INTERNATIONAL ANIMAL HEALTH DIVISION

International Disease Monitoring Unit

Qualitative Risk Assessments

www.defra.gov.uk/animalh/diseases/monitoring/index.htm

Ref: VITT1200/HPAI – outbreaks in the EU and the EU neighbouring countries

Version No.:	1
Date:	30 June 2006

Outbreaks of HPAI H5N1 virus in Europe during 2005/2006

(An overview and commentary)

Working Document

Authors:
Dr Mirzet Sabirovic
Prof John Wilesmith
Simon Hall
Dr Nick Coulson
Fred Landeg

Suggested reference for this publication:

Defra, (2006). Situation Analysis – Outbreaks of HPAI H5N1 virus in Europe during 2005/2006 – An overview and commentary (Authors: Sabirovic, M., Wilesmith, J., Hall, S., Coulson, N., Landeg, F.), International Animal Health Division, 1A Page Street, London, SW1P 4PQ, United Kingdom. Version 1, Released 30 June 2006, pp. 40.

Table of Contents

1 Summary

This document provides an overview of the epidemiology of highly pathogenic avian influenza (HPAI) virus subtype H5N1 in Europe as a preliminary step in improving our understanding of possible future threats of its introduction to Great Britain.

Our understanding of the behaviour of this virus in wild and domestic birds under European conditions has been improved as a result of the active co-ordination by the European Commission of extensive surveillance activities carried out by EU Member States and other countries neighbouring the EU.

This document was discussed at the European Union Standing Committee on the Food Chain and Animal Health (SCoFCAH) in June 2006. We are grateful to all the EU Member States that contributed to improving this document. We have attempted to include all comments that we received on this document. However, we take responsibility for any unintended errors or omissions.

H5N1 has been detected in 13 Member States. Their veterinary services, assisted by the Commission, have been effective in preventing the virus from infecting poultry and, on the few occasions when poultry have become infected, preventing any secondary spread. The epidemiological investigations of these cases has helped to give a preliminary understanding of risk factors.

Our knowledge of the epidemiology of H5N1 in wild birds Europe is limited as it is only a few months since the infection was first detected. Understanding the current epidemiological picture and predicting the future occurrence has limitations and any inferences made therefore have a great degree of uncertainty. However, the available information is clearly of value in starting to improve our ability to assess the risks. The following indicates the key findings and observations to date.

The virus isolates in the EU and the EU neighbouring countries appear to be genetically closely related to the Asian lineage of the virus that has been isolated in China (Qinghai Lake), Russia (Southern Siberia) and Mongolia. They are distinguishable from the apparently chicken-adapted strains infecting domestic poultry in Turkey.

On the basis of the limited information available, it would appear that multiple introductions of the virus in Europe resulting in three genetic groupings may have occurred during the winter 2005. The initial outbreaks were sporadic and occurred at different and distant geographic locations within a relatively short period of time. Subsequent outbreaks peaked in March 2006 and became clustered geographically and temporarily in some EU Member States. These outbreaks may have coincided with wild bird population displacements and their congregation at limited habitats due to exceptional environmental conditions.

On the basis of genetic studies, migratory wild waterfowl may have had a role in the virus introduction and subsequent spread in Europe. The HPAI H5N1 virus was primarily detected in two groups of species of dead wild waterfowl (swans and ducks) that belong to the Order of *Anseriformes*. These species appear to play a greater role in the epidemiology of the virus. This finding is not unexpected as ducks, geese, swans and related web-footed birds are recognised as the primary reservoir hosts for influenza A viruses.

There is growing evidence that the virus has been detected in live and apparently healthy wild waterfowl (i.e. swans and ducks and scavenging birds (i.e. gulls). Given that spring migration of wild waterfowl may have been largely completed, these developments could suggest that the virus may have become established in local wild bird population in some EU Member States. One indication of such development could be further sporadic detections from these Member States, particularly during the forthcoming moulting period when the resident wild waterfowl will congregate in large numbers.

Other wild bird species (e.g. raptors, other wild birds) could be affected with a fatal outcome but appear to play a lesser role in the epidemiology of the virus. However, more systematic studies at various levels (i.e. local, national, international) involving different agencies and interest groups are required to ascertain their role as potential carriers of the virus without showing clinical signs of the disease.

Wild bird migration is a natural phenomenon that cannot be controlled, therefore, the likelihood of the virus introduction to the EU during the forthcoming migration along with other potential pathways would have to be re-assessed taking into account epidemiological developments.

There are a number of aspects of the epidemiology of infection in wild birds which are important in assessing the risks from the coming migration. These include the maintenance of infection in breeding grounds in northern Russia, and, if infection persists, whether infection will be more widespread in this area, particularly the more western parts.

It is unknown at present whether H5N1 infection will persist in wild bird populations throughout the year in Europe in the absence of further introductions. Similarly, if infection does persist, there is uncertainty as to whether infection will extend geographically and/or become established in a wider range of wild bird species. The continued surveillance is crucial in this respect, as is the analysis of the accumulated data from the EU Member States, at least.

The current situation in Europe suggests that extensive surveillance, complemented with appropriate biosecurity measures were an effective way of detecting and preventing the introduction of the virus into commercial poultry operations. However, epidemiological studies are required in the EU Member States in the areas where infection has been found in wild birds to identify the domestic poultry flocks that could be regarded as at risk. This

would provide valuable epidemiological information to support the apparent effectiveness of the biosecurity measures. Obtaining epidemiological evidence on this aspect is particularly important from trade perspectives. It would require further discussions on the existing standards to ensure minimum disruptions to trade in commercial poultry while protecting animal and public health.

The identification and understanding of the risk factors for the various species of farmed poultry, kept under the range of management systems used in the EU countries is also important, as should infection become established in wild birds there are no acceptable means of control in such free living populations. Preventing the transfer of infection to domestic poultry, which if it occurred would increase the risk for infection of the human population, is therefore paramount.

2 Introduction

This qualitative risk assessment considers developments relating to outbreaks of highly pathogenic avian influenza (HPAI) H5N1 virus in the EU Member States and countries neighbouring the EU.

Unless otherwise stated, this document uses official information received from the European Commission, Brussels, Belgium (Animal Disease Notification System, Weekly Reports, CVO Emergency Notifications, SANCO Documents), EU Member States, EU neighbour countries and the World Organisation for Animal Health, Paris, France (http://www.oie.int/eng/info/hebdo/A_INFO.HTM).

Maps and figures were produced by Defra's IAHD International Animal Disease Monitoring and Risk Assessment Team (Fiona Lock and Lynn Raw). We emphasise that the maps and graphs contained in sections 4.1.2.2.1 to 4.1.2.2.13 only represent the data collected from reports provided by the affected EU Member States from January 2006 to 20 April 2006. It should be noted that some EU Member States have reported further cases, which have not been covered by this document, so some data presented in the maps and graphs in this document may not be up to date. Therefore, in some instances, these are highlighted in blue.

3 Hazard identification

3.1 Hazards to be considered

The virus has been primarily reported in dead wild birds that have been collected where die-offs of waterfowl have been reported in the EU. With regard to other free living avian species, natural infection has also been detected in birds of prey and scavenging birds. There have been no reports of the detection of the virus in free-living pigeons in the EU.

The virus has also caused four outbreaks in domestic birds: a commercial poultry operation in France (a turkey farm), in Germany (a mixed free range poultry operation), in a non-commercial (backyard) poultry flock in Sweden and in a non-commercial (backyard) poultry flock in Denmark. Breaches of biosecurity were suspected to have contributed to the introduction of the virus to these flocks. **NOTE:** Hungary also reported an outbreak in domestic poultry (ducks, geese) in June 2006.

Infection with the virus in natural conditions has also been reported in a few domestic and feral cats (Germany, Austria), a single Stone Marten (Germany) and a mink in Sweden.

Therefore, the outbreaks of HPAI H5N1 that occurred at the beginning of 2006 in the EU Member States have been identified as a hazard for consideration in

order to determine which epidemiological factors may have contributed to their occurrence.

4 Risk assessment

4.1 Release Assessment

4.1.1 Terms and definitions

For the purpose of the release assessment (Section 4.1) the following definitions will apply:

Term	Definition
HPAI	*"HPNAI viruses have an IVPI in 6-week-old chickens greater than 1.2 or, as an alternative, cause at least 75% mortality in 4-to 8-week-old chickens infected intravenously. H5 and H7 viruses which do not have an IVPI of greater than 1.2 or cause less than 75% mortality in an intravenous lethality test should be sequenced to determine whether multiple basic amino acids are present at the cleavage site of the haemagglutinin molecule (HA0); if the amino acid motif is similar to that observed for other HPNAI isolates, the isolate being tested should be considered as HPNAI"* (OIE, 2005)

For the purpose of the release assessment (Section 4.1) the following terminology* will apply (OIE, 2004):

Term	Definition
Likelihood	Probability; the state or fact of being likely
Likely	Probable; such as well might happen or be true; to be reasonably expected
High	Extending above the normal or average level
Highly	In a higher degree
Low	Less than average; coming below the normal level
Negligible	Not worth considering; insignificant
Remote	Slight, faint

*This risk assessment uses the OIE recommended terminology. This is important to maintain consistency in expressing estimates. Defra is aware of some concerns that have been expressed lately about the appropriateness of this terminology for practical purposes (ie. clarity for the purpose of understanding by wider non-technical audience).

For the purpose of the release assessment (Section 4.1) the following definition of host will apply (Thrusfield, 2005):

	Definition
1. Host	An "animal that is capable of being infected with and therefore giving sustenance to an infectious agent. Replication or development of the agent usually occurs in the host
1.1 Reservoir	An animal "in which an infectious agent normally lives and multiplies and therefore is a common source of infection to other animals; thus, it is frequently a primary host"
1.2 Primary (natural)	"An animal that maintains an infection" in a long-term often without clinical signs; thus, it is also called a maintenance host
1.2 Secondary (aberrant)	" An animal that is additionally involved in the life-cycle of an agent"
1.3 Intermediate	"An animal in which an infectious agent undergoes some development"
1.4 Amplifier	"An animal that may suddenly increase the amount of infectious agent"
1.5 Incidental (dead-end or accidental)	" An animal that "does not usually transmit an infectious agent to other animals"

4.1.2 Epidemiological developments

4.1.2.1 EU neighboring countries

At the beginning of 2006 HPAI H5N1 virus was confirmed in dead swans in several geographic locations in eastern Europe (Romania, Bulgaria and Croatia) and village poultry and wild birds in Turkey.

Subsequently, the virus was detected in Albania (wild birds and village poultry), Switzerland (wild ducks), Bosnia and Herzegovina (wild swans) and Serbia and Montenegro (wild birds and village poultry).

4.1.2.2 Affected EU Member States

Using pie-charts for each affected Member State, this section outlines reported total positive detections and percentage of various bird species from which the confirmation of the presence of the virus was made. It also provides a timeline of confirmed outbreaks for each affected EU Member State. The timeline is directly related to a numerical number assigned to an affected administrative area(s) presented in an accompanied map. The document also provides an indicative number of total samples tested for all affected EU Member States as of 20 April 2006.

It is important to note that the total number of samples tested do not make a distinction between the number of samples that have been collected by each Member State as a part of their approved active surveillance programme initiated in the autumn and the number of samples from dead wild birds that have been submitted after the first outbreak has been reported. Therefore, we consider that this total number consists of two sets of data that would have to be carefully considered on its own merits given the primary objective of sampling for surveillance purposes and submissions of dead wild birds.

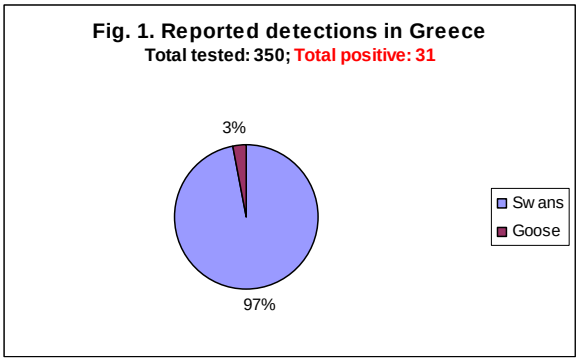
We have not attempted to estimate levels of disease occurrence (i.e. prevalence and incidence) for each Member State or species involved. We do not have reliable data on the numbers of individuals in the population at risk at a specific point in time or data on numbers of healthy individuals in the population at risk at the beginning of the outbreaks for each Member State.

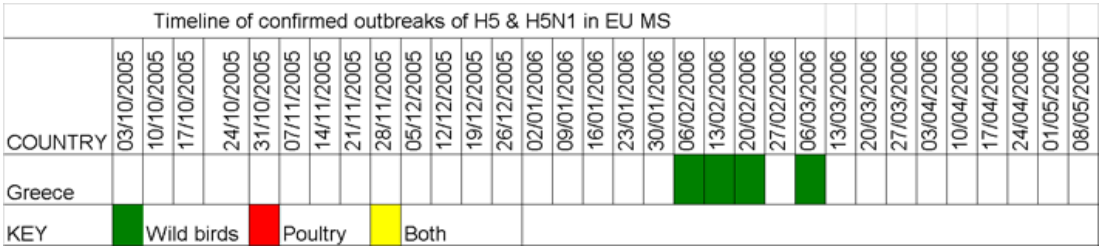
This document provides a basic assessment of the situation by describing when and where the outbreaks occurred in the EU and the species affected in order to determine the potential risk factors associated with the agent, the susceptible host and the environment. The aim is to determine factors for mitigating the likelihood of introducing the virus to the UK and for ensuring appropriate disease prevention and control measures. This document follows a timeline of reported dates when dead birds were detected and submitted for

testing in EU member States. This timeline differs slightly from the timeline of dates when the virus was confirmed in dead birds (see map 1 and map 2 in Section 5.3.1.2) and probably also from the actual introduction of the virus.

4.1.2.2.1 Greece

Greece reported the first detection of highly pathogenic avian influenza (H5N1) virus on 13 February 2006. A few Mute swans (*Cygnus olor*) were found dead on 30 January in two provinces (Thessaloniki and Pieria) in central Macedonia (northern Greece). A red-breasted goose (*Branta ruficollis*) found dead on northern part of the island of Skyros on 3rd February also tested positive for H5N1.





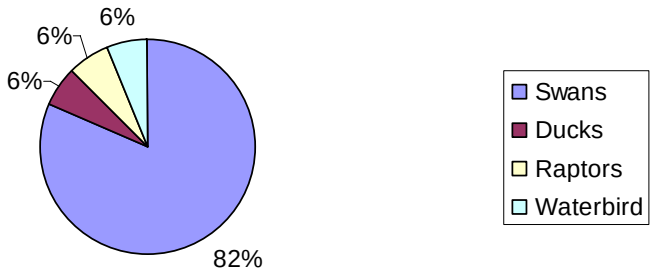
At the end of February and the beginning of March, the virus has also been confirmed in northern Greece in Mute Swans (*Cygnus olor*) found dead in four provinces in Central Macedonia (Thessaloniki, Pieria, Chalkidiki, Pella) and one province in Eastern Macedonia and Thrace (Rodopi). Greece has not reported new cases in wild birds since mid March 2006, despite continuing surveillance. On-going surveillance has not subsequently detected positive findings for the virus in wild birds or domestic poultry.

4.1.2.2.2 Italy

Italy reported the first detection of H5N1 virus in dead Mute swans (*Cygnus olor*) on 11th and 14th February. Dead swans were collected in three provinces in southern Italy (Sicilia, Puglia and Calabria) on 1 February.

At the beginning of March, Italy reported the detection of the virus in a few dead Mute swans in the affected provinces in southern Italy, as well as the province of Umbria. The virus was also reported in dead raptors a Sultan, (*Porphyrio porphyrio)* and a Buzzard, (*Buteo buteo*) in addition to a dead wild mallard duck (*Anas platyrhyncos*).

Fig. 2. Reported detections in Italy
Total tested: 5144; Total positive: 16



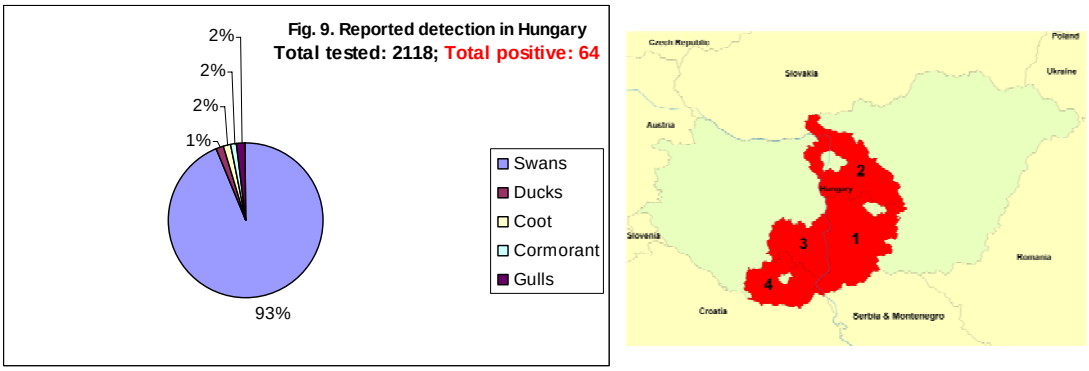
Timeline of confirmed outbreaks of H5 & H5N1 in EU MS

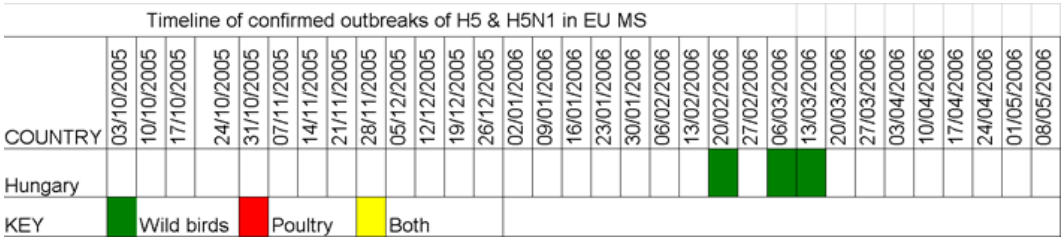
COUNTRY	03/10/2005	10/10/2005	17/10/2005	24/10/2005	31/10/2005	07/11/2005	14/11/2005	21/11/2005	28/11/2005	05/12/2005	12/12/2005	19/12/2005	26/12/2005	02/01/2006	09/01/2006	16/01/2006	23/01/2006	30/01/2006	06/02/2006	13/02/2006	20/02/2006	27/02/2006	06/03/2006	13/03/2006	20/03/2006	27/03/2006	03/04/2006	10/04/2006	17/04/2006	24/04/2006	01/05/2006	08/05/2006
Italy																															
KEY	Wild birds					Poultry				Both																					

Italy has reported no further cases in wild birds since the beginning of March.

4.1.2.2.3 Hungary

On 16 February, Hungary reported that the virus was detected in 5 Mute swans (*Cygnus olor*) found dead at two locations in southern Hungary (Bács-Kiskun county). The birds were collected on 4 February.





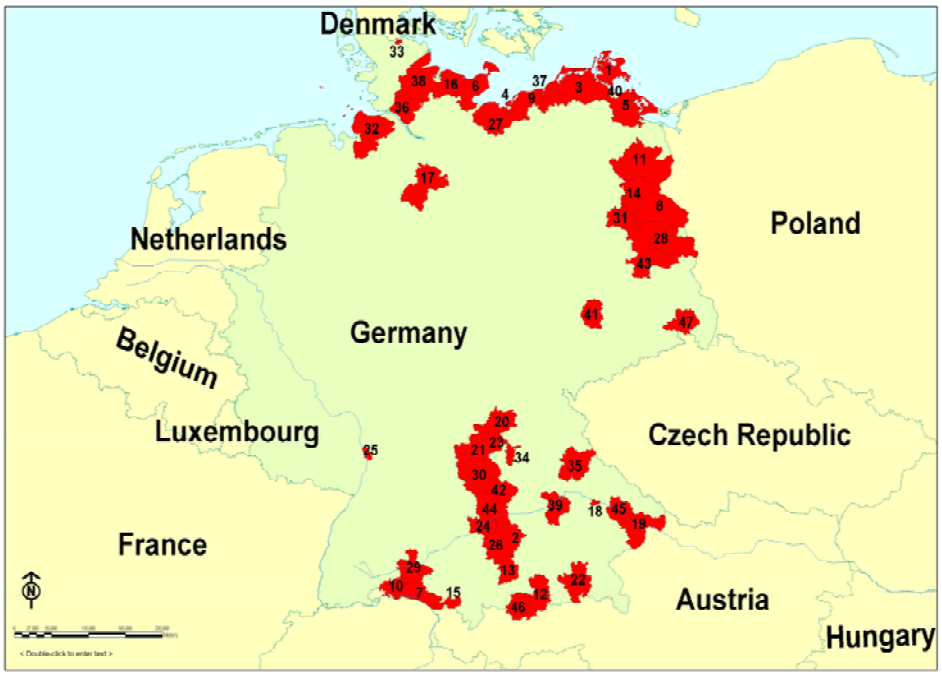
The virus was detected, at a later date, in Mute swans originating from the same area during February. The virus was also detected in a coot (*Fullica atra*); a Mallard (*Anas platyrchynchos*); a cormorant (*Phalacrocorax carbo*) and a black headed gull (*Larus ridibundus*). Virus isolations continued to be made in Mute swans in the affected area during March. No further cases have been reported.

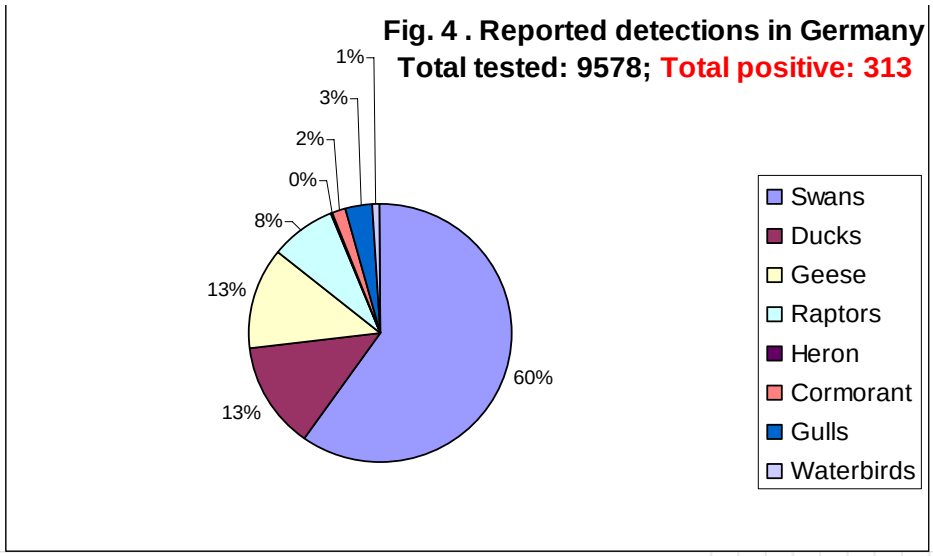
Note: Hungary reported outbreaks in domestic poultry in Bacs Kiskun province. These were first suspected on 3 June and the first flock was stamped out on 7 June. On 10 June there was a secondary outbreak in the same village with 4 contact holdings. The control zones were extended on 12 June. A further outbreak was detected on 16 June, another two on 18 June and 19 June, three on 20 June and another two on 21 June. These outbreaks have affected geese and ducks. This province has a very high density of commercial waterfowl and was where most wild bird cases were detected earlier in 2006. H5N1 was confirmed in the primary outbreak on 16 June.

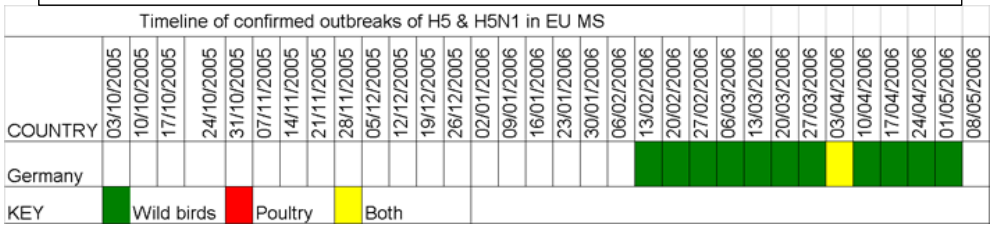
4.1.2.2.4 Germany

Germany reported the detection of H5N1 virus in wild swans found dead at the island of Rügen on the Baltic Sea (northern Germany) on 16 February 2006. The dead swans were collected on 8 February 2006.

Rügen island is located at the north-eastern coast of Germany, close to the border with Poland. During the following months, virus isolations were reported in over 40 districts of north-eastern and south-eastern Germany in different wild bird species. The virus was also detected in a mixed commercial poultry flock at the beginning of April 2006. No further cases were detected in domestic poultry since.





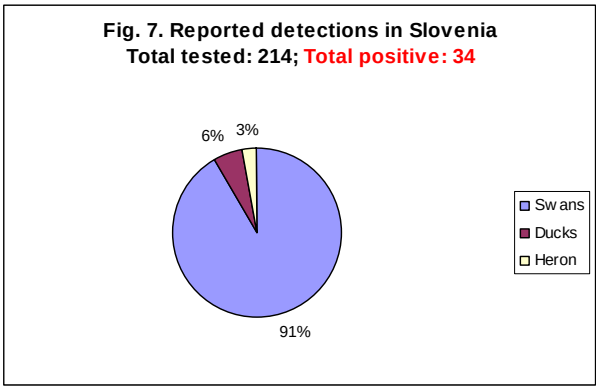


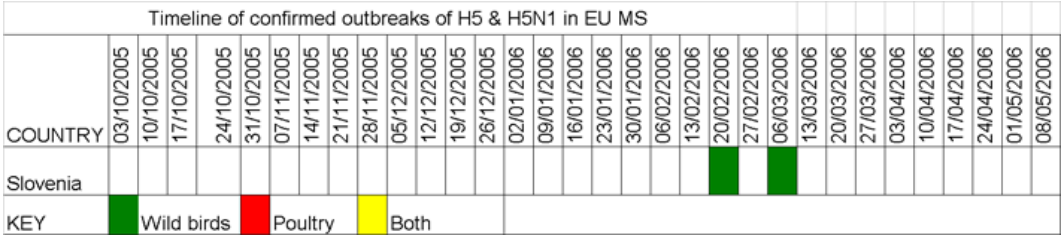
The first confirmed case of H5N1 infection in Europe in domestic cats was in a cat found dead on the coast of the Baltic Sea of the Island of Rügen, North Germany in February 2006. Subsequently, two more affected stray cats and one stone marten have been reported from this area. All affected mammals were found in an area with a high incidence of H5N1 infection in wild birds, where they had access to the carcases of dead, infected wild birds.

NOTE: We understand that total of 337 wild birds tested positive since the event started in February with the last positive result obtained on 12 May 2006.

4.1.2.2.5 Slovenia

On 12 February, the detection of the virus in a dead Mute swan (*Cygnus olor*) was reported in the Podravska region. The swan was collected on 11 February.





By the end of February, the virus was detected in five mute swans (*Cygnus olor*) and one grey heron (*Ardea cinerea*) collected at five locations in the Podravska region.

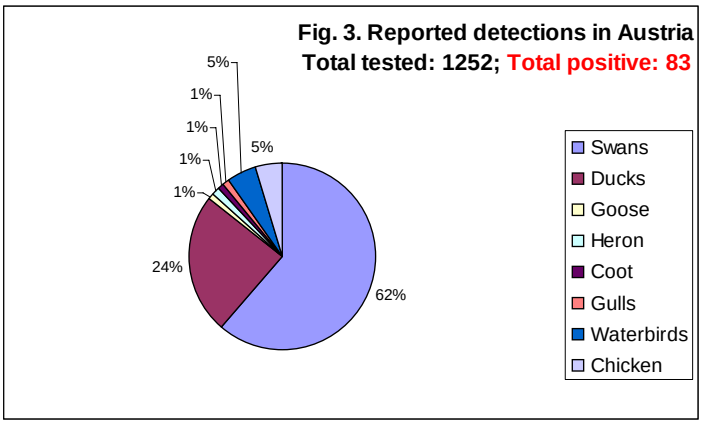
At the beginning of March, the virus was detected in another four mute swans (*Cygnus olor*) in the Podravska region. Isolation of virus was subsequently reported in a northern pintail (*Anas acuta*) and a mute swan (*Cygnus olor*) at the beginning of April.

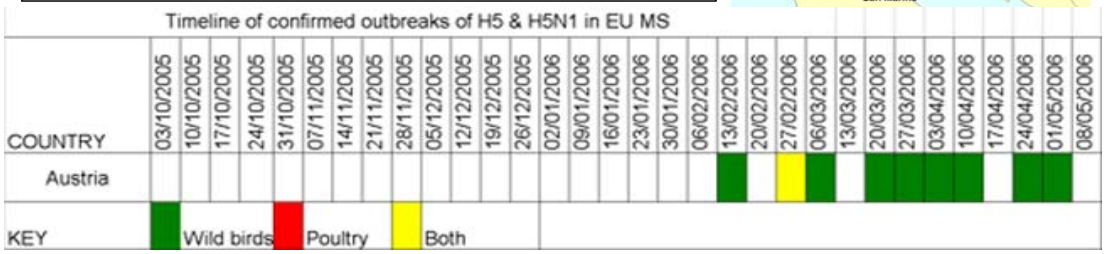
4.1.2.2.6 Austria

Austria reported the detection of the virus in two Mute Swans ((*Cygnus olor)* collected on 13 February. The swans were found at the hydropower station Mellach in southern Austria (Steiermark province). Austria reported positive findings on 14 February 2006.

Subsequently, the virus was detected in a few cats and chicken in this animal shelter which “took in” sick swans.

H5N1 virus has been reported in two cats that have been in a same animal shelter in Austria where a case of the virus infection was reported in a rescued swan which died. Chickens in the same shelter also become infected. All birds (34) in the shelter were culled of which 7 ducks, a goose, 5 chicken and another Mute Swan tested positive for the virus.

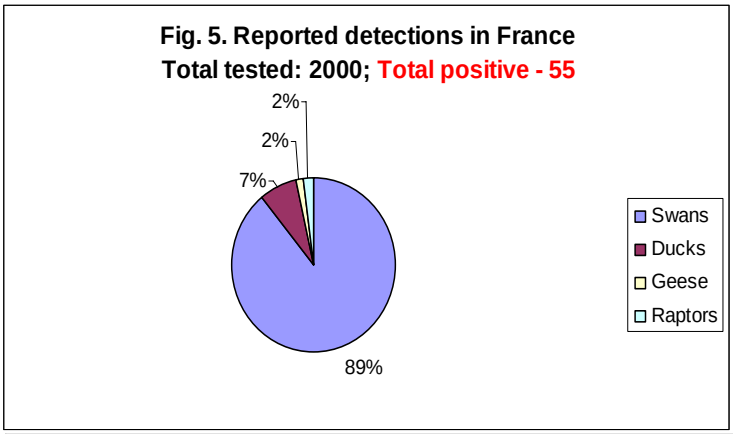


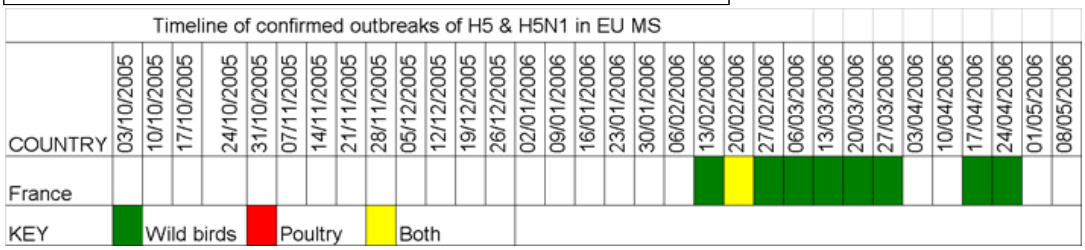


NOTE: We understand that total of 125 positive wild birds have been detected between mid February 2006 and the end of April 2006 when the last case was reported.

4.1.2.2.7 France

The first detection of the virus reported was from a wild duck (Common Pochard - *Aythya ferina*) found dead in the Ain department (eastern France) on 18th and 21st February 2006. The duck was collected on 13 February 2006.





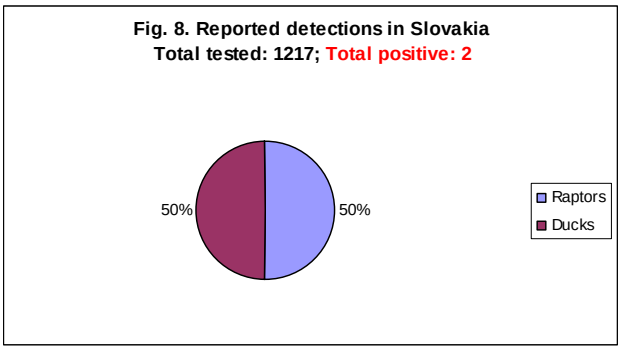
By the end of February, virus isolations were reported from swans, a duck and one heron found dead within the Ain department. The virus was also detected in a commercial turkey flock, which experienced clinical disease, in the Ain department in February, probably as a result of the breach of biosecurity. No further disease incidents in commercial poultry were reported from France

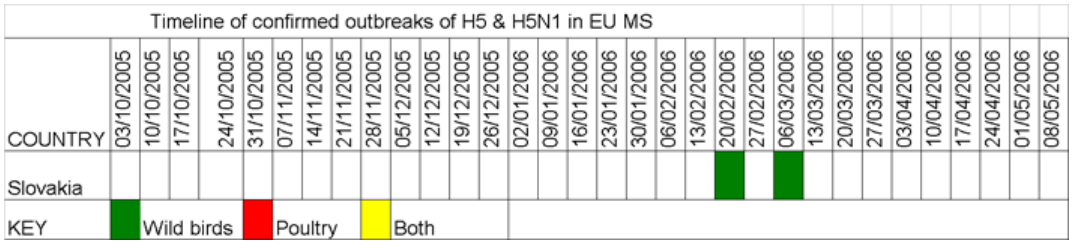
During March, the virus continued to be detected in the Ain department in dead Mute Swans and Whooper swans (Marlieux, Saint-Mitre-les-Remparts, Birieux, Villars les Dombes, Versailleux and Lapeyrouse), a tufted duck (Prévessin-Moëns), a common pochard (*Aythya ferina* - Chanoz Chatenay), a buzzard and a barnacle goose (Saint Marcel en Dombes) and a great crested grebe (Divonne les Bains)

By the end of April, France reported that the virus had been detected in a number of Mute Swans (*Cygnus olor*) found dead at two locations in the Ain Department (Villars Les Dombes, Saint Paul de Varax).

4.1.2.2.8 Slovakia

On 24 February, Slovakia reported the detection of the virus in a dead Smew (*Mergus albellus*) and a Peregrine Falcon (*Falco peregrinus*) (Bratislava and Dunajska Streda districts). The dead birds were collected on 17 February.

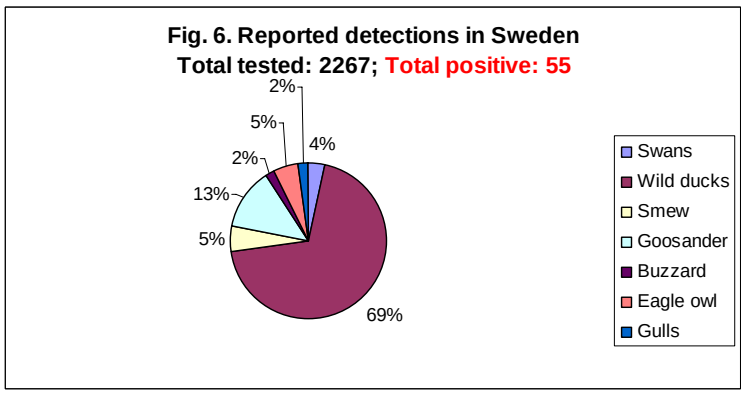


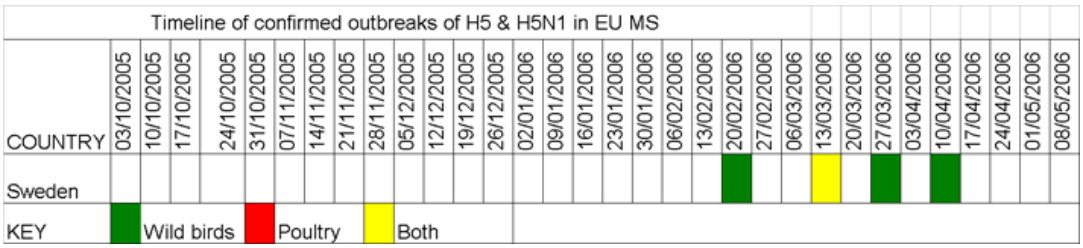


No further cases were reported since February. Slovakia reported that 1217 samples collected from wild birds since 1 January 2006 tested negative.

4.1.2.2.9 Sweden

On 28 February the detection of the virus in two tufted ducks (*Aythya fuligula*) found dead in southern Sweden (county of Kalamar) was reported.





At the beginning of March, the virus was detected simultaneously in a few wild birds (Tufted ducks – *Aythya fuligula*; Goosander – *Mergus merganser*; Scaup duck – *Aythya marila*), one common buzzard *(Buteo buteo*) and one eagle owl (*Bubo bubo*) found dead at different locations in 3 counties (Sodermanland, Blekiga, Gotland). By mid March, the virus was detected in one Mallard duck – *Anas platyrhynchos* (county of Blekinga) and a few Tufted ducks (*Aythya fuligula*) (county of Gotland). By the end of March, the virus was detected in one Smew (*Mergellus albelus*) and one goosander (*Mergus merganser*) (county of Blekinga), one Tufted duck (*Aythya fuligula*) (county of Gotland) and two Mute swans (*Cygnus olor*) (county of Stockholm). During March, the virus was also detected in one wild mink.

On 20 March, Sweden reported that surveillance of 50 mallard ducks and pheasants from a game holding (fenced area) which included game birds (500 farmed mallards, 150 pheasants, 30 pigeons, 10 backyard hens and 2 peafowls, resulted in detection of HPAI virus subtype H5 in one mallard. So far, we are not aware whether this isolate was confirmed as HPAI H5N1. Nevertheless, the restrictions on the affected game holding were lifted on 25 April 2006.

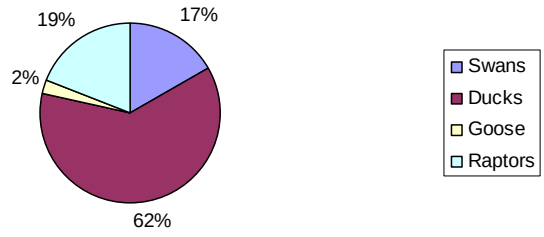
At the beginning of April, the virus was detected in one goosander (*Mergus merganser*) (county of Sodermanland), one herring gull (*Larus argentatus*), one tufted duck (*Aythya fuligula*) and one eagle owl *(Bubo bubo*)(County of Blekinga). By the end of April, the virus was detected in one eagle owl (*Bubo bubo*) (county of Stockholm).

4.1.2.2.10 Poland

On 8 March, Poland reported the detection of the virus in two dead swans (species not stated) in northern Poland (Torunski region). The birds were found dead on 2 March. Further detections were reported from dead swans (species not stated) from Torunski and Gorzowski region and a goosander (*Mergus merganser*) (Swinoujscie region).

By mid March, the virus was detected in two swans (species not stated) found dead in Bydgoski region. By the end of March, further detections were reported in a few dead swans (species not stated) and a hawk (species not stated) from the affected regions, including Grudziadzki region. No further detections have been reported since the beginning of April.

Fig. 10. Reported detection in Poland
Total tested: 1425; Total positive: 61



Timeline of confirmed outbreaks of H5 & H5N1 in EU MS

COUNTRY	03/10/2005	10/10/2005	17/10/2005	24/10/2005	31/10/2005	07/11/2005	14/11/2005	21/11/2005	28/11/2005	05/12/2005	12/12/2005	19/12/2005	26/12/2005	02/01/2006	09/01/2006	16/01/2006	23/01/2006	30/01/2006	06/02/2006	13/02/2006	20/02/2006	27/02/2006	06/03/2006	13/03/2006	20/03/2006	27/03/2006	03/04/2006	10/04/2006	17/04/2006	24/04/2006	01/05/2006	08/05/2006
Poland																															
KEY		Wild birds				Poultry				Both																					

4.1.2.2.11 Denmark

On 14 March, Denmark reported the detection of the virus in a common buzzard (*Buteo buteo*) in southern Denmark (Storstroem county). The bird was found dead on a beach on 12 March.

By mid March, the virus had been detected in 16 tufted ducks (*Aythya fuligula*) on two occasions on the island of Ærø (Funen county). By the end of March, the virus had been detected in a dead Whooper swan (*Cygnus cygnus*) in north-eastern Zealand county, followed by the detection in tufted ducks (*Aythya fuligula*) (southern Zealand county), three tufted ducks in the harbour on the island of Ærø (Funen county), one tufted duck (*Aythya fuligula*) on the island of Falster, a peregrine falcon (*Falco peregrinus*) on the island of Drejø (Funen county), a grelyag goose *(Anser anser*) (south coast of Funen county), two swans and a tufted duck at the lake close to Fåborg (southern part of Funen couty), one common buzzard (*Buteo buteo*) on the island of Lolland and one common buzzard in the southern part of Jutland, one tufted duck on the island of Falster, one tufted duck in Kegnæs (southern Jutland) and one tufted duck in Western Zealand county, a mute swan on the island of Bornholm and a rough-legged buzzard (*Buteo lagopus*) in Frederiksborg county.

At the beginning of April, Denmark reported the detection of the virus in a tufted duck on the iIsland of Lolland (Storstroem county) and a common buzzard (Buteo buteo) in Fåborg (southern part of Funen county), a Whooper swan (Cygnus cygnus) on the island of Lolland, a common buzzard (Buteo buteo) in Funen county and a common buzzard in Storstroem county. No frther cases were reported during April.

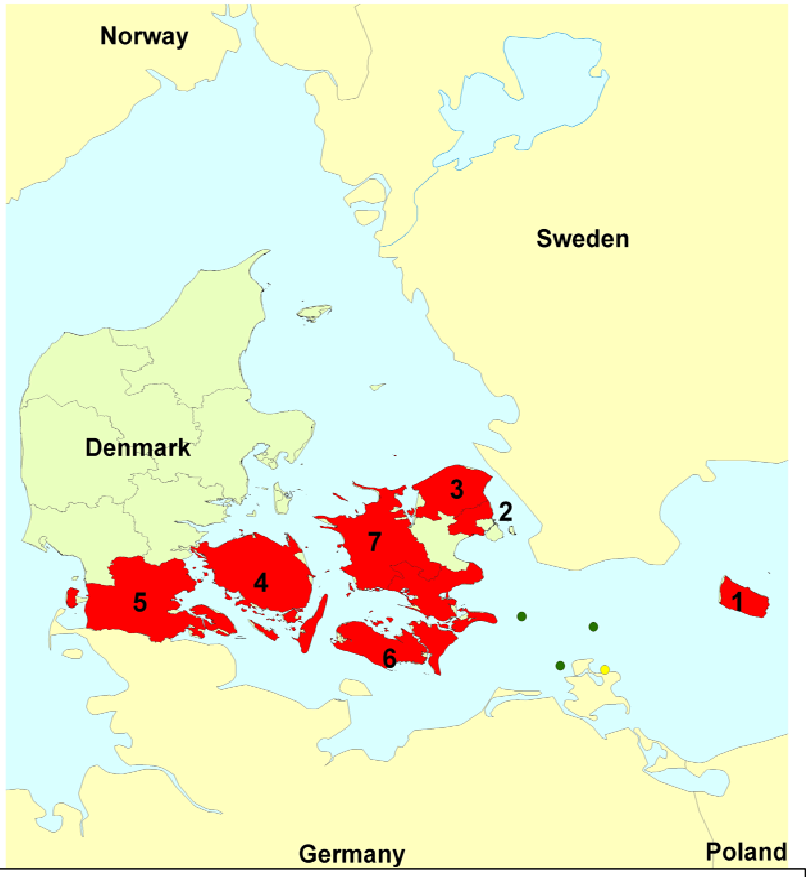
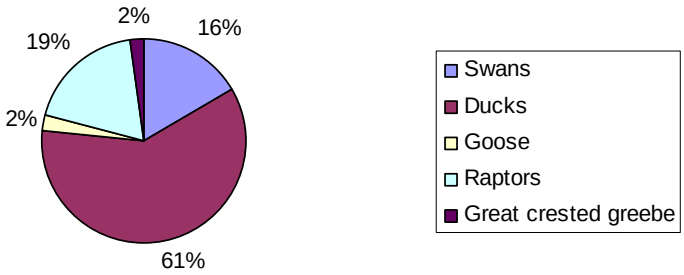


Fig.11. reported detections in Denmark
Total tested: 2790: Total positive: 43



Timeline of confirmed outbreaks of H5 & H5N1 in EU MS

COUNTRY	03/10/2005	10/10/2005	17/10/2005	24/10/2005	31/10/2005	07/11/2005	14/11/2005	21/11/2005	28/11/2005	05/12/2005	12/12/2005	19/12/2005	26/12/2005	02/01/2006	09/01/2006	16/01/2006	23/01/2006	30/01/2006	06/02/2006	13/02/2006	20/02/2006	27/02/2006	06/03/2006	13/03/2006	20/03/2006	27/03/2006	03/04/2006	10/04/2006	17/04/2006	24/04/2006	01/05/2006	08/05/2006
Denmark																															
KEY		Wild birds				Poultry				Both																					

At the end of April, the virus was reported in a great crested grebe (*Podiceps cristatus*) in south Jutland county. Denmark reported no further cases since.

4.1.2.2.12 Czech Republic

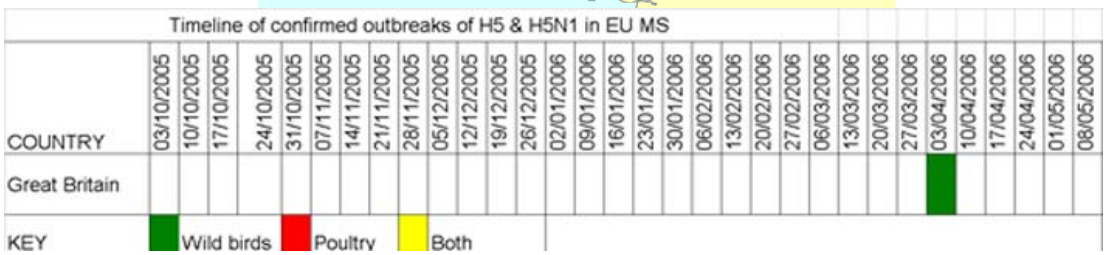
On 27 March, Czech Republic reported the detection of the virus in a mute swan (*Cygnus olor*) in southern Bohemia region. The dead bird was found on 20 March. At the end on March and the beginning of April, further isolations were reported from 11 Mute swans (*Cygnus olor*) at five locations in the same region. No isolations have been reported from other wild birds.

Timeline of confirmed outbreaks of H5 & H5N1 in EU MS

COUNTRY	03/10/2005	10/10/2005	17/10/2005	24/10/2005	31/10/2005	07/11/2005	14/11/2005	21/11/2005	28/11/2005	05/12/2005	12/12/2005	19/12/2005	26/12/2005	02/01/2006	09/01/2006	16/01/2006	23/01/2006	30/01/2006	06/02/2006	13/02/2006	20/02/2006	27/02/2006	06/03/2006	13/03/2006	20/03/2006	27/03/2006	03/04/2006	10/04/2006	17/04/2006	24/04/2006	01/05/2006	08/05/2006
Czech Republic																															
KEY	Wild birds				Poultry				Both																						

4.1.2.2.13 United Kingdom

On 6th April, a dead swan (Whooper swan – *Cygnus Cygnus*), found on the coast in Cellardyke, Fife, Scotland on 30 March 2006 tested positive for H5N1 Virus.



Extensive surveillance in the affected area found no further positive cases.

5 Situation assessment

5.1 H5N1 virus determinants

5.1.1 Genotypes

The European isolates of the Asian H5N1 type of virus could be classified in three distinct but closely related clades (Brown and others, 2006).

5.1.1.1 Virus isolates obtained from wild birds only

This clade contains virus isolates that have very closely related genotypes. It includes the virus isolates from Russian Federation (Novosibirsk region), Germany (the island of Ruegen), Sweden, Denmark and the UK (Scotland). It also contains the virus isolates obtained from wild birds in China (Qinghai lake), Azerbaijan and Ukraine. These wild bird isolates are distinguishable from the isolates that have been classified within the two other clades (see 5.1.1.2 and 5.1.1.3).

5.1.1.2 Virus isolates obtained from wild birds and poultry

This clade contains virus isolates from Romania, Bulgaria, Greece, and Mongolia. These isolates have been circulating between wild birds and poultry infections.

5.1.1.3 Virus isolates obtained from domestic poultry only

This clade includes virus isolates that have been obtained from various village poultry in Turkey and have clearly been circulating in direct poultry-poultry infections.

5.1.2 Virulence and pathogenicity

5.1.2.1 HPAI H5N1

HPAI H5N1 virus isolation has been predominantly from dead wild birds in the EU. The virus has only detected in a relatively small number of live birds.

The Polish authorities reported that 113 live swans had been quarantined in one aviary in the Torunski region on 10 March 2006. At that time, samples were taken from 25 swans and 5 tested positive for H5 virus. One swan in the aviary died and was tested positive for H5N1. On 28 March, tracheal and cloacal swabs and blood samples were taken from the remaining 112 live swans. Thirty-two swans tested positive for H5 virus. The virus was detected in:

a) Tracheal swab (1 swan)
b) Tracheal and cloacal swabs (5 swans)
c) Tracheal swabs and blood samples (4 swans)
d) Cloacal swabs (7 swans)
e) Cloacal swabs and blood samples (6 swans)
f) Tracheal and cloacal swabs and blood samples (9 swans)

This was the first time that the virus has been detected in live wild waterbirds in the EU that have not died as a consequence of infection. Nevertheless, any detailed extrapolation of data related to the virus spread within the flock should be carried out with care. This is because only 25 swans of the112 surviving (from the original 113) swans have been tested. These results can be compared to the 32 positive, in the remaining 112 swans sampled that tested positive 18 days afterwards. It is notable that at least 19 swans may

have been at the viraemic stage at the time of second sampling after 18 days given that the virus was detected in their blood samples (see above). Detection of the virus in tracheal and cloacal swabs suggest that infected swans shed the virus by the respiratory and gastrointestinal routes at the time of sampling. It would be reasonable to assume that the swan density in the quarantine facility was unusually high. While this small study demonstrated the virus transmission between these housed swans, it is epidemiologically important to note that the infected swans did not show any clinical signs. All swans that tested positive have been euthanised on 3 April 2006. The remaining 80 swans that tested negative have been released from the quarantine aviary.

In March 2006, Croatia reported that HPAI H5N1 virus isolated from cloacal swabs of 30 live black-headed gulls (*Larus ridibundus*) that have been sampled as a part of the routine surveillance of wild birds in the southern part of country on the Adriatic coast.

Note: Denmark reported at the end of may that HPAI H5N1 virus was detected in a mixed backyard flock which mainly consisted of domestic ducks. There was no evidence of H5N1 transmission to other poultry holdings.

5.1.2.2 LPAI H5N1 virus

In two instances, low pathogenic avian influenza (LPAI) of H5N1 type was reported from live waterfowl in the EU Member States. Italy has reported the detection of low pathogenic avian influenza (LPAI) virus of H5N1 type. The virus was isolated as a result of the ongoing surveillance programme for avian influenza. The source of the sample was an apparently healthy wild mallard duck shot in the province of Modena (Emilia-Romagna region) during October 2005. Sequencing of the H gene of this virus sample shows a homology at the nucleotide level of 95% to previous H5 low pathogenic strains found in Europe while the homology to the recent 'Asian' H5N1 strain is 91%. These laboratory findings indicated that there is no link between this low pathogenic strain and the highly pathogenic 'Asian' H5N1 strain.

A LPAI H5N1 virus was isolated among several other AI isolates that have been obtained from samples collected from thirty targeted free-range flocks of mule (*Anas platyrynchos* crossed with *Cairina moschata*) ducks in France. The ducks were 4 to 12 weeks of age and showed no clinical signs of the disease. Further testing showed that the N1 gene of the virus was found to be closely related to an Italian LPAI H7N1 (Cherbonnel and others, 2006) but not to the N1gene of the highly pathogenic 'Asian' H5N1 strain.

5.2 Host determinants

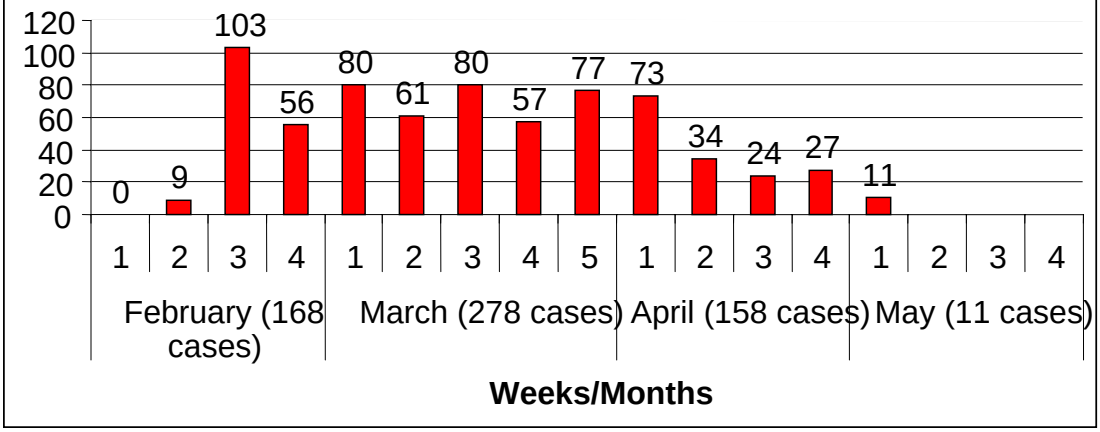
5.2.1 Affected wild bird species

The virus has been detected in 13 EU Member States since the beginning of February 2006. In all affected EU Member States, the virus was detected primarily in dead wild birds. Table 1 provides an outline of the confirmed H5N1 virus in most commonly affected wild bird species in the affected EU Member States since January 2006.

Table 1. Wild bird species reported to be affected in affected EU Member States

	Swans	Ducks	Geese	Gulls	Crested Grebe	Raven	Raptors	Herons	Date of First Report	Date of Last Report
Greece	X		X						01/02/2006	03/03/2006
Italy	X	X					X		21/02/2006	23/02/2006
Hungary	X	X		X					15/02/2006	13/03/2006
Germany	X	X	X	X		X	X	X	17/02/2006	
Slovenia	X	X						X	15/02/2006	10/03/2006
Austria	X	X			X				18/02/2006	on-going
France	X	X	X		X			X	18/02/2006	21/03/2006
Slovakia		X					X		23/02/2006	23/02/2006
Sweden	X	X							28/02/2006	30/03/2006
Poland	X	X					X	X	06/03/2006	
Denmark	X	X	X	X	X		X		16/03/2006	
Czech Rep	X								27/03/2006	07/05/2006
UK	X								31/03/2006	31/03/2006

Fig. 3. HPAI cases in wild birds in the EU MS notified to ADNS from 1 February to 5 May 2006 (Total 615 cases)



For a comprehensive outline of surveillance, prevention and disease management of avian influenza in the EU refer to Pittman (2006).

5.2.1.1 Waterbirds

What appears to be a larger die-off in wild birds was noted in Germany, mainly at the Island of Rügen. However, in other affected parts of Germany, a relatively small number of dead wild birds have been detected. Similarly, no large die-offs in wild birds have been reported from other affected EU Member States, where again, the virus was detected in a relatively small number of dead wild birds.

The virus was primarily detected in dead wild swans (Mute swans – *Cygnus olor* and to a lesser extent in Whooper swans – *Cygnus cygnus*) in eight affected EU Member States (Greece, Italy, Slovenia, Austria, France, Germany, Czech Republic, Hungary) in central and northern EU. The percentage of all positives detected in this species varied between 50% and 99%. The percentage of all positives detected in different species of dead wild ducks varied between 6% and 50%.

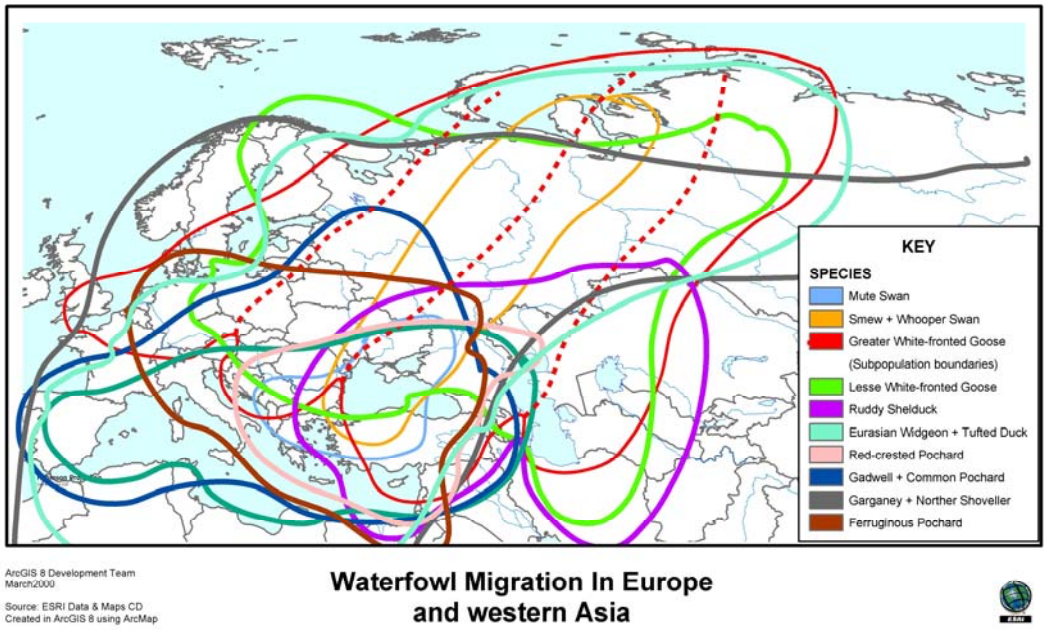
The percentage of all of the isolates was equal (50%) in wild swans and wild ducks in the sample of dead wild birds submitted for testing in one Member State (Slovakia).

The virus was primarily detected in different species of dead wild ducks in three affected EU Member States in the northern EU (Denmark, Sweden and Poland). The percentage of all isolates found in ducks in these countries varied between 61% and 69%. The percentage of all isolates detected in dead wild swans in these three Member States varied between 4% and 17% of the total positive findings in dead wild birds submitted for testing.

In one Member State (UK-Scotland), the virus was detected only in one Whooper swan washed up in a harbour. No further cases have been detected since, despite extensive surveillance in the affected area complemented by ongoing intensive surveillance in the UK.

Our previous risk assessment emphasised that caution is required when generalising trends that may relate to carriage of the HPAI H5N1 virus or any other HPAI virus to different regions or countries by migratory birds because they use different migratory routes (flyways).

NOTE: The map below in this section was prepared by Defra's International Animal Health Division staff and is based on information sourced from Wetlands International (Scott & Rose,1996). It does not necessarily reflect the true situation. The map should be regarded as indicative rather than as a definitive reflection of migratory flyways between Siberia and Europe. Note that this map do not display major flyways between western Europe, Iceland, Greenland and Arctic Canada. The map was produced using ESRI Data and maps CD - 2002.



The map outlines the broad ranges of migratory waterbirds. Within these migratory routes ducks, geese and swans follow mainly north-to-south and northeast-to-southwest directions. The map indicates and highlights the complexity of the migratory pathways.

5.2.1.2 Birds of prey and scavenging birds

Recent events show that the virus has been detected in a number of species of birds of prey or scavenging birds. Presumably, these birds have become infected because of exposure and close contact with a number of dead wild waterfowl available as food.

Although the HPAI H5N1 virus was detected in dead gulls, reports from Croatia indicate that they may be infected without showing clinical signs or die.

5.2.1.3 Free-living pigeons

Free-living pigeons live in contact with people and a variety of species of birds and animals all over the world. No detection of the H5N1 virus has been reported in free-living pigeons in the affected EU Member States. However, the virus was detected in a small number of dead pigeons in Turkey.

5.2.2 Mammals

It has been known for a long time that influenza A viruses can infect a variety of animals, including humans, pigs, horses, sea mammals. In experimental conditions, pigs, ferrets, cats, mink and monkeys had also been infected with influenza viruses originating from avian species (Easterday and others, 1997).

5.2.2.1 Cats

The first confirmed case of H5N1 infection in Europe in a domestic cat was in a cat found dead in the Baltic Sea on the coast of the Island of Rügen, North Germany in February 2006. Two more affected stray cats have been reported so far. These cats were found in an area with an unusually large prevalence of H5N1 infection in dead wild birds. Surveillance within EU Member States so far has not revealed other areas with such a large number of infected birds. These cats were apparently part of an ecological niche of infected waterfowl and predatory species and had access to carcases of dead birds with a high prevalence of H5N1 infection. This is consistent with the findings from Thailand and Cambodia of incidents of infection in big cats (tigers and leopards) and domestic cats in Thailand.

Official reports indicate that cats were also present in the animal shelter in Graz, Vienna, Austria which "took in" dead and dying swans, subsequently resulting in chickens in the shelter becoming infected. All cats (we understand that approximately 70 cats were there) were put in quarantine in Nickelsdorf (Burgenland province). During the on-going investigation, two cats showed a seroconversion and were tested positive for H5N1 antibodies.

5.2.2.2 Stone Marten

HPAI H5N1 infection was confirmed in a Stone Marten (*Martes* spp) that was found in the Rügen area of Germany where three cats were previously confirmed as having H5N1. The Stone Marten was found alive with clinical signs. It was euthanized and submitted for testing.

5.2.2.3 Mink

A mink infected with an H5 virus was found in late March 2006 in the Blekinge region of southern Sweden, where several infected birds have also been found. It was thought to have contracted the virus by consuming infected wild birds, the suspected mode of transmission to felines as well.

5.3 Environmental determinants

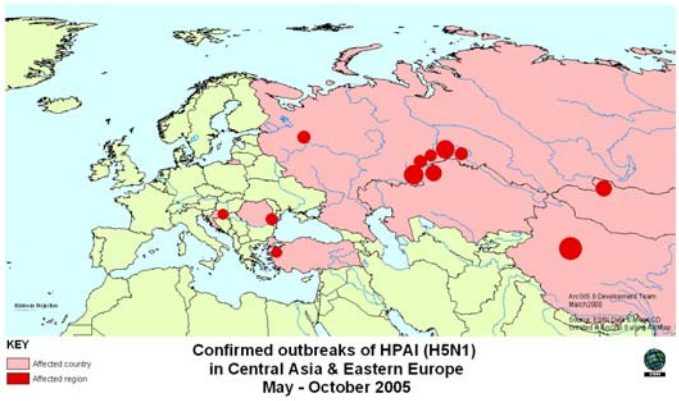
5.3.1 Geographic location

5.3.1.1 Background

Between May and August 2005, outbreaks of HPAI (H5N1) virus (see map) have been reported in Central Asia.
Outbreaks of the disease in domestic poultry have been reported in China, the southern part of Russia and north-east Kazakhstan.

In May 2005, H5N1 was detected in dead wild migratory waterbirds in China. In August 2005, Mongolia reported that an H5 virus was detected in dead wild migratory waterbirds in the northern part of the country close to the Russian border. The virus has been confirmed as HPAI (H5N1).

The reports of the virus finding in dead migratory waterbirds raised concerns on the potential role of these birds in the rapid dissemination of the virus over large geographic distances. Therefore, migratory waterbirds have been identified as a hazard for consideration in this qualitative risk assessment regarding their potential for the introduction of H5N1 virus to the UK from the affected regions in Central Asia.



Following these outbreaks, outbreaks of HPAI (H5N1) virus have been reported in Central Asia and Eastern Europe between May and October 2005. (see map).

Turkey has confirmed an outbreak of H5N1 in a free range turkey flock at the beginning of October 2005. The farm was located in the Region of Balikesir, in

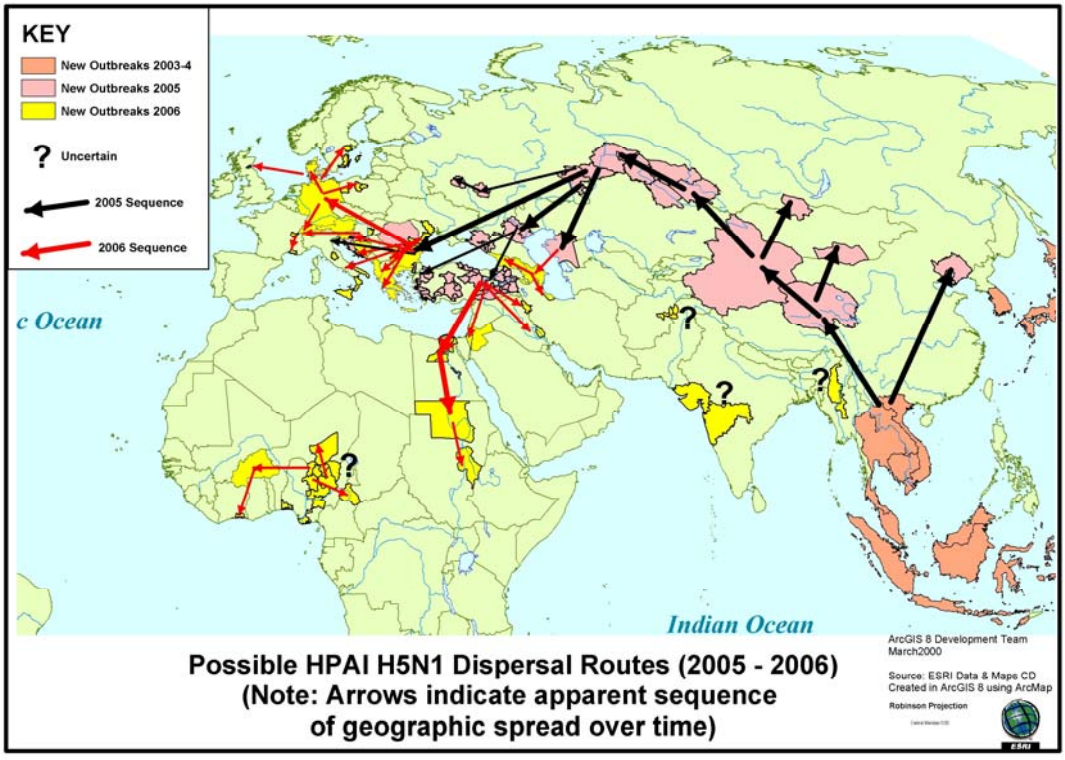
the north-western part of Anatolia. This region is near to an area supporting large numbers of waterbirds in the Kus Lake.

Following reports from Turkey, two outbreaks of the H5N1 virus were confirmed in back-yard poultry and waterbirds (swans – species not specified) in the eastern part of Romania in October 2005. This area is near to an area supporting large numbers of waterbirds in the Danube Delta

A number of H5N1 outbreaks in village poultry (ducks, muskovy ducks, chicken, geese, turkeys) have been reported for the first time in western Russia (Tula province) at the end of October 2005. No outbreaks have since been reported in other provinces in western Russia.

On 25 October 2005, the Croatian authorities confirmed that the H5N1 virus has been confirmed in dead swans (species not stated) that have been discovered in eastern Croatia.

In summary the following map outlines the spatial and temporal sequence of spread of the virus during the years 2005 and 2006. **Note:** The arrows

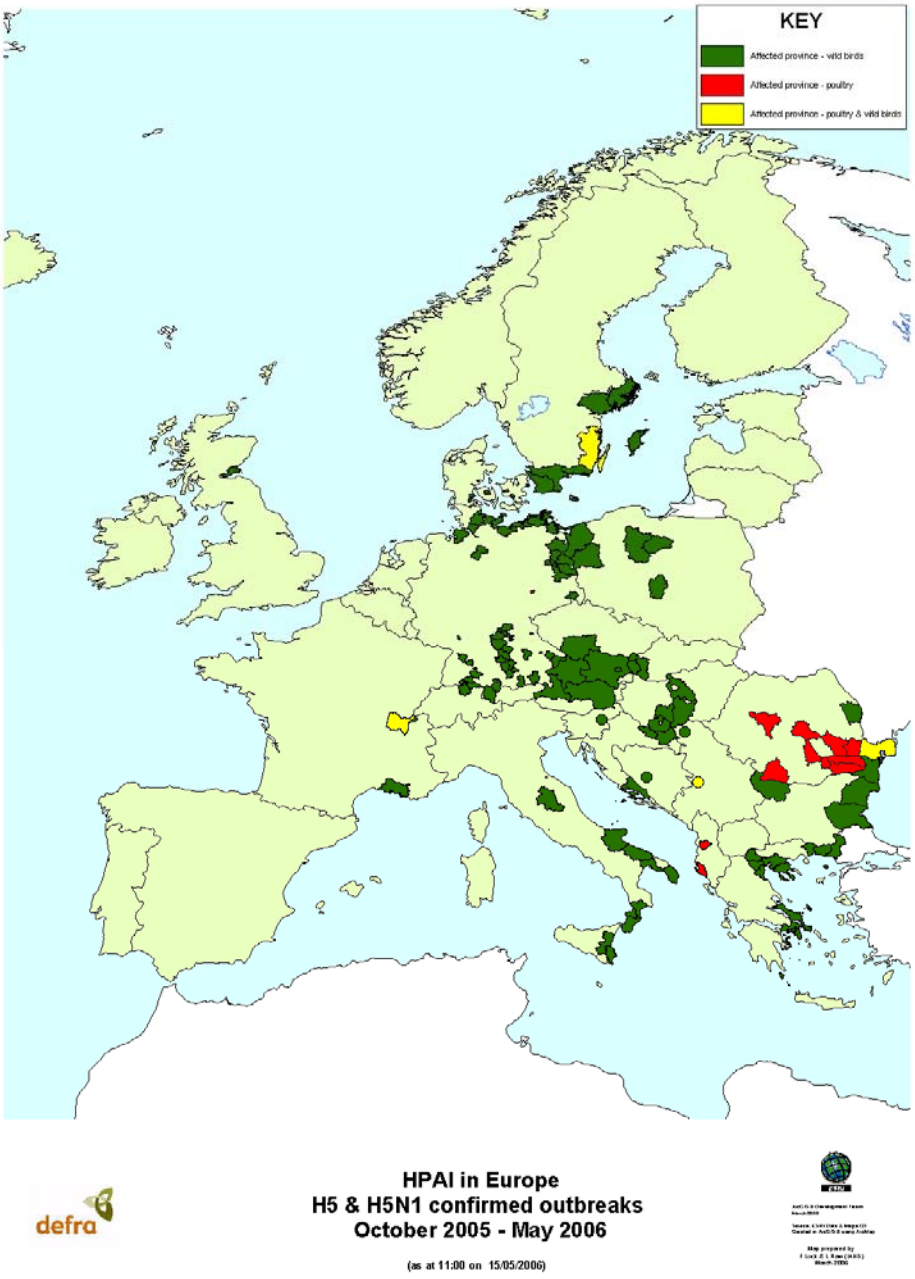


indicate the apparent sequence of spatial (geographic) spread during the years 2005 and 2006.

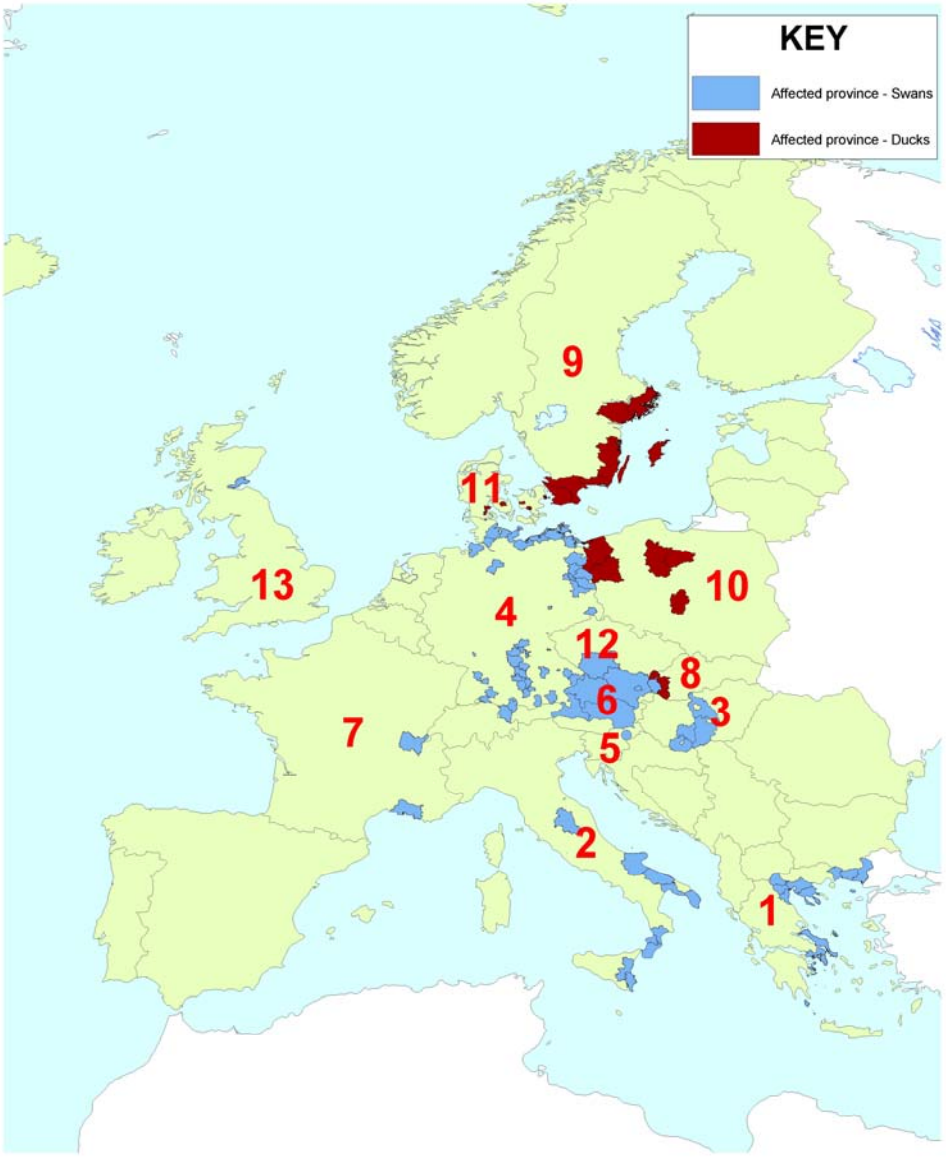
5.3.1.2 The EU and neighbouring countries and general timelines

Greece was the first EU Member State to report detection of the H5N1 virus in wild birds at the beginning of February 2006. Within the next three months, the virus was detected in 12 other EU Member States, including a case in a wild swan in Scotland, UK. It has also been reported in some countries neighbouring the EU.

The initial occurrence of outbreaks in Europe at different geographic locations and in time suggested that appropriate conditions have been fulfilled for them to occur. These were small and localised outbreaks not involving a large number of individuals.



In some EU Member States (e.g. Germany, Austria, Poland), initial outbreaks have been detected within a relatively short period of time at geographically distant locations. Subsequent outbreaks became clustered, both geographically and in time. In contrast, initial outbreaks were detected at relatively close geographical locations and appeared to be more clustered, both geographically and in time in other Member States (Greece, Italy, France, Sweden, Slovenia, Slovakia, Hungary, Czech Republic) (see map and timeline charts).



defra

Timeline of bird species detected dead by the H5 virus in EU Member states January 2006 to May 2006

Fig.1. Affected EU Member States and the EU neighbouring countries

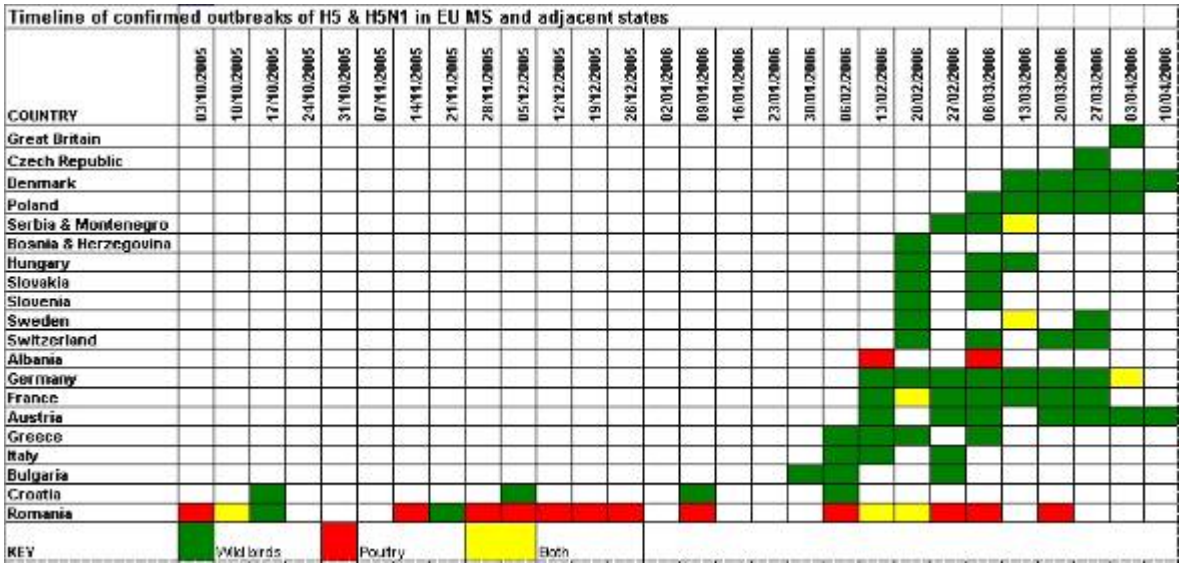


Fig. 2. Chart showing number of European countries affected each week since October 2005

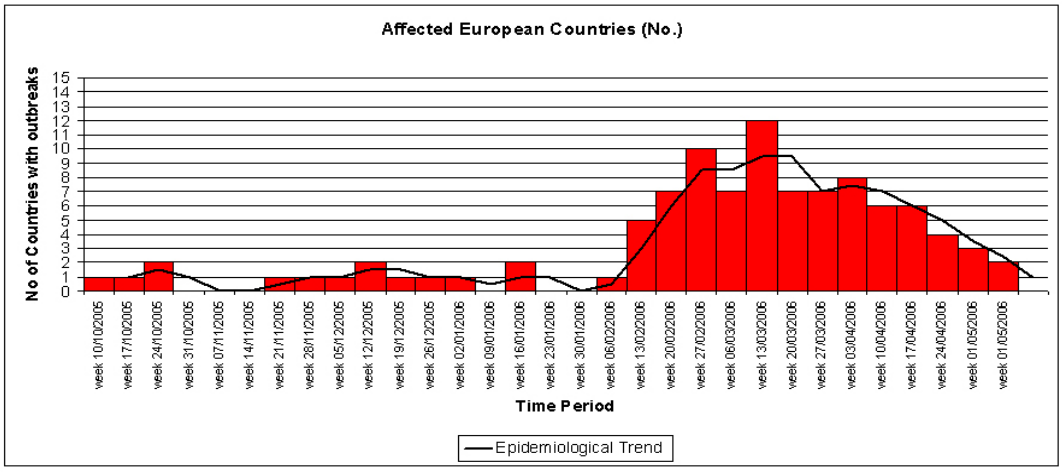
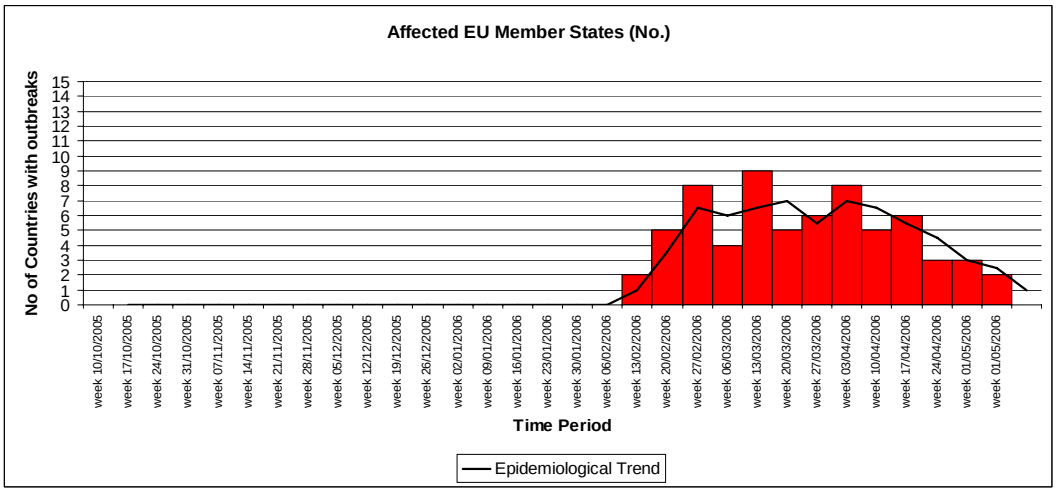


Fig. 3. Chart showing number of EU countries affected each week since February 2006



5.3.1.2.1 Climatic Conditions

Cooler than average temperatures were observed in Eastern Europe in January 2006. By the beginning of February 2006, it was reported that the Black Sea was frozen within a radius of 300-400 meters from the shore due to harsh winter conditions (see photos - courtesy of the British Embassy, Bucharest, February 2006).

Cold weather conditions may have resulted in the freezing of many waterfowl (ducks, geese, swans) habitat areas in the affected areas in eastern Europe.

Similar cold weather conditions have been observed in the Baltic Sea around the coast of Germany in mid February 2006. It has also been reported that a large number of wild waterfowl congregated in relatively small areas where water was not frozen. Germany reported the detection of the virus in mid February, in dead mute swans.

6 Discussion

6.1 The virus

Genetic analysis of the recent isolates shows that three separate lineages of the Asian strain of the virus have been detected in the EU Member States and neighbouring countries and indicates a level of relationship between different outbreaks in Europe and varying host specificity.

One lineage comprises isolates that have been primarily been isolated from wild birds with no associated outbreaks in poultry. This lineage would indicate direct evidence of linkage between the affected areas in China (Qinghai lake), southern Siberia (Novosibirsk) and in the EU (Germany – Rügen Island), Sweden and Denmark. The virus isolated from a single dead Whooper swan found washed up in a harbour in Scotland (UK) also belongs to this lineage.

Information from the World Reference Laboratory for Avian Influenza, Weybridge, UK, suggest that the H5N1 virus isolates from Turkey and Romania obtained in October 2005 are almost identical to the virus isolated in wild birds in Central Asia in May 2005. However, genetic analysis of subsequent isolates suggest that this virus may have subsequently evolved into two clades – one clade is indicative of the lineage of the virus that may be circulating between wild birds and domestic poultry (e.g. Romania). The other clade is indicative of the lineage of the virus that may be circulating between domestic poultry without involvement of wild birds (e.g. Turkey). Matroshovic and others (1999) consider that avian influenza viruses from aquatic birds undergo significant selective pressure in chickens, leading to definite changes in both the HA and the NA during the adaptation process. A single substitution in the HA may result in additional glycosylation sites which in turn may render the virus highly pathogenic in chicken by increasing the release of the virus from cells which facilitates its spread and replication in different tissues of chicken. These features of the HA and NA clearly separate chicken viruses from the viruses of wild aquatic birds.

6.2 The host

6.2.1 Infection

During the period from February to April 2006, H5N1 has been detected in dead wild waterbirds collected at numerous locations in several affected EU Member States. With regard to the species affected, it is notable that most detections of the virus in the affected EU Member States were made in dead wild waterbirds of the order of *Anseriformes* (swans and ducks). There is, however, emerging circumstantial evidence that live waterbirds (e.g. swans) and some scavenging birds (e.g. gulls) may be infected with HPAI H5N1 virus without showing clinical signs.

It is also notable from the above maps that the virus was detected in greater numbers of dead wild ducks in northern EU Member States compared to a greater number of detections in swans in other affected central and south-eastern EU Member States.

Sharp and others (1997) consider that different avian influenza (AI) A virus subtypes are maintained by different avian species. While a particular subtype may infect more than one avian species, they appear to have different, species-specific levels of adaptation.

We have no information on the age and sex of affected wild waterfowl. We assume that all detections were in adult birds. It is however, interesting to note that Sharp and others (1997) consider that juvenile ducks were significantly more likely to be infected with AI type A viruses than adults. It is unknown whether this would apply to infection with HPAI H5N1 virus as well and whether they would be likely to survive such infection and shed the virus for extended period of time.

In experimental conditions, the virus killed seven out of eight 2-week old ducks. Two out of 5-week-old-ducks inoculated with the virus died. The virus did not produce clinical signs in any of these ducks but did infect them. These results confirm that some of the circulating H5N1 isolates are capable of causing disease and death in ducks, however, lethality is age dependant (Pantin-Jackwood and others, 2006). This could suggest that a proportion of ducks infected with the virus could enter the moulting period.

Simulation studies with LPAI virus showed peaks of viral prevalence after nesting due to the population recruitment and during moult period due to high host density. The estimated host population threshold for virus persistence is 380 susceptible individuals on day 1 (Guberti and others, 2006). It remains unknown to what extent this would apply to infection with HPAI H5N1 virus.

6.2.2 Migration

Our previous risk assessment emphasised that caution is required when generalising trends that may relate to carriage of the HPAI H5N1 virus or any other HPAI virus to different regions or countries by migratory birds because they use different migratory routes (flyways).

There may be some limited mixing of the waterbird populations in northern Russia from the four major flyways in Eurasia. However, it is uncertain at this stage whether there is any significant geographic and temporal overlap of these waterbird populations in northern Russia with the waterbird populations in southern Siberia.

Therefore, the level of risk, which will vary from one season of the year to another, will depend on migratory pathways, either direct from infected areas or through contact at intermediate ‘mixing’ points for migratory species. The evidence to quantify this risk seems to be incomplete. Systematic studies are

therefore required to understand these routes, the species susceptibility, pathogenesis and ecology of the virus.

In their official notification to the OIE on 21 October 2005, the Russian authorities confirmed that the H5N1 virus has been confirmed in ducks, muskovy ducks, chicken, geese and turkeys in a number of backyard farms in Tula (Moscow region). This appears to be the only report of the H5N1 virus being detected in western Russia.

In our previous risk assessments we have considered that, should more outbreaks of the H5N1 virus be detected in wider areas of western Russia, this will impact on the likelihood of the virus introduction to the UK. That is, this changed situation could indicate that the virus may be present in migratory populations that arrive to the UK from further east in northern Russia. The expert ornithologists consider that this area would be within the direct migratory routes that exist between the northern Russia and the UK and involve greater numbers of migratory waterfowl.

Around 5 million waterbirds are present in Britain in winter. While some species are resident in the UK (i.e. birds present in winter that have bred here) many species arrive in the UK from arctic areas of North America, Greenland, Iceland, Fenno-Scandia and further east in northern Russia. Many of the waterbird species or populations wintering in the UK derive from northern (arctic or sub-arctic) areas and are highly unlikely to act as carriers of the virus to the UK from the current outbreaks in central Asia. Further, several species of wildfowl have a marine distribution during winter, and, remaining at sea, will therefore not come in to contact with farms or domestic livestock (Cranswick, 2005).

The Volga Basin and North Caspian regions are considered cross-roads for migratory waterbirds that use four major routes in Eurasia and East Europe. These two regions host the vast majority of migratory birds which are nesting in Eastern Fennoscandia, Northern-Central territories of the Russian plain, Ural and parts of western Siberia on their way to overwintering grounds in East Africa. A small proportion of these birds spend winters in south-western Asia. (Lvov and others 2001). Some species of ducks migrate from their breeding grounds in western Siberia to the area around the Caspian Sea.

The existence of complex migratory pathways mean there is a possibility that a small number of individual birds, from a few species, could migrate to Western Europe from areas in Europe currently affected with highly pathogenic AI (HPAI). These represent only a small proportion of individual birds arriving in the UK.

Ringing recoveries (Wernham and others, 2002) show there is some, albeit limited, movement of birds between the UK and southern Russia. Therefore, the inferences about the scale and regularity of the movement of birds between Southern Russia and the UK can only be preliminary and need to be treated with caution. For example, some of the extreme eastern recoveries of UK birds are highly unlikely to have travelled that far in a single winter. Rather,

they may have paired with different mates in different breeding seasons and their wintering and breeding grounds may have moved east. Lastly, the UK plays host to only a proportion of these species' populations during the winter: the majority of individuals breeding in Russia are highly unlikely to reach Britain because they winter further east in Europe, for example in the Mediterranean, and for some species in the Baltic (Cranswick, 2005)

It needs to be emphasised that *"although bird banding* (ringing) *has enabled scientists to gather very detailed information on birds, tracking the birds to understand their movements is a difficult task"* (Anonymous, 2005). We have been advised by experts that there is a great amount of ring recovery data. This data is held by individual schemes within the EU member states and centrally at the EU level on behalf of the different schemes for birds ringed in Europe. We consider that it would be useful if this data could be collated and analysed on a continental and national scale to provide much more information on bird movements.

6.3 The environment

6.3.1 Geographic spread

Severe weather conditions in the affected areas in the EU neighbouring countries and the EU may have caused temporary and erratic displacement of unknown numbers of birds from either northern parts of Europe or the Black Sea region, some of which may have been infected with the virus.

7 Conclusions

It is only a relatively short time since the H5N1 strain of the virus was first detected in wild birds. This was in Hong Kong in 2002. Our knowledge of the epidemiology of the virus still remains limited particularly as the study of infection in wild bird populations is difficult. Sufficiently large samples of live birds are impossible to obtain and there is therefore a reliance on the sampling of birds found dead, which involves its own practical difficulties and biases.

Our knowledge of the epidemiology of H5N1 in wild birds Europe is limited as it is only a few months since the infection was first detected. Understanding the current epidemiological picture and predicting the future occurrence has limitations and any inferences made therefore have a great degree of uncertainty. However, the available information is clearly of value in starting to improve our ability to assess the risks. The following indicates the key findings and observations to date.

The virus isolates in the EU and the EU neighbouring countries appear to be genetically closely related to the Asian lineage of the virus that has been isolated in China (Qinghai Lake), Russia (Southern Siberia) and Mongolia.

They are distinguishable from the apparently chicken-adapted strains infecting domestic poultry in Turkey.

On the basis of the presented limited information, it would appear that multiple introductions of the virus in Europe resulting in three genetic groupings may have occurred during the winter 2005. The initial outbreaks were sporadic and occurred at different and distant geographic locations within a relatively short period of time. Subsequent outbreaks peaked in March 2006 and became clustered geographically and in time in some EU Member States. These outbreaks may have coincided with wild bird population displacements and their congregation at limited habitats due to exceptional environmental conditions.

On the basis of genetic studies, migratory wild waterfowl may have had a role in the virus introduction and subsequent spread in Europe. The HPAI H5N1 virus was primarily detected in two species of dead wild waterfowl (swans and ducks) that belong to the Order *Anseriformes*. These species appear to play a greater role in the epidemiology of the virus. This finding is not unexpected as ducks, geese, swans and related web-footed birds are recognised as the primary reservoir hosts for influenza A viruses.

There is growing evidence that the virus has been detected in live and apparently healthy wild waterfowl (i.e. swans and ducks and scavenging birds (i.e. gulls). Given that spring migration of wild waterfowl may have been largely completed, these developments could suggest that the virus may have become established in local wild bird population in some EU Member States. One indication of such development could be further sporadic detections from these Member States, particularly during the forthcoming moulting period when the resident wild waterfowl will congregate in large numbers.

Other wild bird species (e.g. raptors, other wild birds) could be affected with a fatal outcome but appear to play a lesser role in the epidemiology of the virus. However, more systematic studies at various levels (i.e. local, national, international) involving different agencies and interest groups are required to ascertain their role as potential carriers of the virus without showing clinical signs of the disease.

Wild bird migration is a natural phenomenon that cannot be controlled, therefore, the likelihood of the virus introductions to the EU during the forthcoming migration along with other potential pathways would have to be re-assessed taking into account epidemiological developments.

There are a number of aspects of the epidemiology of infection in wild birds which are important in assessing the risks from the coming migration. These include the maintenance of infection in breeding grounds in northern Russia, and if infection persists whether infection will be more widespread in this area, particularly the more western parts.

It is unknown at present whether H5N1 infection will persist in wild bird populations throughout the year in Europe in the absence of further

introductions. Similarly, if infection does persist, there is uncertainty as to whether infection will extend geographically and/or become established in a wider range of wild bird species. The continued surveillance is crucial in this respect, as is the analysis of the accumulated data from the EU Member States, at least.

The current situation in Europe suggests that extensive surveillance, complemented with appropriate biosecurity measures were an effective way of detecting and preventing the introduction of the virus into commercial poultry operations. However, epidemiological studies are required in the EU Member States in the areas where infection has been found in wild birds to identify the domestic poultry flocks that could be regarded as at risk. This would provide valuable epidemiological information to support the apparent effectiveness of the biosecurity measures. Obtaining epidemiological evidence on this aspect is particularly important.

The identification and understanding of the risk factors for the various species of farmed poultry, kept under the range of management systems used in the EU countries is also important, as should infection become established in a wild birds there are no acceptable means of control in such free living populations. Preventing the transfer of infection to domestic poultry, which if it occurred would increase the risk for infection of the human population, is therefore paramount.

8 References

Anonymous, (2005). Flyway Information. Learning and Doing. Accessed 31 August 2005 (http://www.abc.net.au/wing/community/learningflyinfo.htm)

Brown, I., Londt, B.Z., Shell, W., Manvel, R.J., Banks, J., Gardner, R., Outtrim, L., Essen, S.C., Sabirovic, M., Slomka, M., Alexander, D.J (2006). First incursion of H5N1 highly pathogenic avian influenza viruses of the 'Asia' lineage into Europe. Session 9. Late Breaking Issues. 6th International Symposium on Avian Influenza, St John's College, Cambridge, UK, 3-6 April 2006.

Cherbonnel, M., Lamande, J., Allee, C., Schmitz, A., Ogor, K., Guillemoto, C., Pierre, I., Le Bras M.O., Le Gall-Recule, G., Morin, Y., Picault, J.P., Jestin. V. (2006). Results of avian influenza virus surveillance in targeted free range mule ducks. Session 5. Avian Influenza epidemiology and ecology (Abstracts – Posters). 6th International Symposium on Avian Influenza, St John's College, Cambridge, UK, 3-6 April 2006.

Cranswick, P. (2005). The Wildfowl & Wetlands Trust, Slimbridge, Glos GL2 7BT, UK./ Personal communication, 23 August 2005.

Easterday, B.C., Hinshaw, V.S., Halvorson, D.A. (1997). Influenza: In: Diseases of Poultry, 10th ed. Calnek, B.V. and others (Ed), Iowa State University Press, Ames, 583-605.

Guberti, V., Scremin, M., Buscani, L., Bonfanti, L., Terregino, C. (2006). A simulation model for the LPAI viruses in dabbling ducks in Europe. Session 5. Avian Influenza epidemiology and ecology (Abstracts – Posters). 6th International Symposium on Avian Influenza, St John's College, Cambridge, UK, 3-6 April 2006.

Lvov, D.K., Yamnikova, S.S., Gambaryan, A.S., Fedaykina, I.T., Matroshevich, M.N. (2001). Isolation of influenza viruses from wild birds in the Volga River Basin and in the North Caspian Region, *International Congress Series*, 1219, 251-258.

Matrosovich, M., Zhou, N., Kawaoka, Y., Webster, R. (1999). The surface glycoproteins of H5 influenza viruses isolated from humans, chicken and wild aquatic birds have distinguishable properties. Journal of Virology, 1146-1155

OIE, (2005). Chapter 2.7.12: Avian Influenza. Terrestrial Animal Health Code, 14th Ed., Office International des Epizooties, 12 rue de Prony, Paris, France. Accessed 25 October 2005 (http://www.oie.int/eng/normes/mcode/en_chapitre_2.7.12.htm)

OIE, (2004). Handbook on Import Risk Analysis for Animals and Animal Products. Vol.1. Office International des Epizooties, 12 rue de Prony, Paris, France.

Pantin-Jackwood, M., Swayne, D., Suarez, D., Spackman, E. (2006). Pathobiology of H5N1 avian influenza viruses in ducks. Session 5. Avian Influenza epidemiology and ecology. 6th International Symposium on Avian Influenza, St John's College, Cambridge, UK, 3-6 April 2006.

Pittman, (2006). Surveillance, prevention and disease management of avian influenza in the EU. FAO/OIE International Scientific Conference on Avian Influenza and Wild Birds. 30-31 May 2006, Rome, Italy. Accessed 9 June 2006 (http://ec.europa.eu/food/animal/diseases/controlmeasures/avian/surveillance2_en.pdf

Scott, D.A., Rose, P.M. (1996). Atlas of Anatidae populations in Africa and Western Eurasia. *Wetlands International Publication*, 41. Accessed 12 October 2005 (http://www.wetlands.org/IWC/wpal&swa/atlas/AEAatlas.htm)

Sharp, G.B., Kawaoka, Y., Jones, J.D., Bean, J.W., Paul Pryor, S., Hinshaw, V, Webster, R.G. (1997). Coinfection of wild ducks by influenza A viruses: distribution patterns and biological significance. Journal of Virology, 6128-6135.

Thrusfield, M. (2005). Veterinary Epidemiology. Third Edition. Blackwell Science Ltd, a Blackwell Publishing Company, UK/USA.

Wernham, C.V., Toms, M.P., Marchant, J.H., Clark, J.A., Siriwardena, G.M. & Baillie, S.R. 2002. *The Migration Atlas: Movements of the Birds of Britain and Ireland.* T. & A.D. Poyser, London, UK. 884 pp.