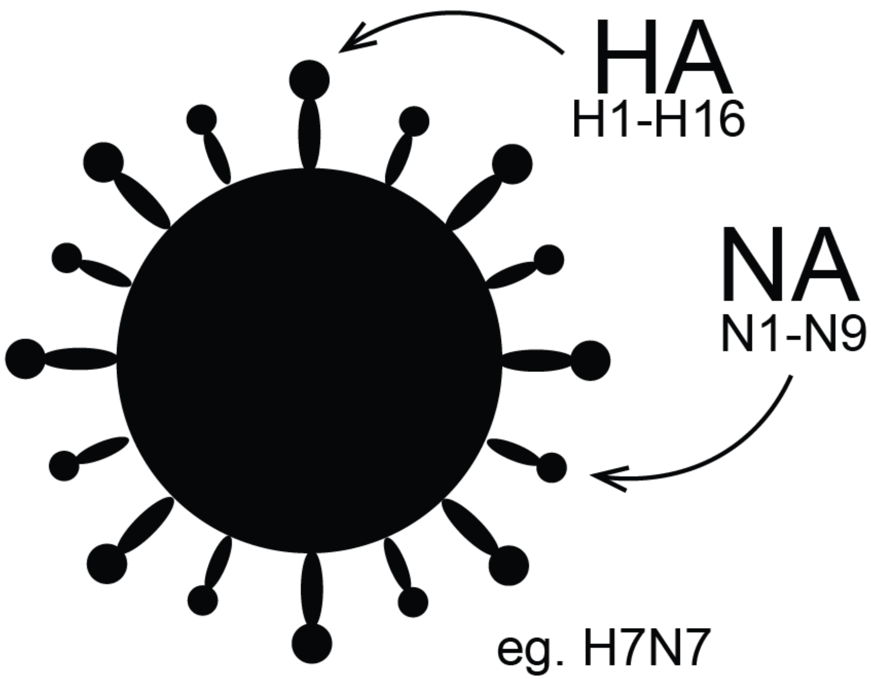
H5 genetic lineage or clade	Pathogenicity	HA-NA Subtype
Clade 2.3.4.4b	**HPAI**	**H5N1**

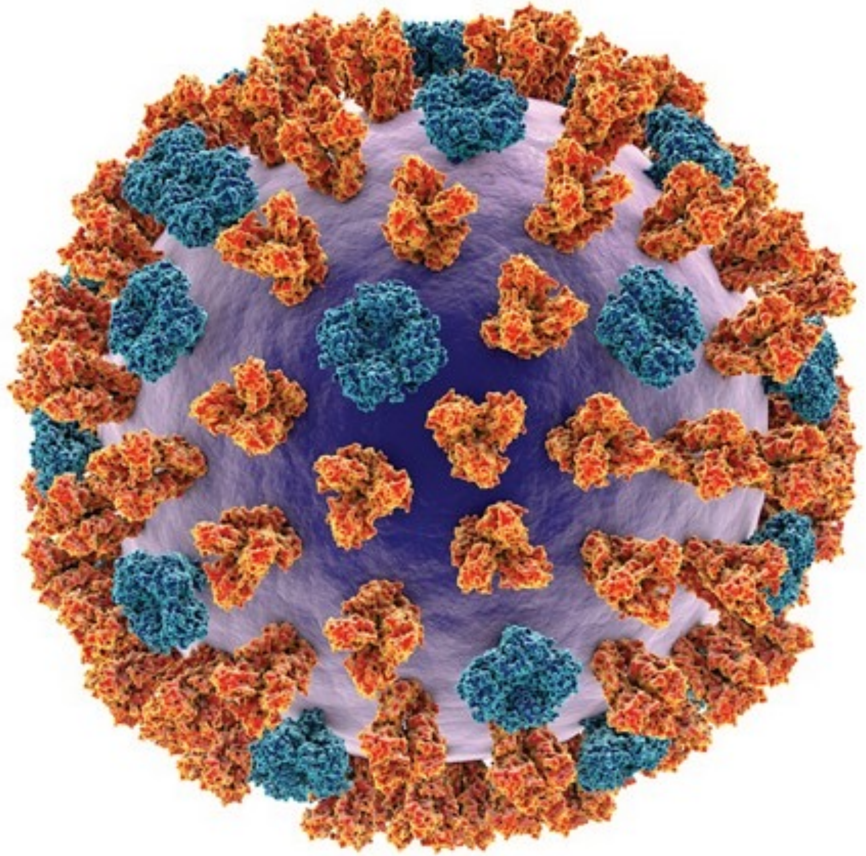
“clade 2.3.4.4 Gs/GD HPAI”

“Clade 2.3.4.4 HPAI H5Nx”

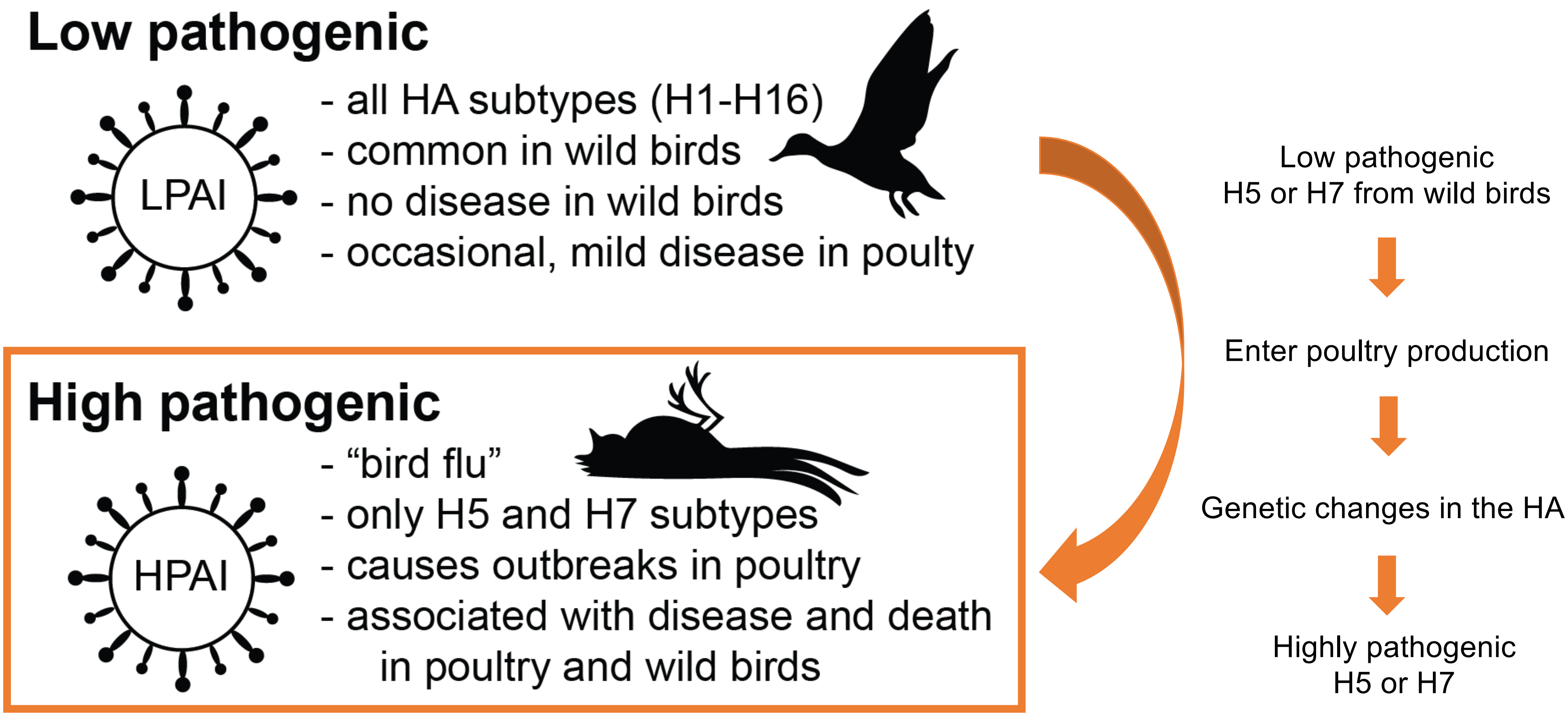
What’s in the name?

Avian influenza “subtype”

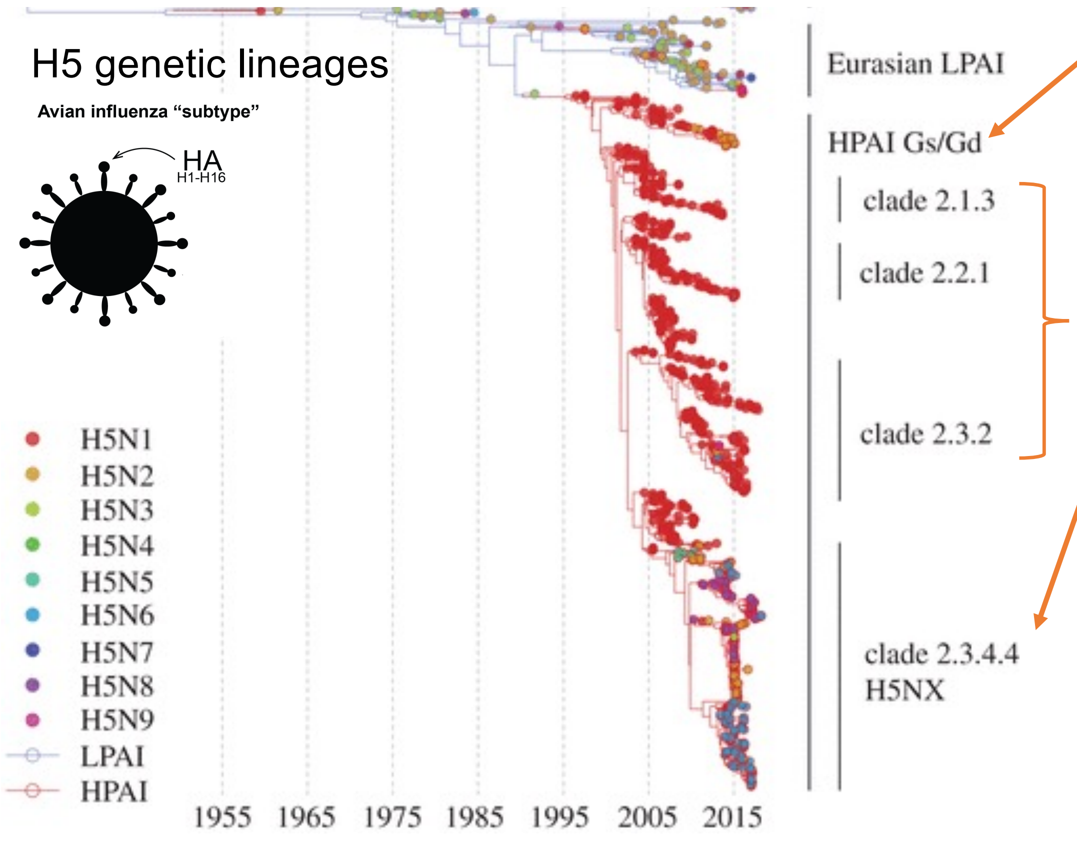




What's in the name?

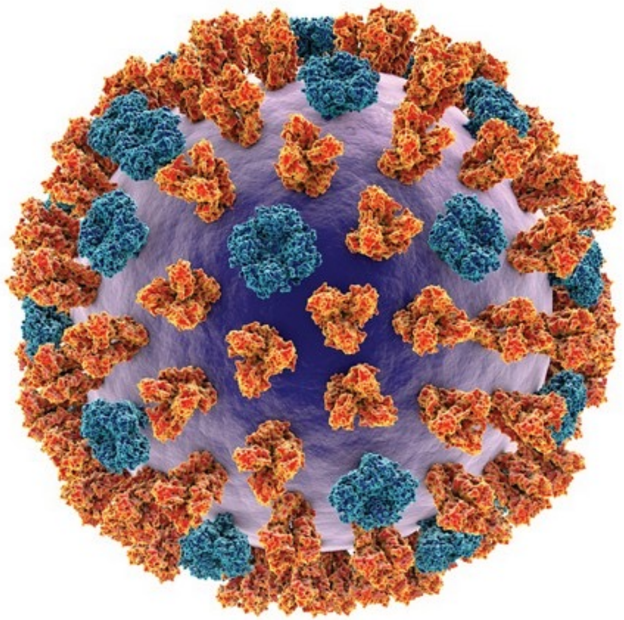


What's in the name?



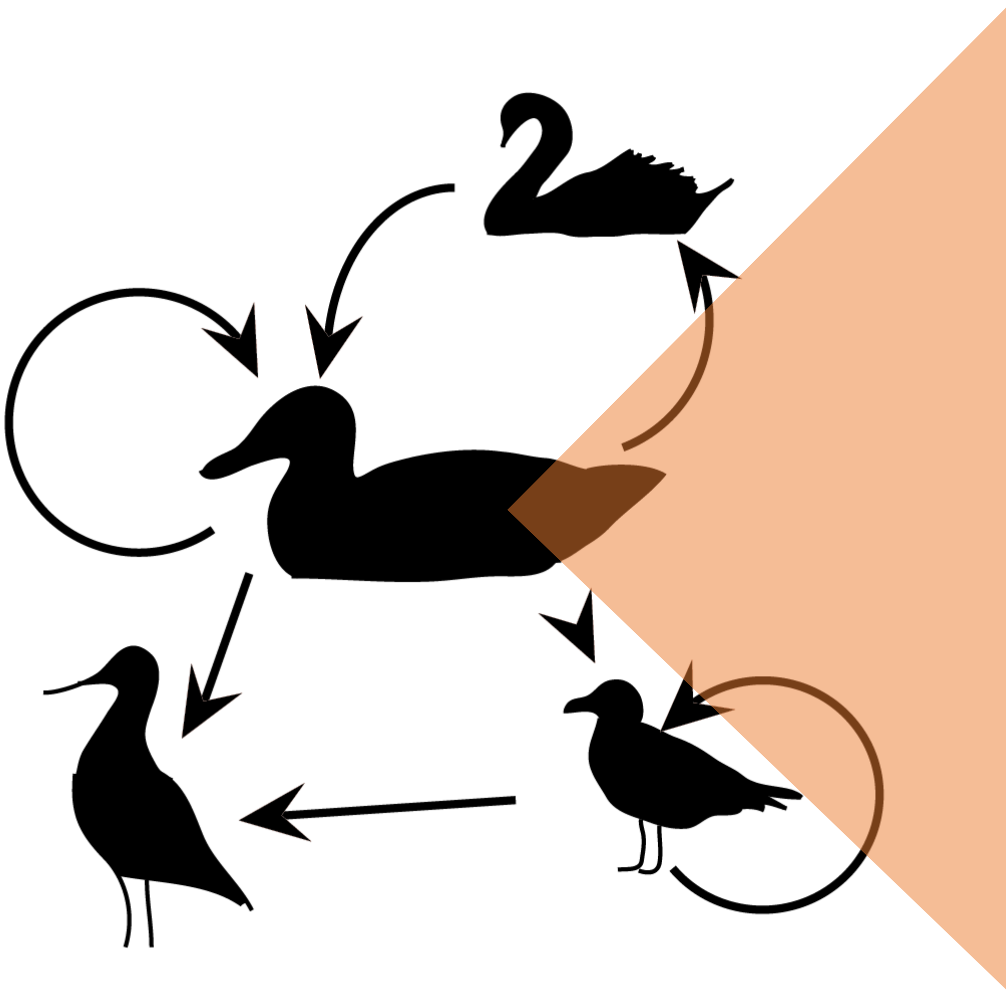
Lycett et al. 2019. A short history of bird flu. Proc Roy Soc B.

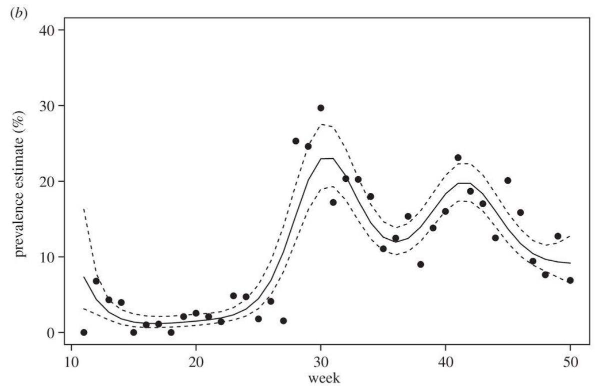
- HPAI H5N1 emerged in Asia in 1996 and became endemic in poultry (goose/guandong lineage)
- In 2005, large outbreaks across Asia. In addition to poultry, large outbreaks in wild birds (<u>*e.g.*</u> Lake Qinghai) and detections in Europe
- Evolution continues.. Lineages come and go…
- In 2014, lineage 2.3.4.4 emerges
  - Widespread detection in wild birds
  - Spread to Europe and North America
  - Rather than N1, we see the emergence of H5N8
- In 2016 lineage 2.3.4.4 spread to Africa
- Clade 2.3.4.4 has multiple subclades including 2.3.4.4b
- In 2021 we see an "old foe", H5N1.



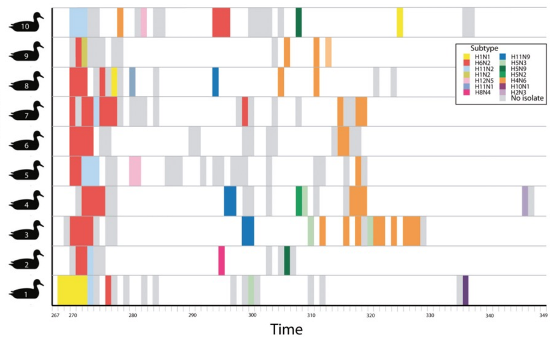
Avian influenza in seabirds: history and context

Today: Key players for LPAI (and frequently affected by HPAI)





Up to 20% virus prevalence in population through autumn



Frequent re-infection

Huge subtype diversity

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16
N1	***		***		***	***	***		***		***					
N2	***	***	***	***	***	***	***		***		***					
N3	***	***	***		***	***	***			***	***					
N4						***	***	***								
N5					***	***						***				
N6			***	***		***	***									
N7						***	***		***	***						
N8			***	***	***	***	***		***							
N9		***		***	***	***	***		***		***					

First outbreak of avian influenza in wild birds:

HPAI H5N3 caused mass mortality event in South Africa in 1961.
1300 dead terns found.

Becker. 1965. The isolation and classification of Tern virus: Influenza Virus A/Tern/South Africa/1961. Journal of Hygiene

J. Hyg., Camb. (1966), **64**, 309
Printed in Great Britain

The isolation and classification of Tern virus: Influenza Virus A/Tern/South Africa/1961

BY W. B. BECKER
C.S.I.R. and U.C.T. Virus Research Unit, University of Cape Town, South Africa

(*Received* 31 *December* 1965)

THE EPIZOOTIC IN COMMON TERNS—*STERNA HIRUNDO*

The field observations on the epizootic among Common Terns along the coast of the Cape Province of South Africa in April 1961 have been reported in detail by Rowan (1962). The Common Tern is usually seen in the Republic of South Africa from October to February, but in 1961 many Common Terns delayed their migration to the breeding grounds in the temperate regions of the Northern Hemisphere until May. Several dead terns were reported in the region of Cape Town in the second and third weeks of April, but the epizootic became explosive in the third and fourth weeks and either spread rapidly or was multifocal in origin along the 1000-mile stretch of coast from Port Elizabeth to Lambert's Bay (Fig. 1). The

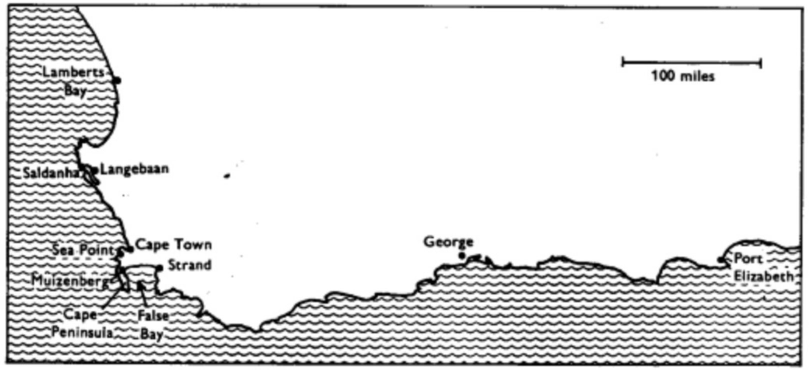


Fig. 1. Places in South Africa where dead Common Terns were found during the epizootic of 1961.

First detection of avian influenza in healthy wild birds:

Detection of H6N5 in healthy Wedge-tailed Shearwaters on Tyrion Island, Australia

Downie and Laver. 1973. Isolation of a type A influenza virus from an Australian pelagic bird. Virology

VIROLOGY 51, 259–269 (1973)

Isolation of a Type A Influenza Virus from an Australian Pelagic Bird

JEAN C. DOWNIE AND W. G. LAVER

Department of Microbiology, The John Curtin School of Medical Research, The Australian National University, Canberra, A.C.T. 2601, Australia

Accepted October 16, 1972

A type A influenza virus was isolated from a tracheal swab taken from an apparently healthy shearwater bird (mutton bird, *Puffinus pacificus chlororhynchus*) nesting on Tryon Island off the east coast of Australia. The hemagglutinin subunits of the shearwater virus were of antigenic subtype Hav6, but the neuraminidase subunits were not related antigenically to those of any known virus and represent a new neuraminidase subtype, Nav5. The hemagglutinin and neuraminidase subunits of the shearwater virus were segregated by recombination of the virus with other influenza A viruses. The size and polypeptide composition of these subunits, isolated electrophoretically from the SDS-disrupted recombinant viruses, were similar to those of other influenza viruses.

These findings suggest that there may be other avian influenza viruses with novel hemagglutinin or neuraminidase subunits, from which human pandemic strains could arise by genetic recombination.

INTRODUCTION

Pandemics of type A influenza, which occur in man at irregular intervals, are caused by "new" strains of influenza virus which suddenly appear in the human population. These viruses have surface antigens (hemagglutinin and neuraminidase) which are unrelated immunologically to those of viruses previously circulating, but it is not known where the "new" strains originate. Recent experiments (Webster and Laver, 1972; Laver and Webster, 1972; Webster *et al.*, 1971; Webster and Campbell, 1972) have suggested that the new strains do not arise by direct mutation from existing human influenza viruses, but rather that they are derived, probably by genetic recombination, from influenza viruses infecting lower mammals or birds (Laver and Webster, in press a).

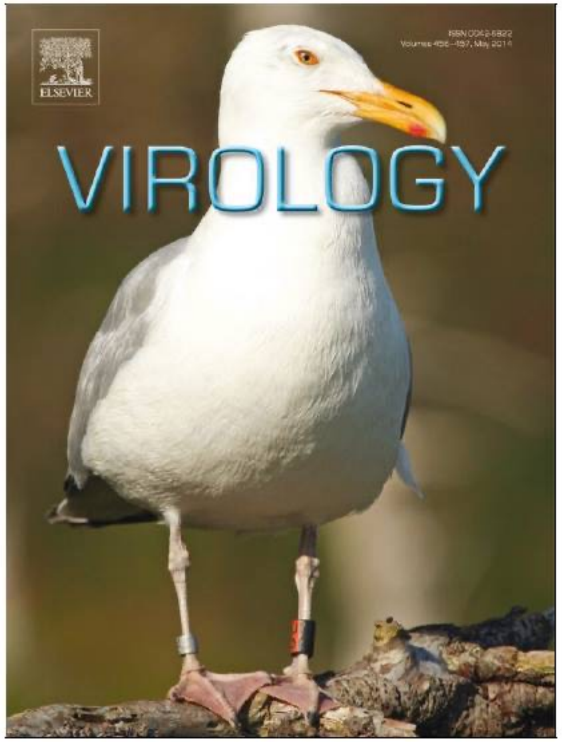
Because of the possibility that animal or avian influenza viruses may be the progenitors of human pandemic strains we have sought to isolate and characterize as many animal or avian strains as possible. Avian influenza has never been reported to occur in Australian domestic birds, but we found recently (Dasen and Laver, 1970; Laver and Webster, in press b) that migratory sea birds off the eastern Australian coast possessed antibody directed against the neuraminidase of the A2/Asian/57 strain of human influenza, and this prompted us to attempt to isolate influenza viruses from these birds. Type A influenza viruses have been isolated many times from domestic birds (Pereira *et al.*, 1965), but the only reported isolation of type A influenza from wild birds (terns) was that of Becker (1966) in South Africa in 1961.

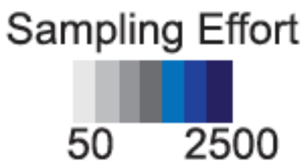
We now report the isolation and characterization of an influenza type A virus from an apparently healthy Australian pelagic bird (mutton bird or shearwater; *Puffinus pacificus chlororhynchus*) nesting on a coral cay off the east Australian coast.

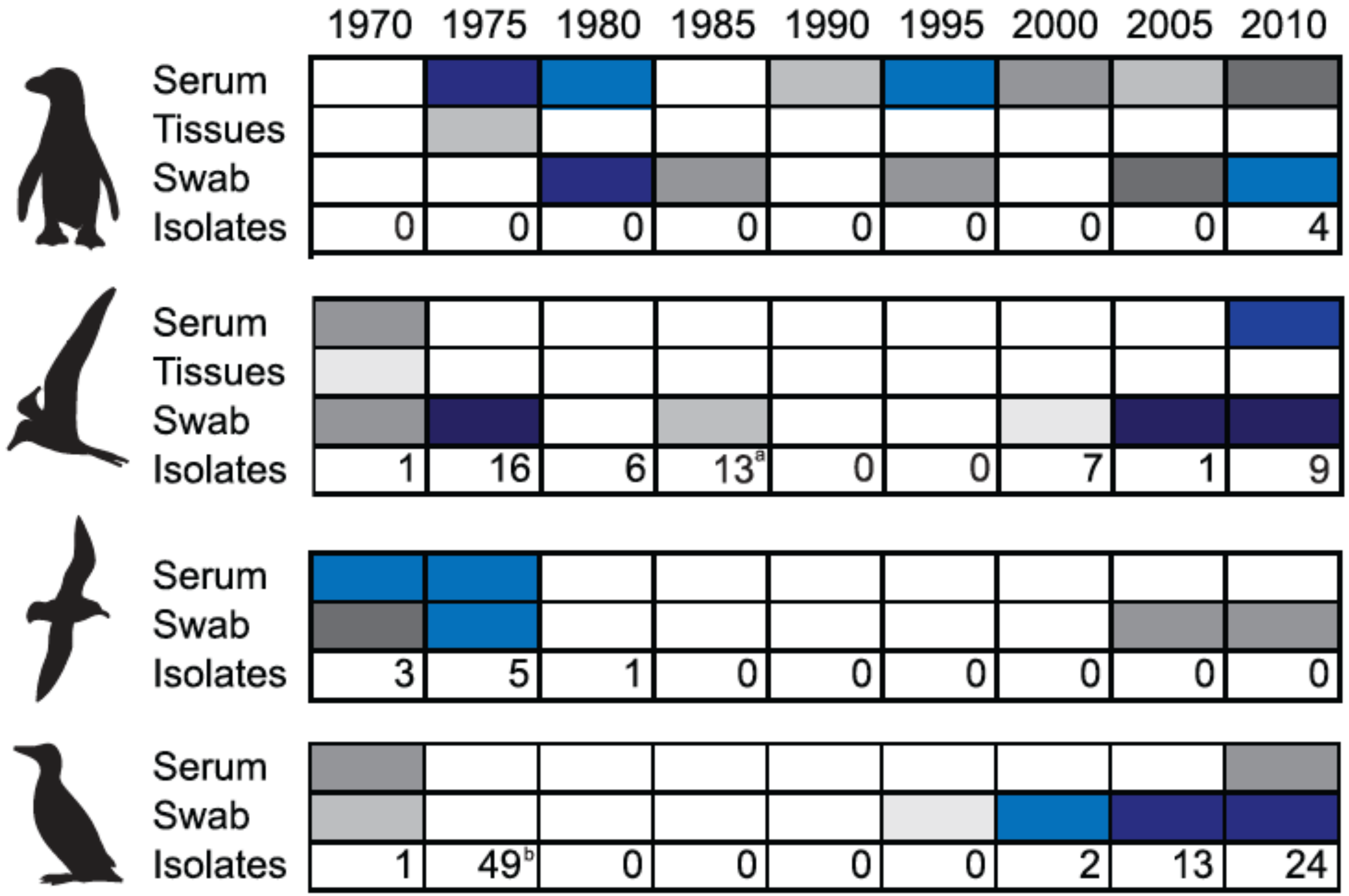
MATERIALS AND METHODS

Collection of material. Sera and tracheal swabs were collected from 201 shearwaters (mutton birds, *Puffinus pacificus chlororhyn-*

Seabirds are important hosts for low pathogenic avian influenza virus





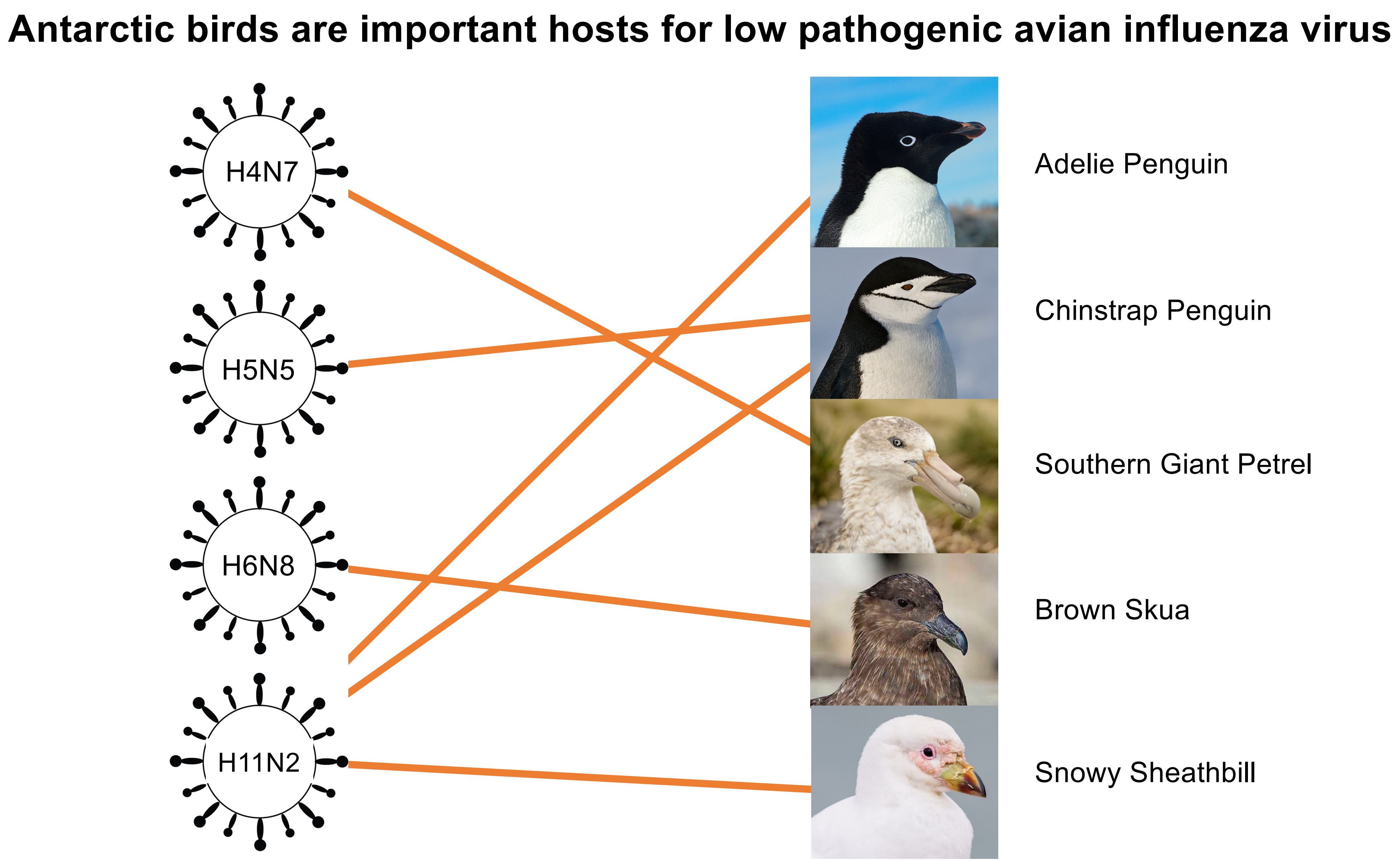


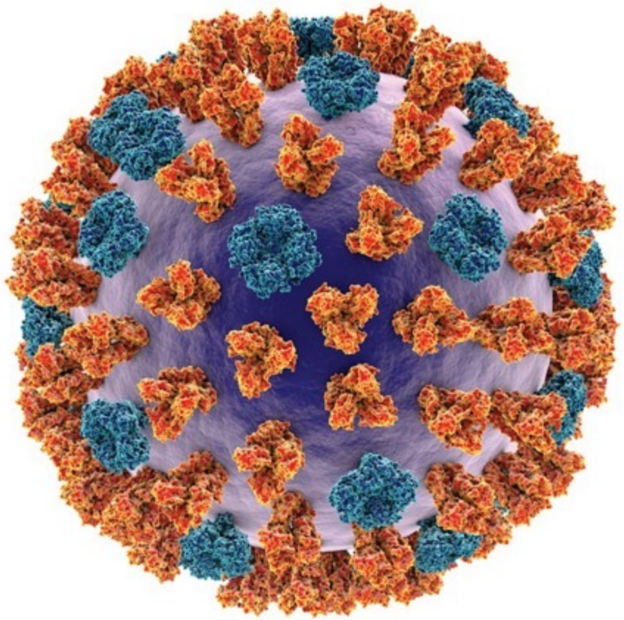
Lang et al. 2016. Assessing the role of seabirds in the ecology of influenza A virus. Avian Diseases.

Seabirds are important hosts for low pathogenic avian influenza virus

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16
Sooty tern									26%			9%				46%
Brown noddy						4%	4%				4%					
Lesser noddy	4%	5%	6%		1%	6%		3%	5%			9%		1%		48%

Lebarbenchon et al. 2015. Influenza A virus on Oceanic Islands: Host and Viral Diversity in Seabirds in the Western Indian Ocean. PLoS Pathogens

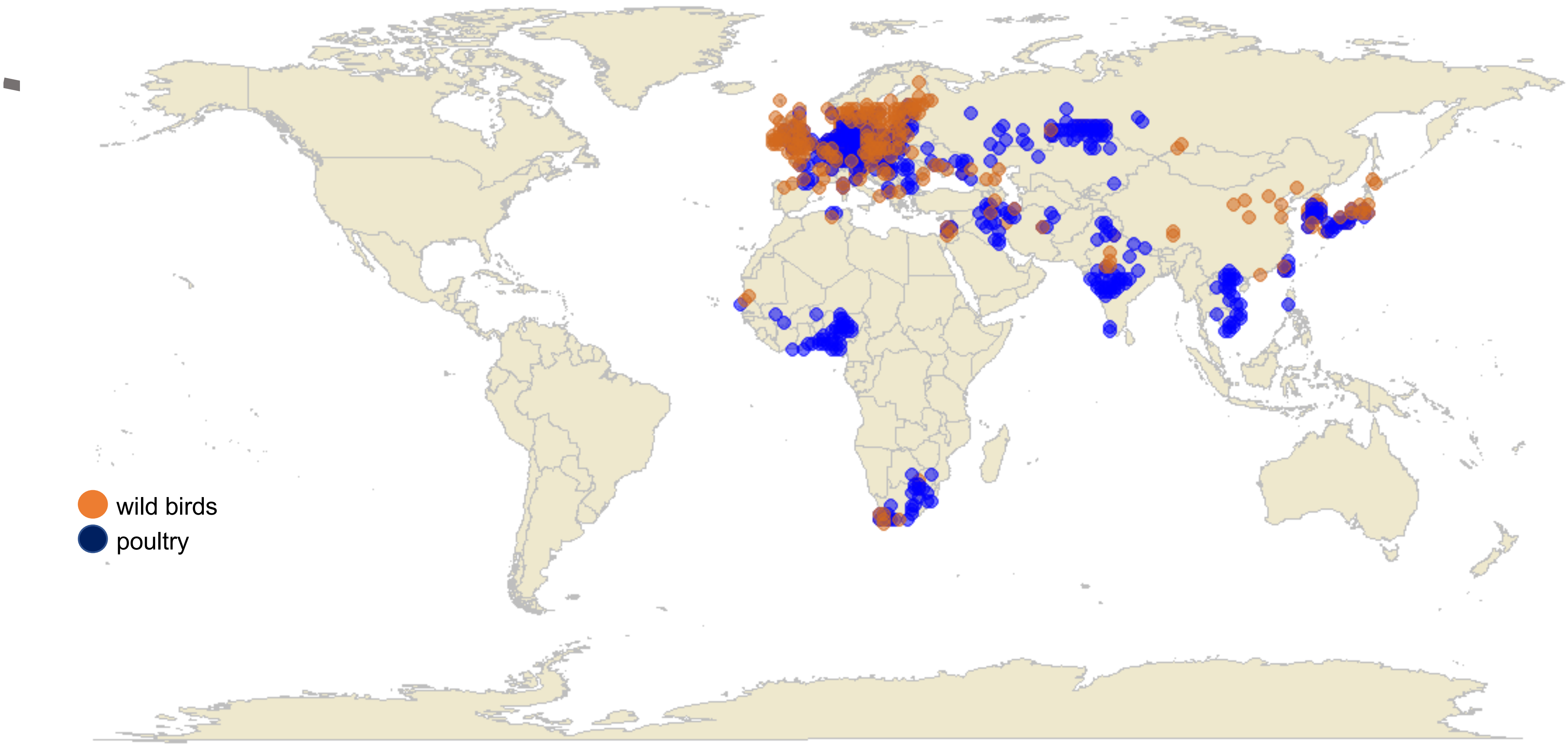

Antarctic birds are important hosts for low pathogenic avian influenza virus
H4N7
H5N5
H6N8
H11N2
Adelie Penguin
Chinstrap Penguin
Southern Giant Petrel
Brown Skua
Snowy Sheathbill



HPAI current situation and outbreaks in seabirds

Global situation of HPAI

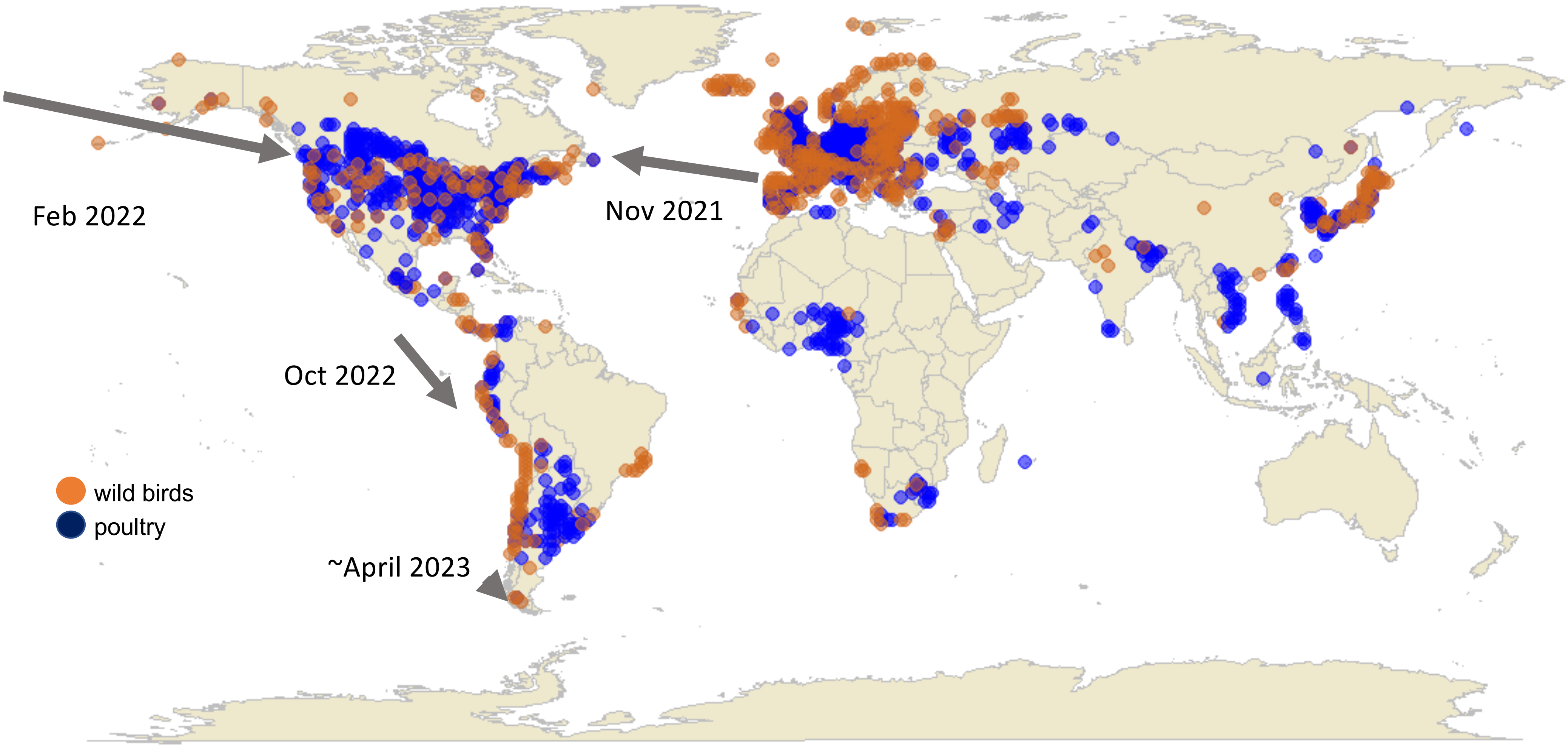
Outbreak notifications April 2020-Septeber 2021



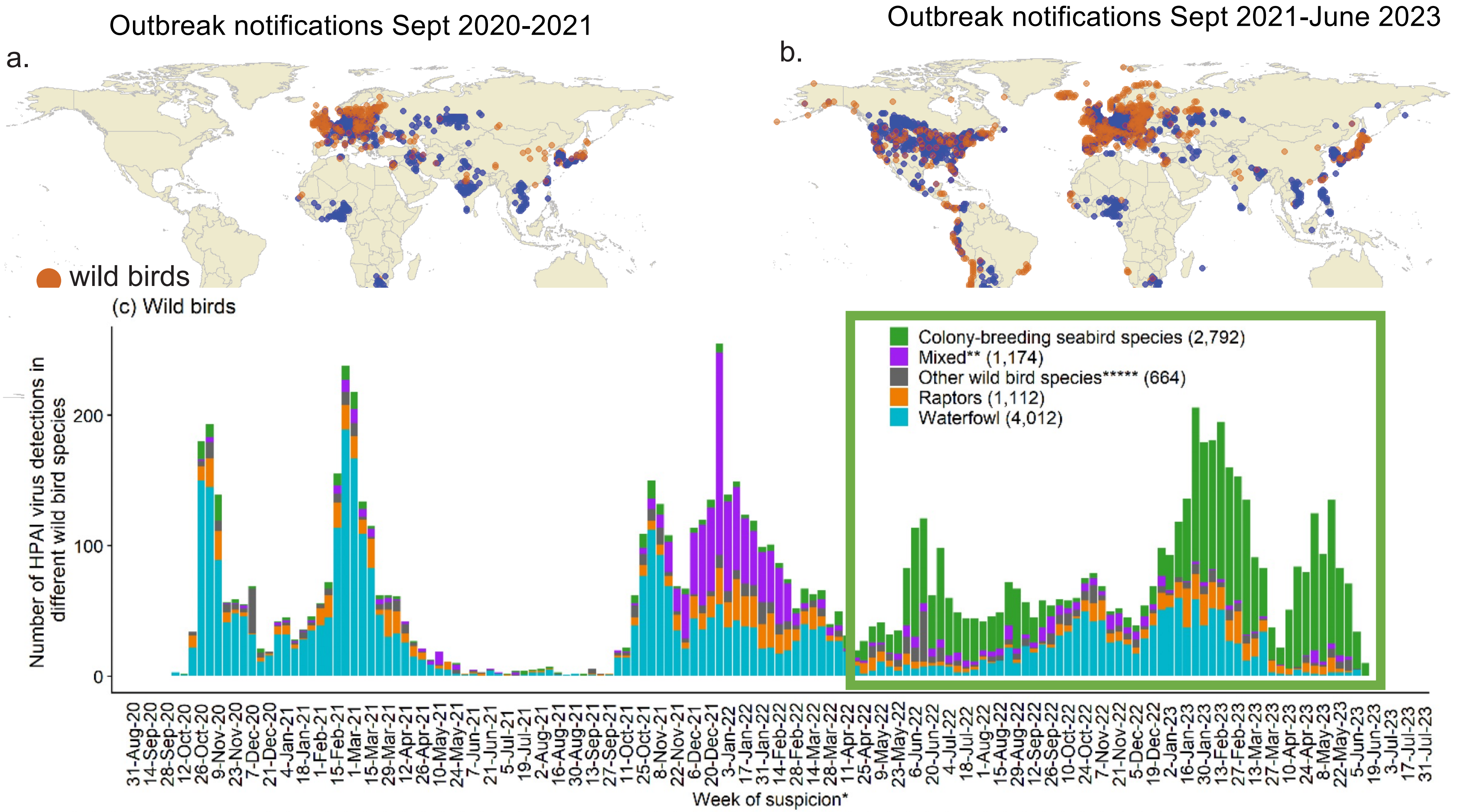
Klaassen and Wille. 2023. Nature Ecology and Evolution

Global situation of HPAI

Outbreak notifications Sept 2021-June 2023

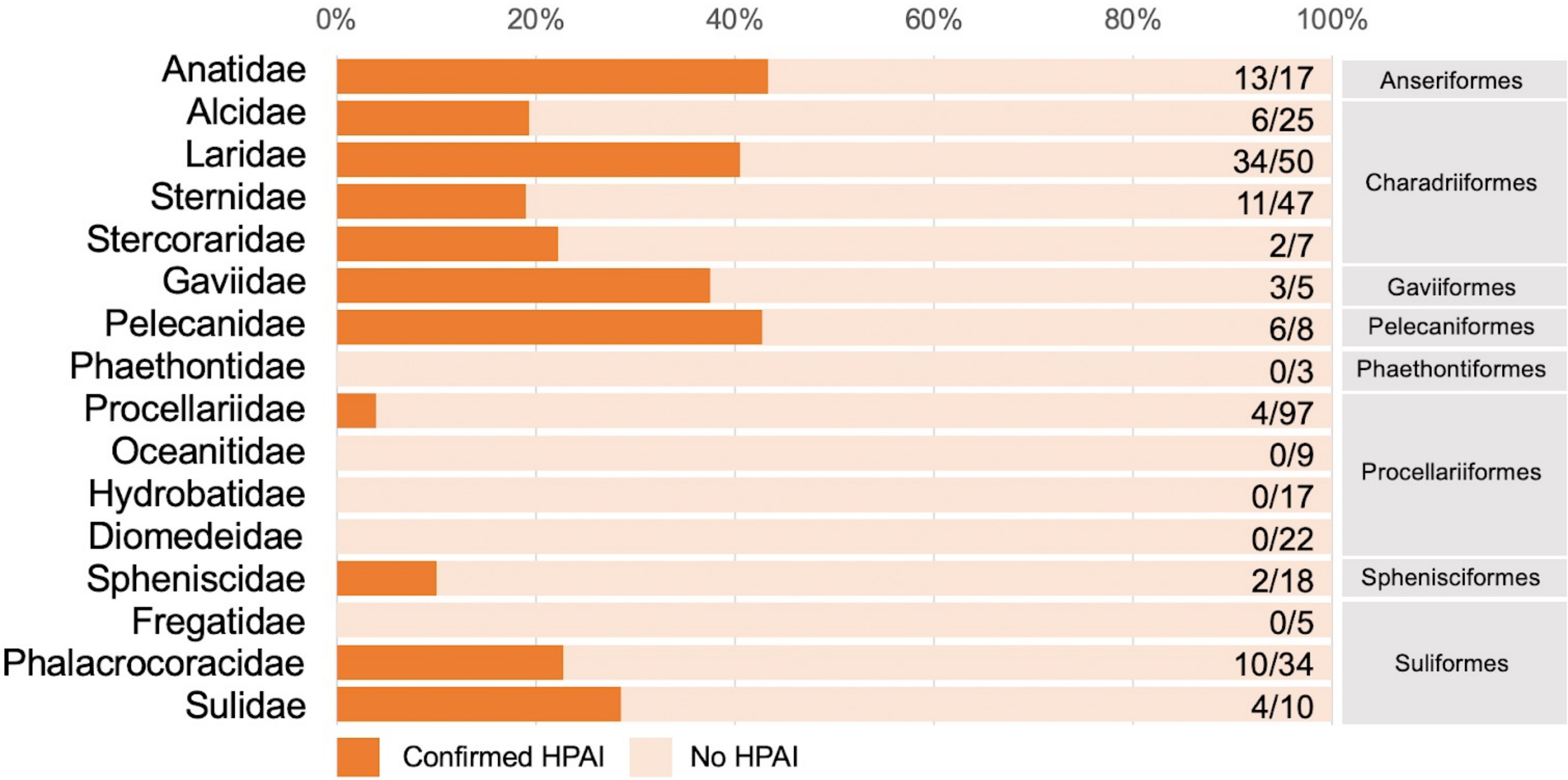


Klaassen and Wille. 2023. Nature Ecology and Evolution



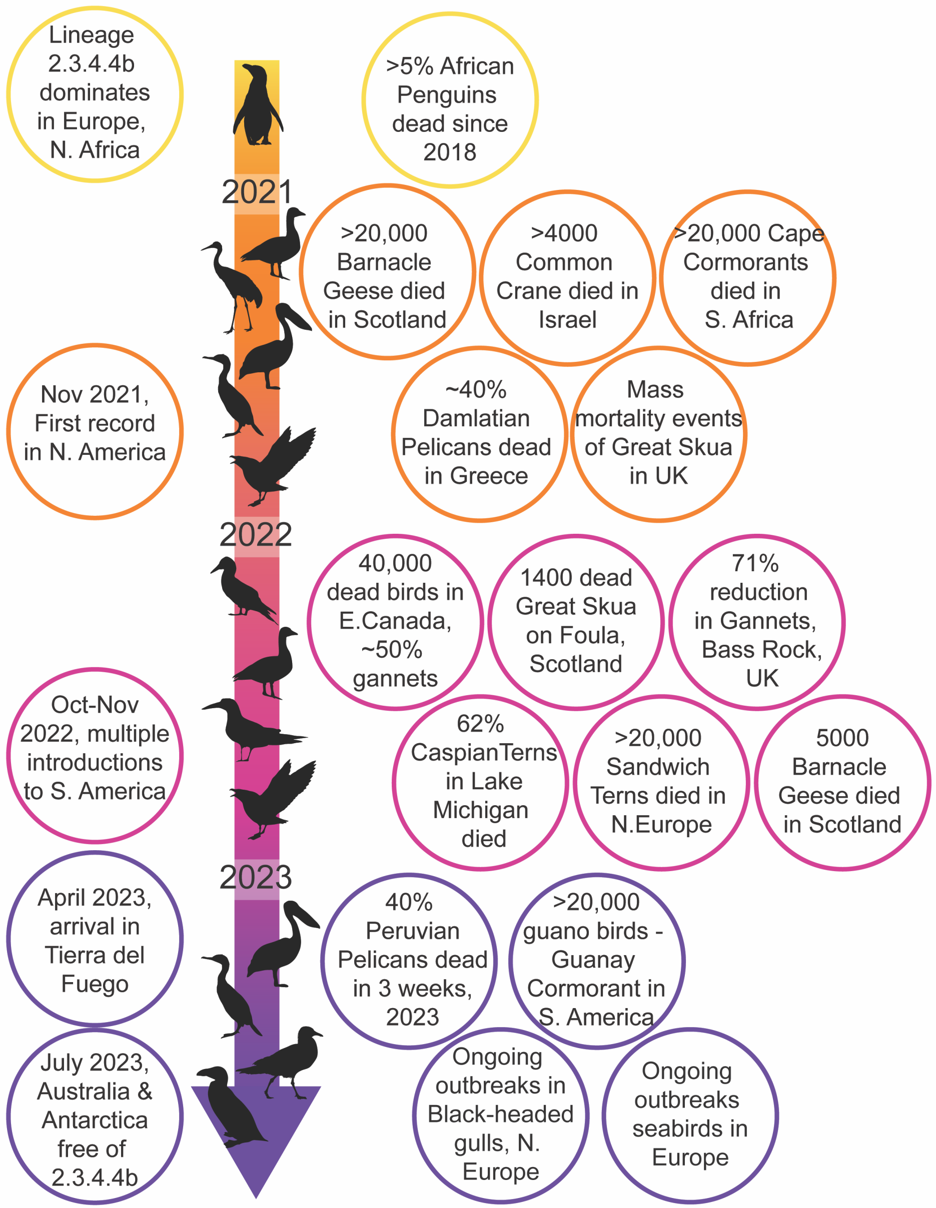
EFSA report, 2023

HPAI outbreaks in seabirds



Number of seabird species identified in WAHIS, June 2023

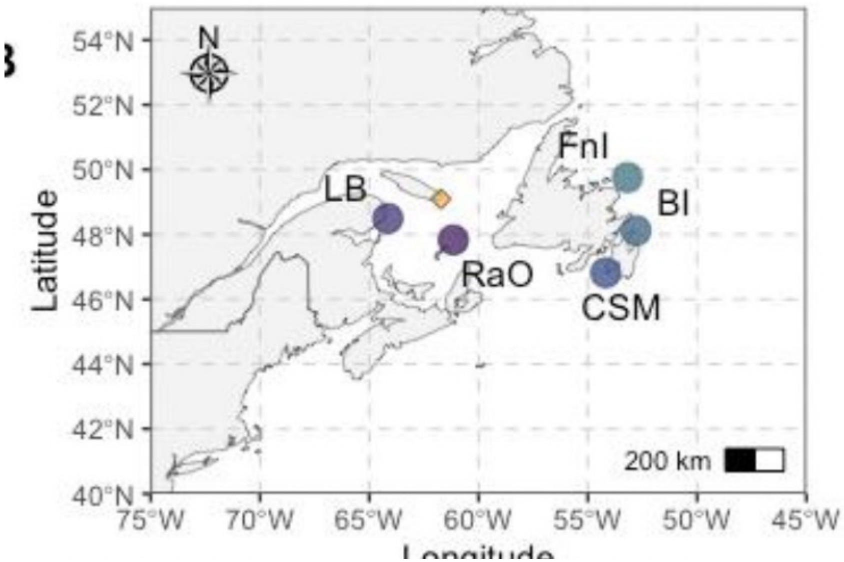
Notable HPAI outbreaks in seabirds

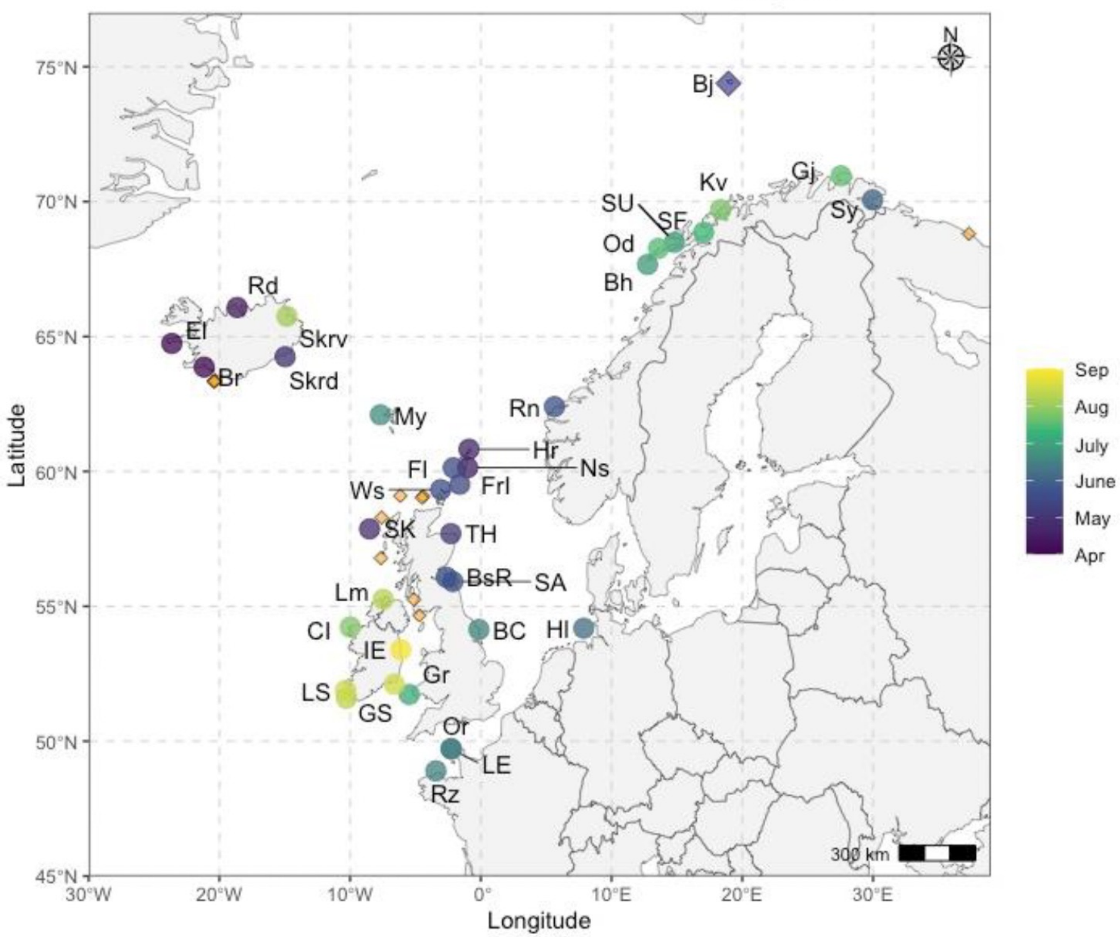


Wille & Waldenström. Under review.

Notable HPAI outbreaks in seabirds

Substantial geographic range in single species, within short periods of time: Northern Gannets

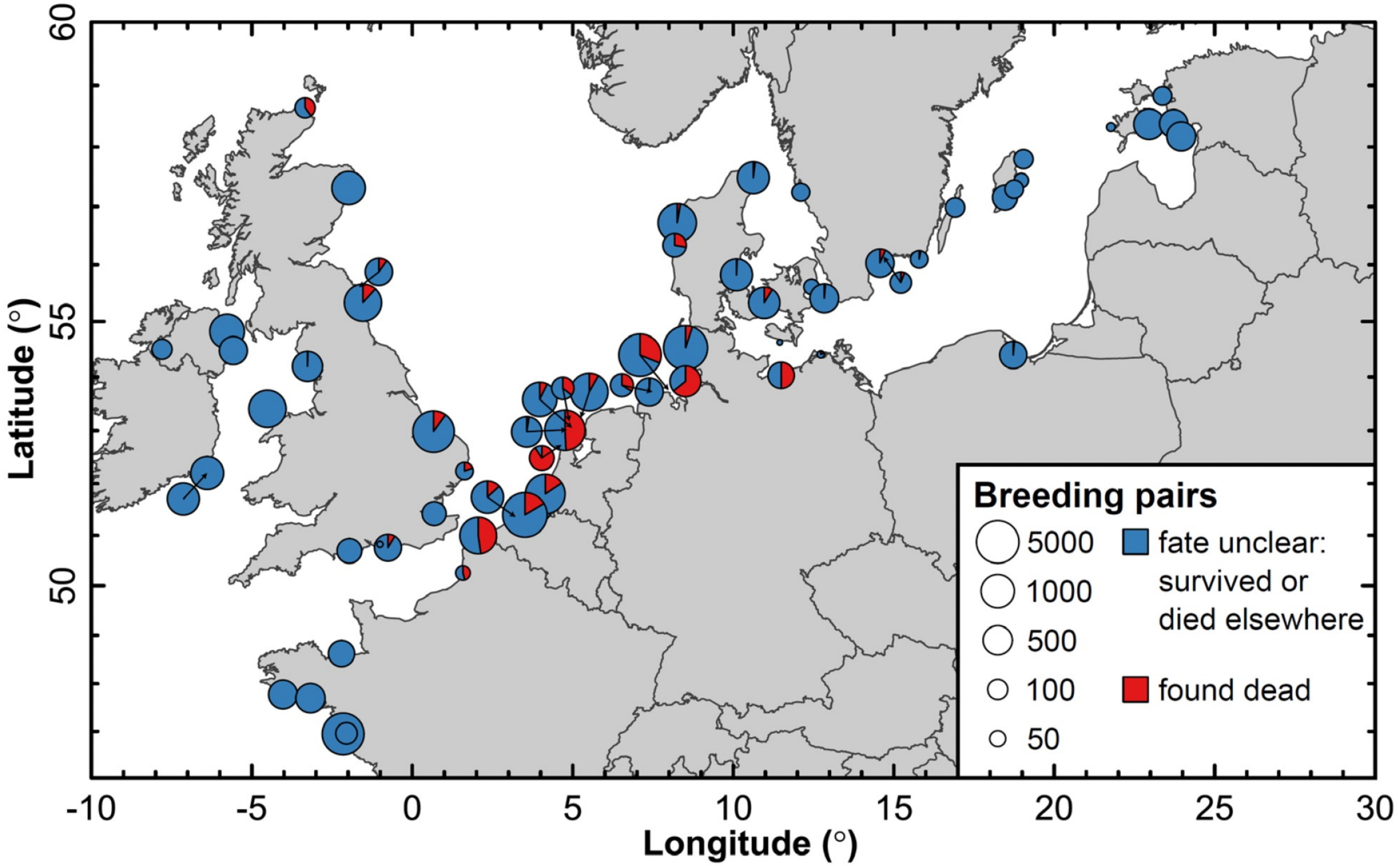




Notable HPAI outbreaks in seabirds

Population level effects: Sandwich Terns

17% of European population of Sandwich Terns died
Almost 100% mortality of chicks in affected colonies



Notable HPAI outbreaks in seabirds

Population level effects: Great Skuas

Foula skuas

Notable HPAI outbreaks in seabirds

Gateways to Antarctica: Africa

MW to update
With more recent
examples

"By 17 January 2019, more than 200 penguin carcasses had been retrieved, several sick birds were seen on the island, and more carcasses were reported by tour boats in the surrounding waters."

Molini et al. 2020. Avian influenza H5N8 Outbreak in African Penguins, Namibia, 2019. J. Wildlife Dis

25 Nov 2021

Western Cape avian flu oubreak sees seabird deaths top 21 000

news24 Nicole McCain

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The Cape cormorant species remains the most affected by the avian flu outbreak in the Western Cape.

Supplied

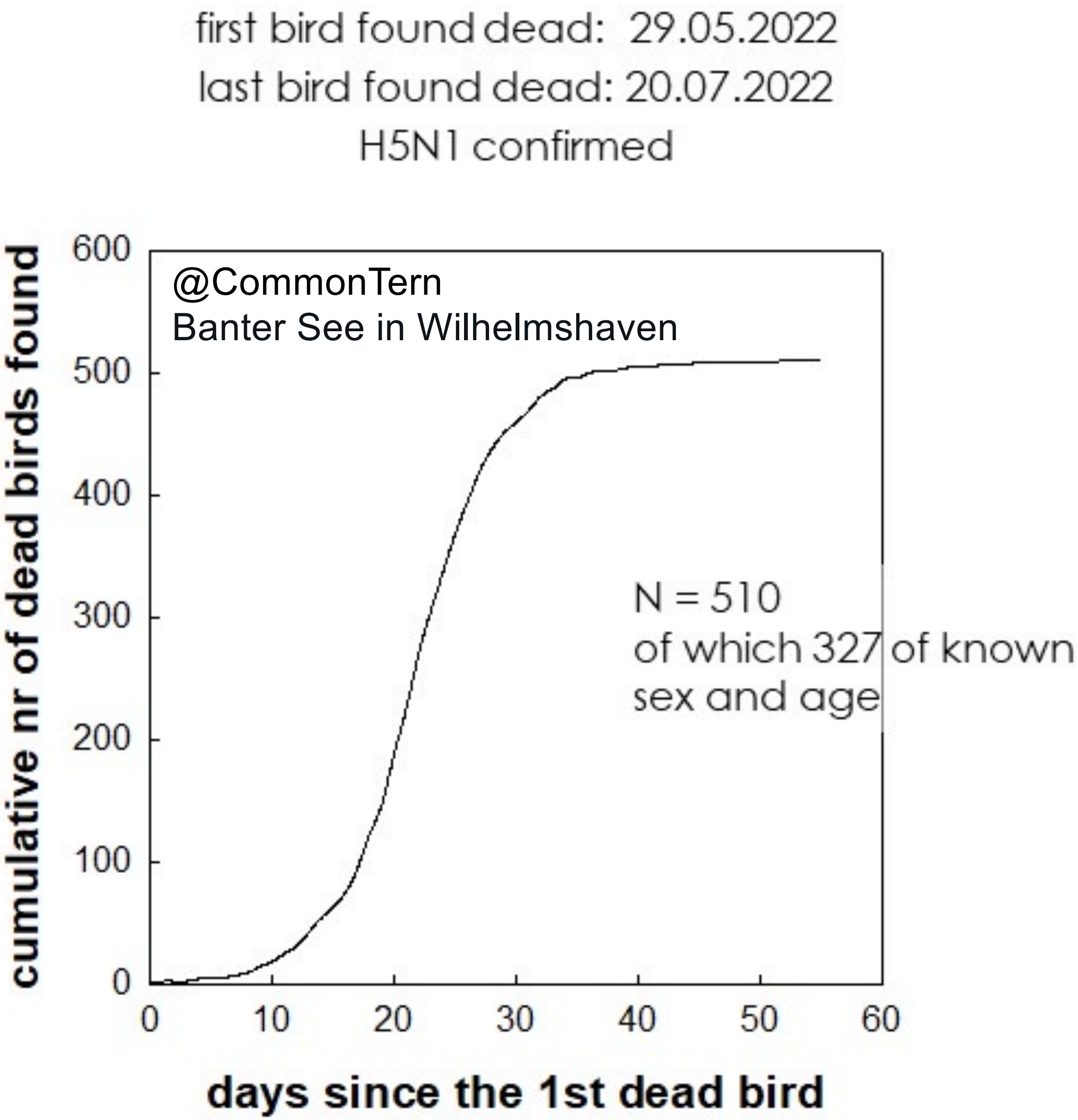
"1,200 deaths in an estimated tern population of 2,000"

Ndumu et al. 2018. Highly pathogenic avian influenza H5N8 clade 2.3.4.4b in Uganda, 2017

Notable HPAI outbreaks in seabirds

South American outbreaks

HPAI disease signs in seabirds



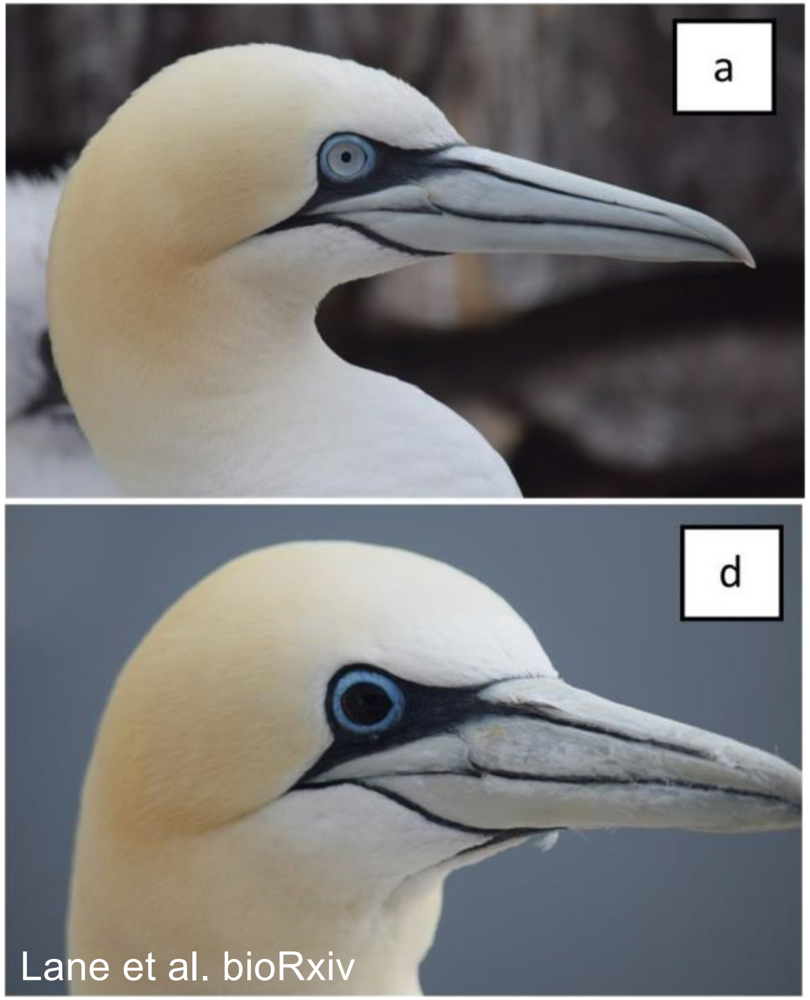
HPAI disease signs in seabirds

Rijks et al. EID

HPAI disease signs in seabirds

SANCOB video of African Penguins.


SANCOB


a
d
Lane et al. bioRxiv

HPAI disease signs in seabirds

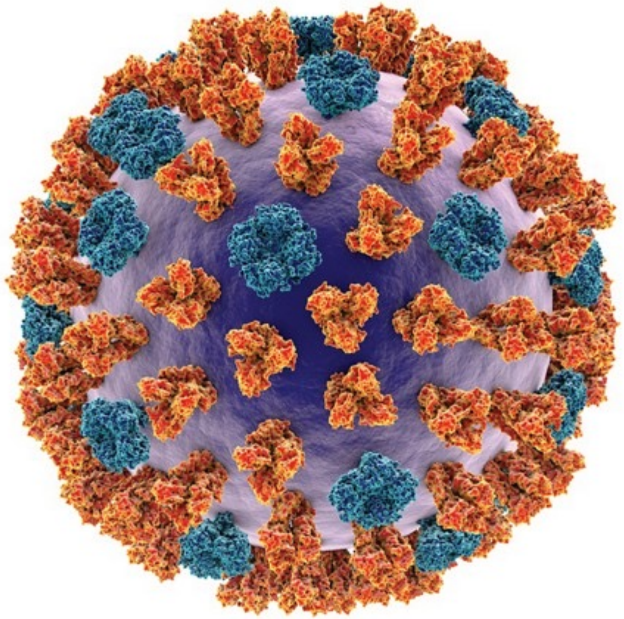
Neurological signs such as loss of coordination and balance, trembling head and body, or twisting of the neck

Lethargy and depression, unresponsiveness, lying down, drooping wings, dragging legs,

Closed and excessively watery eyes, possibly with opaque cornea or darkened iris (new symptom associated with current outbreak),

Respiratory distress such as gaping (mouth breathing), nasal snicking (coughing sound), sneezing, gurgling, or rattling,

Sudden and rapid increase in the number of birds found dead between visits,



HPAI risk in Antarctica

Resources

Avian influenza 101

Lycett et al. 2019. A short history of bird flu. Proc Roy Soc B.

Wille & Barr. 2022. Resurgence of avian influenza virus. Science.

Klaassen and Wille. 2023. Wild bird's plight and role in the current bird flu panzootic. Nature Ecology and Evolution

EFSA 2023. Avian influenza overview, April – June 2023. The EFSA Journal.

Low pathogenic avian influenza in Antarctic seabirds

Lang et al. 2016. Assessing the role of seabirds in the ecology of influenza A virus. Avian Diseases.

Barriga, et al. 2016. Avian influenza virus H5 strain with North American and Eurasian lineage genes in an Antarctic penguin. Emerging Infectious Diseases

De Seixas et al. 2022. H6N8 avian influenza virus in Antarctic seabirds demonstrates connectivity between South America and Antarctica. Transboundary and Emerging Diseases

Hurt et al. 2016. Evidence for the introduction, reassortment, and persistence of diverse influenza A viruses in Antarctica. Journal of Virology

Hurt et al. 2014. Detection of evolutionarily distinct avian influenza A viruses in Antarctica. mBio

Ogrzewalska et al. 2022. Influenza A(H11N2) Virus detection in fecal samples from Adélie (*Pygoscelis adeliae*) and Chinstrap (*Pygoscelis antarcticus*) penguins, Penguin Island, Antarctica. Microbiology Spectrum

Petersen et al. 2017. First detection of avian influenza virus (H4N7) in Giant Petrel monitored by geolocators in the Antarctic region. Marine Biology

Resources

HPAI in seabirds

EFSA report
Klaassen and wille
Wille and Waldenstrom

Notable HPAI outbreaks in seabirds

Abolnik et al. 2018. The incursion and spread of highly pathogenic avian influenza H5N8 clade 2.3.4.4 within South Africa. Avian Diseases

Khomenko et al. 2018. 2016-2018 spread of H5N8 highly pathogenic avian influenza (HPAI) in sub-Saharan Africa. FAO Focus on

Ndumu et al. 2018. Highly pathogenic avian influenza H5N8 clade 2.3.4.4b in Uganda, 2017. Infection Genetics and Evolution

Molini et al. 2020. Avian influenza H5N8 Outbreak in African Penguins, Namibia, 2019. J. Wildlife Dis

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