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# Report about HPAI introduction into Europe, HPAI detection in wild birds and HPAI spread between European holdings in the period 2005-2015

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## Abstract

This report describes information provided by European Member States (MSs) relating to HPAI introduction into Europe, HPAI detection in wild birds and HPAI spread between European holdings. Regarding HPAI introduction into Europe, data were collected for 345 HPAI outbreaks occurring in 13 MSs (2005-2015). These consisted of 159 outbreaks of HPAI H5, 11 outbreaks of HPAI H7 and 175 outbreaks where the H subtype was not reported. Most HPAI H5 outbreaks were reported in 2006-2007 and in 2015; most HPAI H7 outbreaks in 2013; and most HPAI outbreaks of unreported H subtype (but presumably H5) in 2006. Overall, most HPAI H5 outbreaks were reported in 2006 from Romania and Hungary, and in 2015 from France, whereas most HPAI H7 outbreaks were reported in 2013 from Italy. The species affected by HPAI H5 outbreaks were most frequently reported as ducks, mixed ducks and geese, and backyard flocks of undetermined species; those affected by HPAI H7 outbreaks as chickens; and those affected by HPAI of undetermined H subtype (but presumably H5) as backyard flocks of undetermined species. Regarding HPAI detection in wild birds (2005-2015), there were 1055 records for wild birds with HPAI, all of the subtype H5, from 13 EU Member States. These HPAI-infected birds were found in the years 2006-2010 and 2014-2015. The majority of HPAI-H5-positive birds were recorded from Germany in 2006-2007. The wild bird species in which HPAI H5 was most frequently reported were mute swans and black-necked grebes. Other species in which HPAI H5 was frequently reported were mallards, tufted ducks, Canada geese, whooper swans, common buzzards, and great crested grebes. Regarding HPAI spread between European holdings, a selected number of experimental studies were reviewed, involving HPAI H5N2 in chickens, HPAI H7N7 in chickens, turkeys, golden pheasants and ringed teal, HPAI H5N1 in Pekin ducks and chickens.

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**Key words:** H5N1, H7N7, avian influenza, transmission, wild birds, poultry

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## 1. Introduction

### 1.1. Background and Terms of Reference as provided by the requestor

This contract was awarded by EFSA to: Consortium leader Erasmus University Medical Centre (EMC, Rotterdam, the Netherlands).

Contractor/Beneficiary: EFSA

Contract title: Data collection, literature review and spatial models for virus spread in preparation to the mandate on avian influenza

Contract number: OC/EFSA/ALPHA/2015/01

Task 3.1 Review collected data/information provided by Member States and produce a report (report 1) about HPAI introduction into Europe, HPAI detection in wild birds and HPAI spread between European holdings. A report relating to HPAI introduction into Europe, HPAI detection in wild birds and HPAI spread between European holdings is produced in Microsoft Word, mainly through collaboration of partners 1 (EMC) and 3 (Animal Plant and health Agency, APHA). This report includes a description of the whole process of data identification and selection as well as descriptive statistics of the collected data. The amendments to data from original versions to final submission version has been tracked. This report includes results from experimental transmission studies involving HPAI.

## 2. Data and Methodologies

### 2.1. Data

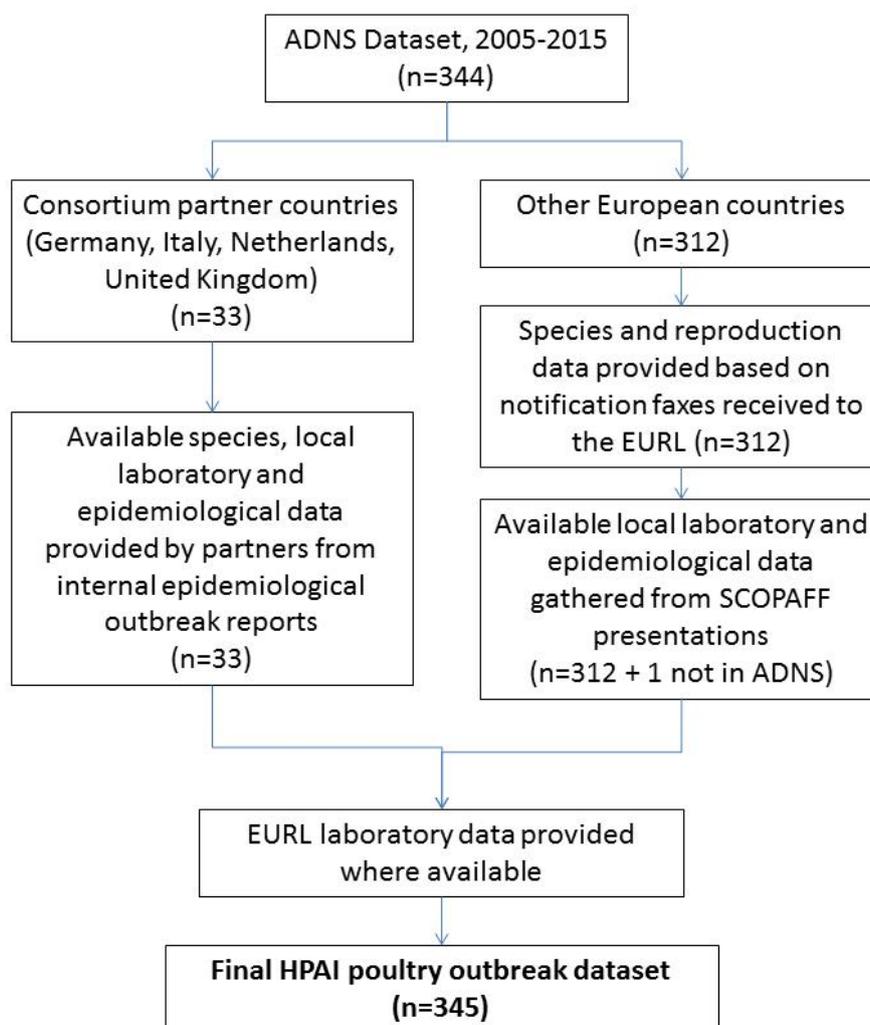
#### 2.1.1. Sources of data for collation of EU AI poultry outbreak data

The following sources of data were used to create a collated dataset of EU AI poultry outbreak data:

1. Entries of notifiable avian influenza reported to the Animal Disease Notification System between 2005 and 2015 were used as the basis of the gathered dataset (Appendix A, fields 1-28).
2. Consortium partners, Germany, Italy, Netherlands and the United Kingdom, added information regarding species (field 34), reproduction type (field 35), local laboratory results (fields 39-44) and epidemiological data (fields 51-83) from internal epidemiological outbreak investigations, where available.
3. For all other Member States, details of the species and reproduction system affected by outbreaks was determined from official notification faxes received to the EURL for Avian Influenza (APHA Weybridge) (fields 34-35).
4. In addition, for all other Member States, local laboratory data (fields 39-44) and epidemiological data (fields 51-83) was gathered from presentations made by Member States to the Standing Committee on the Food Chain and Animal Health (SCoFAH) at the European Commission.
5. Finally, laboratory data for samples handled by the EURL was added to the dataset (fields 45-50), including clades and accession numbers for sequences uploaded to online databases, where available.

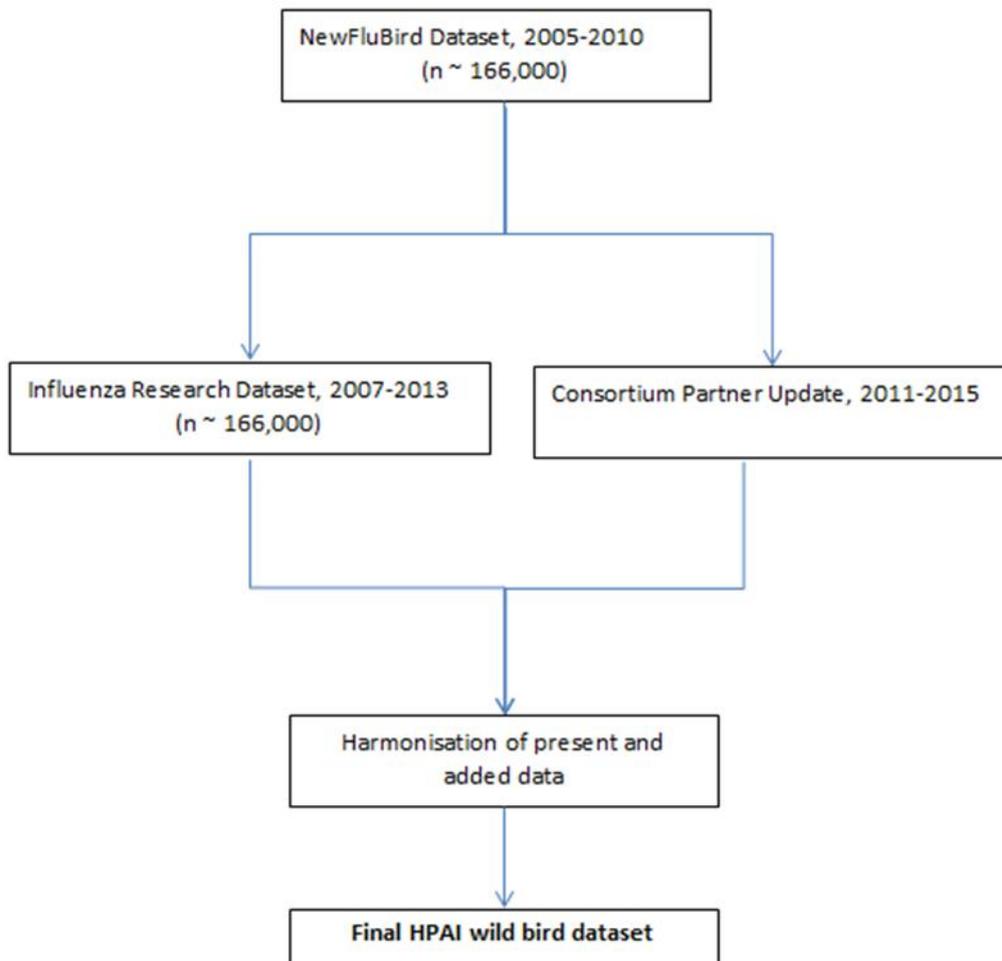
Figure 1 describes the process by which European highly pathogenic avian influenza (HPAI) data was collected for outbreaks occurring between 2005 and 2015. The design of the data model (Appendix A) was agreed with EFSA and five data sources were consulted in order to populate this model with as comprehensive coverage as was reasonably practicable.

**Figure 1: HPAI Poultry Outbreak Data Collection Process**



n = number of outbreaks each data source was consulted for

**Figure 1:** HPAI Poultry Outbreak Data Collection Process for the period 2005-2015



**Figure 2:** HPAI Wild Bird Data Collection process for the period 2005 to 2015. n = number of samples from wild birds.

### 2.1.2. Sources of data for HPAI detection in wild birds

The following sources of data were used to create a collated dataset of HPAI data in wild birds:

1. The basis of the dataset was the NewFluBird database, that contains >166,000 samples collected from wild birds between 2005 and 2010, the vast majority (>90%) of which was provided by participating institutes in this proposal (Germany, Netherlands, Sweden, Italy, United Kingdom).
2. Data were added from the Influenza Research Database (<http://www.fludb.org/>). This database has ~70,000 samples from wild birds in Europe collected between 2007 and 2013.
3. Data up to 2015 were added from consortium partners EMC, Central Veterinary Institute, APHA, Friedrich Loeffler Institute, Istituto Zooprofilattico Sperimentale delle Venezie, and Linnæus University.
4. Added data were harmonized with the data already present.

### 2.1.3. Sources of data for HPAI spread between European holdings

Results from transmission experiments involving HPAI were obtained from published studies selected by the consortium based on their relevance and included in the technical offer, not by a formal literature review.

The data used from experimental transmission studies were those scientific articles listed in the methodology section of the technical offer and listed below in the References section.

## 2.2. Methodologies

### 2.2.1. Poultry data cleaning

The merged poultry dataset was cleaned to facilitate harmonisation between outbreaks. This included ensuring that all country codes, poultry species and reproduction types conformed to a catalogue of entries. In addition, all dates submitted to the additional epidemiological information fields were formatted to follow the YYYYMMDD format requested by the data model.

NUTS 3 and latitude/longitude WGS84 data was added based on decimal/degrees/seconds coordinates submitted to the ADNS system.

The outbreak start date (startY, startM, startD) was populated using the 'firstInfectionDate' provided in ADNS, where available. Where this was not submitted to the ADNS system, the ADNS 'confirmationDate' was used as this is the first known date of infection for that holding.

### 2.2.2. Wild bird data methods

Data were collected on the basis of individual birds. For the purpose of the data collection, wild birds were defined as all birds that are free-living and do not qualify as "poultry" or "captive bird" according to Annex 7 of the Tender Specifications<sup>1</sup>. HPAIV was defined as any H5 or H7 influenza A virus with an IVPI in 6-wk-old chickens > 1.2 and/or a multibasic cleavage site in the haemagglutinin protein. When test results were positive, full or partial subtype information (H5/H7) and links to virus genome sequences were included where available. Avian species were identified by common name and scientific name, e.g., Eurasian wigeon, *Anas penelope*, to the extent possible. However, also lower level of specificity, e.g., Wild bird (not specified), Duck (not specified), Goose (not specified) were allowed, to allow maximum inclusion of surveillance data. Location of sample collection was specified to the maximum detail possible, but as a minimum should include country information. When available, also latitude-longitude and/or NUTS code and/or NUTS region and/or place (nearest village or town) were included. Please see Appendix 2 for fields included in the dataset. After collation and harmonisation of the dataset in the NewFluBird database, an export module was developed to allow transfer to the EFSA of the HPAI positive cases.

### 2.2.3. Review of experimental transmission studies

Values of the following parameters, where available, were extracted from publications of experimental transmission studies: Group size, virus subtype, host species/breed/age, infectious period, transmission rate, clinical signs, mortality, and vaccination status.

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<sup>1</sup> 'poultry' means all birds that are reared or kept in captivity for the production of meat or eggs for consumption, the production of other products, for restocking supplies of game birds or for the purposes of any breeding programme for the production of these categories of birds and 'captive bird' means any bird other than poultry that is kept in captivity for any reason other than those referred to in point 4 including those that are kept for shows, races, exhibitions, competitions, breeding or selling

### 3. Assessment/Results

#### 3.1. HPAI introduction into Europe

Data were collected for 345 HPAI outbreaks occurring in 13 Member States between 2005 and 2015. These consisted of 159 outbreaks of HPAI H5, 11 outbreaks of HPAI H7 and 175 outbreaks where the H subtype was not reported either to the ADNS system, or in the other data sources consulted (Table 1). Most HPAI H5 outbreaks were reported in 2006-2007 and in 2015; most HPAI H7 outbreaks in 2013; and most HPAI outbreaks of unreported H subtype (but presumably H5) in 2006 (Table 2). Overall, most HPAI H5 outbreaks were reported in 2006 from Romania and Hungary, and in 2015 from France (Figure 2), whereas most HPAI H7 outbreaks were reported in 2013 from Italy (Figure 3). The species affected by HPAI H5 outbreaks were most frequently reported as ducks, mixed ducks and geese, and backyard flocks of undetermined species; those affected by HPAI H7 outbreaks as chickens; and those affected by HPAI of undetermined H subtype (but presumably H5) as backyard flocks of undetermined species (Table 3).

A total of 79 HPAI outbreaks in poultry flocks were recorded as 'secondary outbreaks', suggesting onward transmission from one infected premise to another. In 2005, Hungary reported six H5 positive flocks where the disease origin was recorded as infection by contact from neighbouring holding (n=1); unknown (investigation continuing) (n=1); purchase of animals (n=3) and propagated by a transport vehicle (n=1)

In 2006, there were three from the Czech Republic (subtype unknown) with the disease origin reported as infection by contact from a neighbouring holding (n=1), and two as unknown (investigation continuing). Poland reported four (three of which were HPAI H5 positive) and the disease origin was recorded as infection by contact from neighbouring holding (n=2) and unknown (investigation continuing) (n=2). The UK also had one H5 positive although the disease origin was recorded as unknown (investigation continuing).

In 2013, Italy reported four HPAI H7 positive flocks as secondary outbreaks, with disease origin of infection by contact from neighbouring holding (n=1) unknown (investigation continuing) (n=2) or left blank (n=1). In 2014, the Netherlands had one positive flock recorded as a secondary outbreak which was subtype H5 and the disease origin was unknown. In 2015, Germany had one flock recorded as a secondary outbreak (disease origin and subtype unknown) and in France, 59 HPAI H5 positive flocks were recorded as a secondary outbreak (all of which were disease origin unknown).

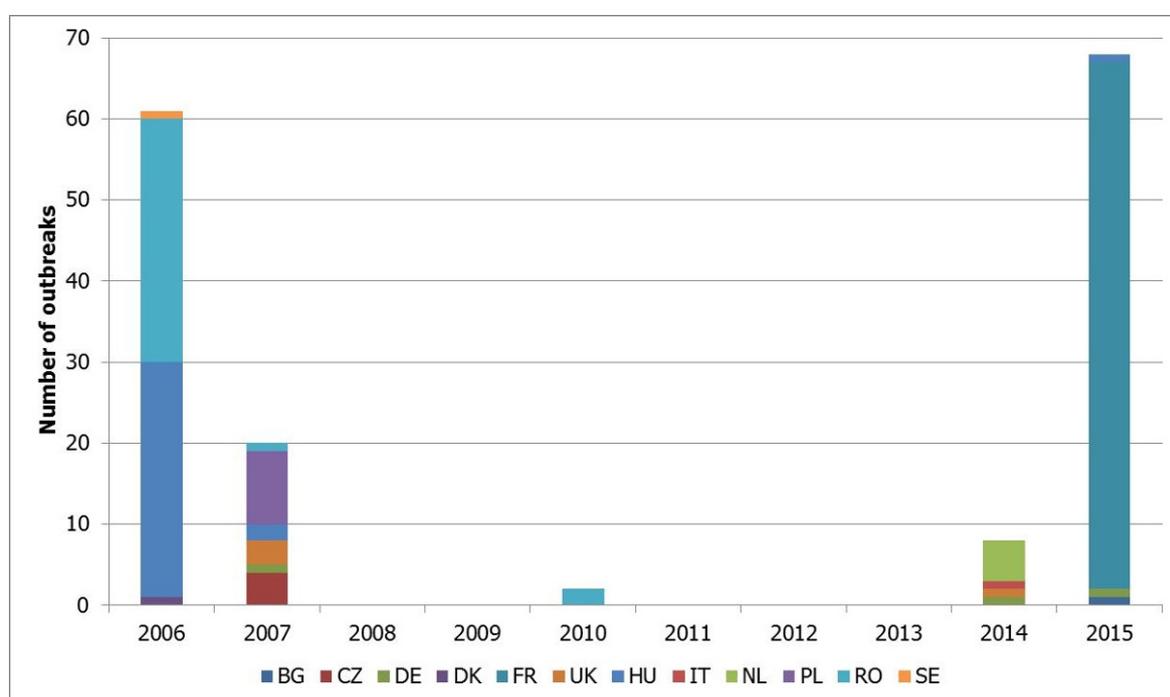
**Table 1:** HPAI outbreaks by Member State and H subtype (where reported)

Member State	H5	H7	H subtype unreported	Total HPAI
Bulgaria	1	-	-	1
Czech Republic	4	-	-	4
Germany	3	1	11 <sup>a</sup>	15
Denmark	1	-	-	1
Spain	-	2	-	2
France	65	-	1 <sup>a</sup>	66
United Kingdom	4	2	-	6
Hungary	32	-	-	32
Italy	1	6	-	7
Netherlands	5	-	-	5
Poland	9	-	-	9
Romania	33	-	163 <sup>a</sup>	196
Sweden	1	-	-	1
<b>Total</b>	<b>159</b>	<b>11</b>	<b>175</b>	<b>345</b>

(a): Assumed to be HPAI H5.

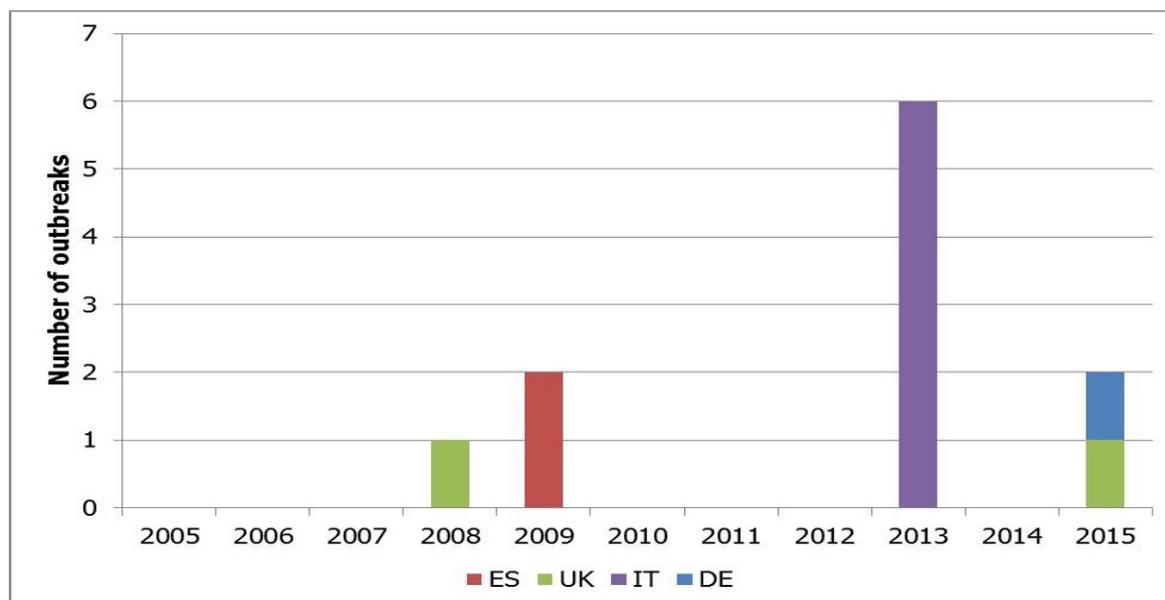
**Table 2:** HPAI outbreaks by year and H subtype (where reported)

Year	H5	H7	H subtype unreported	Total HPAI
2005	-	-	21	21
2006	61	-	144	205
2007	20	-	5	25
2008	-	1	1	2
2009	-	2	-	2
2010	2	-	-	2
2013	-	6	-	6
2014	8	-	2	10
2015	68	2	2	72
<b>Total</b>	<b>159</b>	<b>11</b>	<b>175</b>	<b>345</b>



**Figure 3:** Number of HPAI H5 outbreaks reported on poultry holdings in EU Member States, by year

HPAI data collection 2005-2015



**Figure 4:** Number of HPAI H7 outbreaks reported on poultry holdings in EU Member States, by year

**Table 3:** HPAI outbreaks by species and H subtype (where reported)

Production system	Species	H5	H7	H subtype unreported	Total HPAI	
Backyard	Unknown	39	-	158	197	
Commercial	Ducks	54	-	3	57	
	Ducks and geese	29	-	-	29	
	Chickens	11	10	6	27	
	Turkeys	7	1	3	11	
	Geese	6	-	-	6	
	Chickens and ducks	3	-	-	3	
	Chickens, ducks and geese	2	-	-	2	
	Guinea fowl	2	-	-	2	
	Mixed poultry	2	-	-	2	
	Chickens, ducks and guinea fowl	1	-	-	1	
	Ducks and capons	1	-	-	1	
	Unknown	2	-	5	7	
	<b>Total</b>		<b>159</b>	<b>11</b>	<b>175</b>	<b>345</b>

### 3.2. HPAI detection in wild birds

Between 2005 and 2015, there were 1055 records for wild birds with HPAI, all of the subtype H5, from 12 EU Member States (Table 4). These HPAI-infected birds were found in the years 2006-2010 and 2014-2015 (Table 5). The majority of HPAI-H5-positive birds were recorded from Germany in 2006-2007 (Figure 4). The wild bird species in which HPAI H5 was most frequently reported were mute swans (*Cygnus olor*) and black-necked grebes (*Podiceps nigricollis*) (Table 6). Other species in which HPAI H5 was frequently reported were mallards (*Anas platyrhynchos*), tufted ducks (*Aythya fuligula*), Canada geese (*Branta canadensis*), whooper swans (*Cygnus cygnus*), common buzzards (*Buteo buteo*), and great crested grebes (*Podiceps cristatus*) (Table 6).

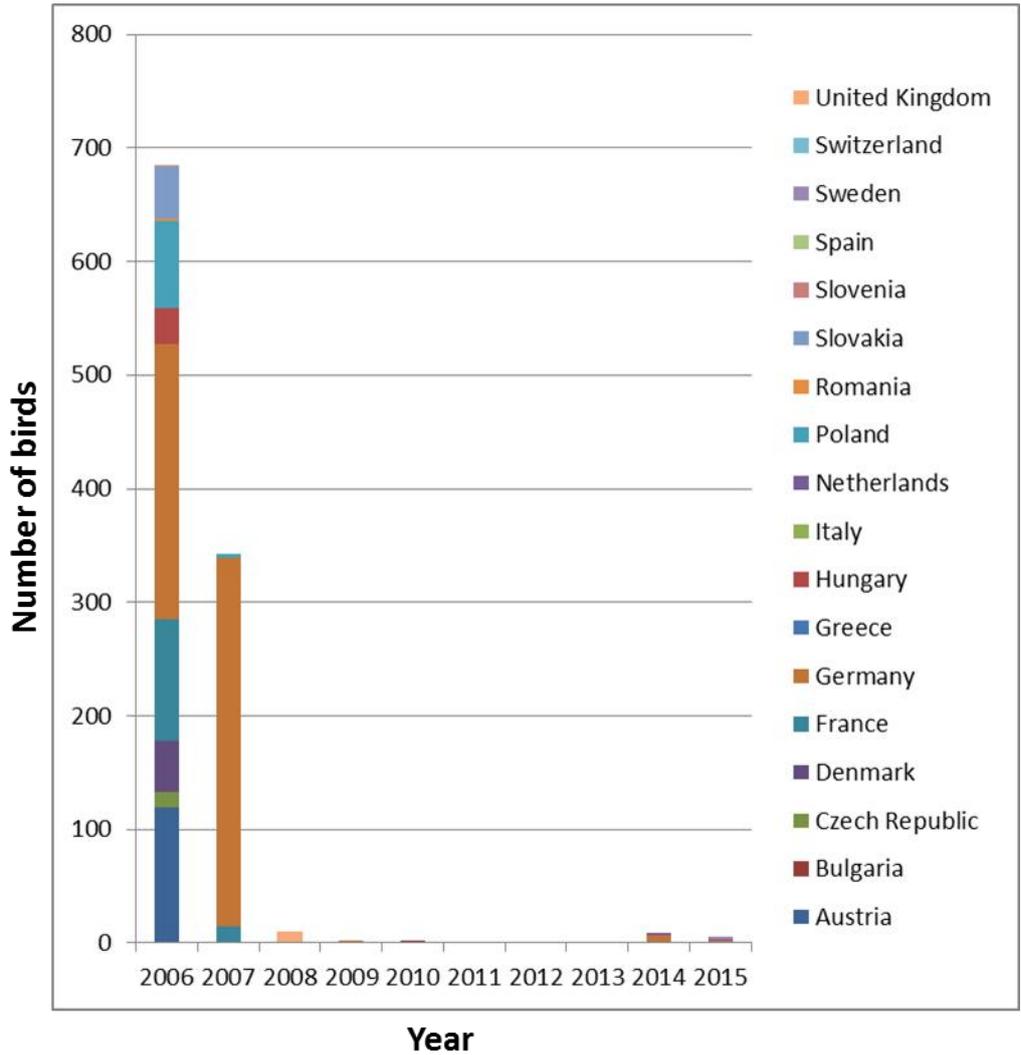
**Table 4:** HPAI detections in wild birds by Member State and H subtype, 2005-2015

Member State	HPAI H5
Austria	119
Bulgaria	2
Czech Republic	15
Denmark	45
France	121
Germany	577
Hungary	32
Netherlands	3
Poland	80
Romania	2
Slovakia	46
United Kingdom	11
<b>Total</b>	<b>1055</b>

**Table 5:** HPAI virus detections by year

Year	HPAI H5
2005	0
2006	685
2007	342
2008	10
2009	2
2010	2
2011	0
2012	0
2013	0
2014	9
2015	5
<b>Total</b>	<b>1055</b>

HPAI data collection 2005-2015



**Figure 5:** Number of HPAI H5 virus detections reported in wild birds by Member State and by year.

## HPAI data collection 2005-2015

Table 6: HPAI H5 virus detections by species

Order	Species		HPAI H5
	Common name	Scientific name	
Anseriformes	Northern pintail	<i>Anas acuta</i>	1
	Gadwall	<i>Anas crecca</i>	1
	Eurasian wigeon	<i>Anas penelope</i>	3
	Mallard	<i>Anas platyrhynchos</i>	39
		<i>Anas sp.</i>	21
	Eurasian pochard	<i>Aythya ferina</i>	6
	Tufted duck	<i>Aythya fuligula</i>	37
		<i>Aythya sp.</i>	3
	Common goldeneye	<i>Bucephala clangula</i>	1
	Smew	<i>Mergellus albellus</i>	1
	Common merganser	<i>Mergus merganser</i>	1
	Red-breasted merganser	<i>Mergus serrator</i>	1
	Muscovy duck	<i>Cairina moschata</i>	1
	Greylag goose	<i>Anser anser</i>	5
	Bean goose	<i>Anser fabalis</i>	1
		<i>Anser sp.</i>	7
	Canada goose	<i>Branta canadensis</i>	15
	Ashy-headed goose	<i>Chloephaga poliocephala</i>	4
	Whooper swan	<i>Cygnus cygnus</i>	76
	Mute swan	<i>Cygnus olor</i>	357
	<i>Cygnus sp.</i>	35	
Charadriiformes	Black-headed gull	<i>Chroicocephalus ridibundus</i>	1
	Herring gull	<i>Larus argentatus</i>	4
	Common gull	<i>Larus canus</i>	1
	Greater black-backed gull	<i>Larus marinus</i>	2
		<i>Larus sp.</i>	7
Ciconiiformes	White stork	<i>Ciconia ciconia</i>	3
Accipitriformes		<i>Accipiter sp.</i>	6
	Common buzzard	<i>Buteo buteo</i>	23
	Rough-legged buzzard	<i>Buteo lagopus</i>	1
	<i>Buteo sp.</i>	3	
Gruiformes	Common coot	<i>Fulica atra</i>	5
Pelecaniformes	Grey heron	<i>Ardea cinerea</i>	5
		<i>Ardea sp.</i>	1
Podicipediformes	Great crested grebe	<i>Podiceps cristatus</i>	44
	Black-necked grebe	<i>Podiceps nigricollis</i>	246
	Little grebe	<i>Tachybaptus ruficollis</i>	2
Passeriformes	Hooded crow	<i>Corvus cornix</i>	1
	Eurasian jay	<i>Garrulus glandarius</i>	1
	Eurasian magpie	<i>Pica pica</i>	1
Falconiformes	Peregrine falcon	<i>Falco peregrinus</i>	3
	Common kestrel	<i>Falco tinnunculus</i>	1
		<i>Falco sp.</i>	1
Suliformes	Great cormorant	<i>Phalacrocorax carbo</i>	4
<b>Total</b>			<b>982</b>

### 3.3. Experimental transmission studies

Experimental studies were performed with HPAI H5N2 in chickens, HPAI H7N7 in chickens, turkeys, golden pheasants and ringed teal, HPAI H5N1 in Pekin ducks and chickens (Appendix C). The main conclusions were:

-HPAI H5N2 in chickens: Previous infection with LPAI H5N2 (A/Chicken/Pennsylvania/83) virus effectively reduces susceptibility of the host to infection and decreases transmission of the corresponding HPAI virus (van der Goot et al., 2003a).

-HPAI H5N2 in chickens: In a model comparing A/Chicken/Pennsylvania/21525/83 (LPAI) and A/Chicken/Pennsylvania/1370/83 (HPAI), the reproduction ratio of the HPAI virus is significantly higher than that of the LPAI (van der Goot et al., 2003b).

-HPAI H7N7 in chickens: Vaccination is able to reduce the transmission level of HPAI A/Chicken/Netherlands/03 H7N7 to such an extent that a major outbreak is prevented, important variables being the type of vaccine (H7N1 or H7N3) and the moment of challenge after vaccination. Two weeks after vaccination, both vaccines completely block transmission. One week after vaccination, the H7N1 vaccine is better than the H7N3 vaccine at reducing the spread of the H7N7 virus (van der Goot et al., 2005).

-HPAI H7N7 in turkeys: Unvaccinated contact turkeys had a mean infectious period of 6.2 days, and an estimated transmission rate parameter of 1.26 per infectious bird per day. No virus shedding was found in inoculated vaccinated turkeys, indicating that vaccination with H7N1 protected against challenge with HPAI H7N7 virus (Bos et al., 2008).

-HPAI H7N7 in golden pheasants and ringed teal: Virus can spread in unvaccinated birds with or without clinical signs, depending on host species. Vaccination reduces clinical signs markedly, but need not always reduce virus transmission (van der Goot et al., 2007c).

-HPAI H5N1 in Pekin ducks: Despite low homology between virus (A/Chicken/China/1204/04) and vaccine strain, virus transmission was significantly reduced two weeks after a single or double vaccination, while mortality and disease rates were reduced markedly already one week after a single vaccination (van der Goot et al., 2007b).

-HPAI H5N1 in chickens: Different inoculation doses did not significantly affect the transmission rate, implying that the quantity of shed virus is not a measure to predict transmission or the infectiousness of chickens (Spekreijse et al., 2011a).

-HPAI H5N1 in chickens: the rate of airborne transmission of A/turkey/Turkey/1/2005 H5N1 between chickens over short distances is low, suggesting that airborne transmission over a long distance is an unlikely route of spread (Spekreijse et al., 2011b)

-HPAI H5N1 in chickens: The rate of indirect transmission of A/turkey/Turkey/1/2005 H5N1 associated with dust was 20-fold lower than the rate of direct transmission between chickens housed in the same cage, suggesting that indirect transmission can occur but is probably less efficient (Spekreijse et al., 2013).

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## Glossary and Abbreviations

### Glossary

**Poultry:** All birds that are reared or kept in captivity for the production of meat or eggs for consumption, the production of other products, for restocking supplies of game birds or for the purposes of any breeding programme for the production of these categories of birds.

**Captive bird:** Any bird other than poultry (see above) that is kept in captivity for any reason other than those referred to for poultry, including those that are kept for shows, races, exhibitions, competitions, breeding or selling.

**Wild bird:** All birds that are free-living and do not qualify as poultry or captive bird (see above).

### Abbreviations

ADNS: Animal Disease Notification System

APHA: Animal and Food Health Agency

EFSA: European Food Safety Authority

EMC: Erasmus University Medical Centre

EURL: European Union Reference Laboratory

H subtype: Haemagglutinin subtype

HPAI: Highly pathogenic avian influenza

LPAI: Low pathogenic avian influenza

NUTS: Nomenclature of Territorial Units for Statistics

SCoFAH: Standing Committee on the Food Chain and Animal Health

## Appendix A – Poultry data model

Field	Element name	Definition	Catalogue	Data source
1	ID	Identification		
2	country	Country reporting the disease notification		ADNS database
3	outbreakYear	Year in which the outbreak was reported		
4	adnsRef	Report reference number, unique to the outbreak year		
5	region	Region or province where the outbreak was reported		
6	outbreakType	Primary or secondary outbreak		
7	pathogenicity	HPAI or LPAI	HPAI/ LPAI	
8	hSubtype	H5 or H7, where available		
9	diseaseOrigin	Origin of the outbreak, if known		
10	relatedOutbreakYear	Year in which a related outbreak occurred, if relevant		
11	relatedAdnsRef	Reference number for related outbreak, if relevant		
12	latitude	Latitude either North (NO) or South (SO), if latitude given		
13	latitudeDecimal	Latitude co-ordinate- decimal figure		
14	latitudeMinute	Latitude co-ordinate- minute figure		
15	latitudeSecond	Latitude co-ordinate- second figure		
16	longitude	Longitude either East (EA) or West (WE), if longitude given		
17	longitudeDecimal	Longitude co-ordinate- decimal figure		
18	longitudeMinute	Longitude co-ordinate- minute figure		
19	longitudeSecond	Longitude co-ordinate- second figure		
20	suspicionDate	Date the suspicion of disease was reported		
21	confirmationDate	Date the disease event was confirmed		
22	firstInfectionDate	Date of first infection in the outbreak		
23	killedDate	Date the animals were slaughtered for control (or date animals died as a result of the infection)		
24	destructionDate	Date the destruction of animals for control was completed		
25	susceptible	Number of susceptible birds present		
26	cases	Number of cases reported		

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Field	Element name	Definition	Catalogue	Data source
27	deaths	Number of deaths reported		
28	destroyed	Number of birds destroyed		
29	depopulated	Number of birds depopulated (both deaths and those destroyed)		
30	countryCode	Country where the holding is located	COUNTRY	Populated according to the country code corresponding to ADNS country data (field 1)
31	NUTScode	Code for region where holding is located using Nomenclature for Territorial Units for Statistics	NUTS (for Europe)	Populated according to the NUTS 3 region relating to the decimal/ minutes/ seconds co-ordinates submitted to the ADNS system (fields 12-14)
32	NUTSregion	Text for region where holding is located using		
33	latitude	Latitude of site where sample was taken in WGS84 format		Populated according to the WGS84 latitude/ longitude data relating to the decimal/ minutes/ seconds co-ordinates submitted to the ADNS system (fields 12-14)
34	longitude	Longitude of site where sample was taken in WGS84 format		
35	species	Name of the species tested for AIV		For consortium outbreaks, details of the species and reproduction type was provided by partners; for outbreaks in other member states, details of the species and reproduction type were determined from official notification faxes received to the EURL for Avian Influenza (APHA Weybridge)
36	reproduction	reproduction for production of eggs, meat, mixed, breeding or other	MEAT/ EGG/ MIXED/ BREED/ OTHER	
37	startY	Year when the outbreak in the holding started		Derived from ADNS first infection date, or confirmation date where no first infection date was provided (fields 21 and 20, respectively)
38	startM	Month when the outbreak in the holding started		
39	startD	Day when the outbreak in the holding started		
40	labID	Identifier for laboratory performing test		For consortium outbreaks, local laboratory details were provided by partners, where available; for outbreaks in other member states, local laboratory details were gathered from presentations made to the European Commission's SCoFCAH, where available
41	tissueType	Type of tissue sampled	Carcass/ Faeces/ Environment	
42	localLabTest	Type of test	PCR/ ELISA/ Virus Isolation/ DFA/ Sequencing	
43	localLabPath	Sample pathotype		
44	localLabSubtype	Sample H and N subtype, i.e. H5N8		
45	nPos	Number of samples testing positive		
46	EURLID	Sample name given by the EURL		Details of EURL sample handling was added to the dataset where samples submitted to the EURL could be matched to an outbreak reported to

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Field	Element name	Definition	Catalogue	Data source
				ADNS
47	EURLLabTest	Diagnostic tests performed by the EURL		Details of EURL sample handling was added to the dataset where samples submitted to the EURL could be matched to an outbreak reported to ADNS
48	EURLClade	Clade of virus, where available		
49	sequenced	Was the virus sequenced	Y/N/U	
50	virusName	Name of the sequence generated		
51	sequenceID	Accession number of the sequence, if uploaded to Genbank or GISAID		
52	symptomatic	Were clinical signs observed on farm (mild respiratory disease, decreased egg production)	Y/N/U	For consortium outbreaks, the additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFAH, where available
53	housing	Describe the housing on the affected farm	Indoor controlled environment/ Indoor open to environment/ outdoor access	
54	deconVehicle	Does the farm operate decontamination procedures for vehicles entering the farm	Y/N/U	
55	deconPeople	Does the farm operate decontamination procedures people entering farm (shoes and clothing)	Y/N/U	
56	protectedFeed	Is the feed on the farm kept under controlled conditions which prevent access by wild birds	Y/N/U	
57	biosecurity	Level of biosecurity on farm	1/2/3/4	
58	travelAsia	Has anyone working on the farm travelled from Asia in the last month	Y/N/U	
59	travelDate	If yes, date of travel in format 20141101		
60	travelCountry	If yes, to which country	COUNTRY	
61	newWorker	Have any new workers joined the farm in the last month	Y/N/U	
62	startDate	If yes, date of the worker started employment in format 20141101		

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Field	Element name	Definition	Catalogue	Data source
63	nationality	If yes, which nationality	COUNTRY	
65	hobbies	Do any of the workers on the farm have hobbies which may result in exposure to wild or tropical birds (e.g. bird watching, breeding or pet birds)	Y/N/U	For consortium outbreaks, the additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFAH, where available
66	workerLinks	Do any of the workers have links to other poultry farms in area	Y/N/U	
67	farmLinks	Are there operational, financial, administrative or community links to other poultry farms (e.g. farm is one of a number of farms operating under a larger holding company)	Y/N/U	
68	importedFeed	Has imported feed or feed ingredients been used on the farm in the last month	Y/N/U	
69	feedDate	If yes, date when feed was used in format 20141101		
70	origin	If yes, country of origin	COUNTRY	
71	productName	If yes, name of feed product		
72	birdToFarm	Have live birds been moved onto the farm in the last month (including pet birds)	Y/N/U	
73	arrivalDateBird	If yes, date when birds arrived in format 20141101		
74	sourceLiveBird	If yes, the country the birds came from	COUNTRY	
75	sourceDetLiveBird	Text for region where the live birds came from	NUTS (for Europe)	
76	eggToFarm	Have bird eggs for hatching been moved onto the farm in the last month	Y/N/U	
77	arrivalDateEgg	If yes, date when the eggs arrived in format 20141101		
78	sourceEgg	If yes, the country the eggs came from	COUNTRY	
79	sourceDetEgg	Text for region where the live eggs came from	NUTS (for Europe)	
80	birdsFromFarm	Have live birds been moved out the farm in the last month	Y/N/U	
81	departDate	If yes, date when birds left the farm in format 20141101		
82	destinLiveBird	If yes, the destination of the live birds	COUNTRY	
83	destinDetLiveBird	Text for region of the destination of the live birds	NUTS (for Europe)	
84	envSamp	Have environmental samples	Y/N/U	For consortium outbreaks, the

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Field	Element name	Definition	Catalogue	Data source
		been taken from the farm (water, feed, manure etc)		additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFCAH, where available
85	envSampType	Type of environmental samples taken on the farm		
86	NenvPos	Number of environmental samples positive for AIV		
87	contactWildBird	Indicate whether it is probable that indirect or direct contact with wild birds occurred, for example observations of large numbers of wild birds around the farm location	Y/N/U	
88	explanation	Describe how contact with wild birds may have occurred, or other route of infection suspected.		
89	oneKmHoldings	Number of holdings within 1km of the outbreak		
90	threeKmHoldings	Number of holdings within 3km of the outbreak		
91	tenKmHoldings	Number of holdings within 10km of the outbreak		

## Appendix B – Wild bird data model

Data export from NewFluBird Database (NFB-DB): Pos.	Field name	Description
1	CountryCode	Country code according to „ISO 3166-1-alpha-2“.
2	Country	Country name.
3	BirdId	Non-ambiguous identifier of each single bird sampled at a unique location and date.
4	Organisation	Short name/key of corresponding organisation which provided the data to the NFB-DB. Possible values can be found on page 2!
5	Area	Area name, if available, for European geographical regions (equivalent to NUTS5). Area codes can be found in <b>NFB_DB_EU_nuts5.dbf</b> .
6	X	Longitude in WGS84 (decimal). If “Area” field has not the value “exact location”, this coordinate was randomly distributed within the spatial unit
7	Y	Latitude in WGS84 (decimal). If “Area” field has not the value “exact location”, this coordinate was randomly distributed within the spatial unit
8	XYInfo	Indicates whether the provided location is geo-referenced or not (e.g. missing information by the data provider).
9	Date	Bird localisation date.
10	SpcWbdb	Bird species WBDB (World Bird Database) code. See <b>NFB-DB_SpeciesList.xls</b> .
11	SpcEuring	Bird species EURING code.
12	SpcSciname	Bird species scientific name.
13	SpcCommonName	Bird species common name.
14	Specimen	Health status of the tested animal.
15	SurvStratification	Bird sampled by active or passive surveillance.

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16	BodyScore	Rough body condition scoring.
17	Age	Age class.
18	Sex	Gender class.
19	Tag	Bird ring number.
20	SampleNr	Incrementing number of sample per bird; serves to implement one-to-many relationship to BirdId.
21	SampleType	Type of sample.
22	Infa	Result of the molecular Influenza-A screening assay (M-PCR).
23	Isolat	Virus isolation.
24	Haema	Hemagglutinin subtyping (molecular test).
25	Neura	Neuraminidase subtyping (molecular test).
26	Patho	Result of the pathotyping (molecular test: cleavage site sequencing in H5 and H7 subtypes).
27	HaemaS	Hemagglutinin subtyping (serological test).
28	NeuraS	Neuraminidase subtyping (serological test).
29	Remarks	Remarks / Comments about laboratory results etc.

### Appendix C – Results from 11 experimental transmission studies listed in References

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status	
<b>Bos et al, 2008 (#2)</b>	Group 0: 1-20	HPAI H7N7	Sixty-four 12-week old turkeys	6.2d	1.26 per infectious bird per day	20/20 showed symptoms of illness	Unvaccinated	
	Group 1:21-40					No positive swabs over multiple days	None observed in inoculated vaccinated turkeys. 1/10 showed illness	Vaccinated once (H7N1)
	Group 2: 41-60					No positive swabs over multiple days	None observed in inoculated vaccinated turkeys	Vaccinated twice (H7N1)
<b>Van der Goot et al 2007b (#3)</b>	a (n=10)	HPAI H7N7	Pheasants	12.2 (7.7-16.7)	2.8 (1.4-5.5)	Severe signs of illness and dead (8) (inoculated)	Unvaccinated	
						Severe signs of illness and dead (4) (contact)		
	b (n=10)		Teals	10.4 (7.6-13.2)	>2.7	Conjunctivitis (2) (inoculated) Conjunctivitis (2) (contact)	Unvaccinated	

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
	c (n=10)		Pheasants	13.3 (9.6-16.9)	1.0 (0.4-2.5)	Sneezing (2) (inoculated) Conjunctivitis (2) (contact)	Vaccinated
	d (n=10)		Teals	na	<0.5	No symptoms (10) (inoculated) No symptoms (10) (contact)	Vaccinated
<b>Spekreijse et al. 2011a (#4)</b>	Inoculation dose [log10 EID50]	HPAI H5N1	Chickens			58/176 died (all AI symptoms) 55/58 had one or more qRRT-PCR result	
	2			1.5 (0-7.8)	1.7 (0.1-19.3)		
	2.5			1	2.2 (0.1-44.4)		
	3			1.3 (0.8-1.7)	0.9 (0.1-10.0)		
	3.5			2.8 (0.6-5)	2.0 (0.3-14.0)		
	4			1.4 (1-1.7)	1.6 (0.2-11.0)		

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
	5			1.8 (1.2-2.4)	2.7 (1.2-5.9)		
<b>Gonzales et al, 2012 (#5)</b>	a	H7N7	Lohmann brown layer breed (LB)	8.0 (7.0-8.9)	0.16 (0.06-0.32)	14/15 infected/inoculated	
	b	H7N7	Lohmann white layer breed (LSL)	6.8 (5.8-7.7)	0.04 (0.01-0.14)	14/15	
	c	H5N7	LB	1 (1.0-4.0)		3/10	
	d	H5N7	LSL	1.0-2.0		2/10	
<b>Spekreijse et al, 2011b (#6)</b>	Experiment 1	HPAI H5N1	Chickens	1.3 (1.2-1.5)		13/16 died	
	Experiment 2	HPAI H5N1	Chickens	1.6 (1.4-1.7)		56/56 died	

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
<b>Van der Goot et al, 2007b (#7)</b>		HPAI H5N1	Peking ducks	4.3 (3.8-4.8)	4.7 (2.3-9.4)		Unvaccinated
				3.4 (2.9-3.9)	2.7 (0.87-8.6)		Single vaccination (challenge 1 week)
				5.3 (1.9-4.8)	0.23 (0.09-0.55)		Single vaccination (challenge 2 weeks)
				5 (n=1)	na		Double vaccination (challenge 2 weeks)
<b>Van der Goot et al, 2007a (#8)</b>		HPAI H5N1	Peking ducks		(R=1.5)	All infected	Unvaccinated
	A inoculated (n=5)					2 died, 5 conjunctivitis	Vaccinated
	B contact (24h later)(n=5)					3 conjunctivitis	Vaccinated

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
	C inoculated (n=5)					All infected, 1 conjunctivitis	Vaccinated (challenged 7d post infection)
	D contact (24h later)(n=5)					All infected, 1 conjunctivitis	Vaccinated (challenged 7d post infection)
<b>Van der Goot et al, 2003b) (#9)</b>	Exp 1	LPAI virus	Chickens			0/5 contact animals seroconverted. No sign of illness	
	Exp 2	LPAI				3/5 contact animals seroconverted. No sign of illness	
	Exp 1	HPAI virus				4/5 contact animals seroconverted (1/5 died)	
	Exp 2	HPAI				5/5 contact animals died	
	Specific pathogen free (SPF)					Seronegative and no sign of illness	

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
sentinel animals							
<b>Van der Goot et al, 2003a (#10)</b>	1-4	LPAI H5N2	Chickens			0, 2, 3, 5 (virus isolation, VI) 0, 0, 3, 3 (serology)	
	5-6	HPAI H5N2				5, 5 (VI and serology)	
	7-8	HPAI H5N2				1, 3 (VI); NA (serology)	
<b>Spekreijse et al, 2013 (#11)</b>	1, inoculated	HPAI H5N1	chickens			48/48 infected	
	1 recipient MD8					0/14 infected	
	2 inoculated					35/36 infected	
	2 recipient non-respirable					14/14 infected	

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
	2 recipient respirable						
	3 inoculated dust cloth					30/37 infected	
	3 recipient dust cloth					0/14 infected	
	3 recipient non respirable						
	3 recipient respirable						
	4 inoculated dust cloth					47/47 infected	
	4 recipient dust cloth					14/14 infected	
	4 recipient MD8						
<b>Van der Goot et al,</b>	Unvaccinated	HPAI H7N7		6.3 (3.9-8.7)	33 (n=2)		

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
<b>2005</b>				(n=10)			
	H7N1 (1 week)			1 (n=1)	0.030 (0.01-0.09) n=18		
	H7N3 (1 week)			3.7 (0.7-6.7) (n=6)	0.30 (0.09-0.9) n=12		
	H7N1 (2 weeks)			na	Na		
	H7N3 (2 weeks)			na	na		