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RESOLUTION 4.XX

RESPONDING TO THE SPREAD OF HIGHLY PATHOGENIC AVIAN INFLUENZA H5N1

(*Draft for discussion by the Technical Committee*)

Recalling Resolution 3.18 on Avian Influenza which highlighted important issues raised by highly pathogenic avian influenza (HPAI) subtype H5N1 and its implications for waterbird conservation; and *Concerned* by the continued spread of this virus into Europe, the Middle East and Africa since MoP 3;

Aware of the very significant socio-economic impacts posed by the spread of this infection, especially in respect of the implications of control measures on rural livelihoods especially in developing countries;

Aware Also of the multiple routes through which HPAI H5N1 has spread within the region, including through a number of different vectors; although *Conscious* that the relative significance of these means of spread varies both spatially and temporally, and that the sources of many outbreaks are either unknown or uninvestigated, thus significantly hampering efforts better to understand the epidemiology of this disease and thus hindering development of improved strategies to limit further spread of infection;

Noting the significant efforts that have been made to improve the availability of synthesized data and information on the abundance and distribution of waterbirds to inform decision makers and as an aid to risk assessment as requested by Resolution 3.18;, *But Aware* however, that away from Europe, such information tools are still generally lacking;

Welcoming the considerable enhancement of avian influenza surveillance that has occurred through the efforts of national governments and their agencies, non-governmental organisations, and with the inputs of the UN Food and Agriculture Organisation (FAO), Wetlands International, the Wildlife Conservation Society and many other organisations;

Welcoming Also the development of the Global Avian Influenza Network for Surveillance as a means of better sharing the results of such surveillance, but concerned that there remains a considerable need to further enhance the scope of surveillance undertaken, its strategic co-ordination at international scales, and the quality of data collected;

Conscious that to better understand the dynamics of infection in wild birds requires epidemiological research and that this is of high priority wherever cases of infection occur in wild birds – whether or not this is associated with infection in poultry;

Conscious Also that capacity development and training are essential to all responses to this and other emerging infectious diseases of waterbirds, giving wider benefits to other aspects of wetland conservation, yet in many countries this remains a major issue requiring attention, especially within the veterinary sector;

Recalling the conclusion of recent international assessments (summarised in Resolution 3.7) that indicated enhanced frequency of emergent and re-emergent diseases of waterbirds, and *Conscious* that in most countries have limited capacity for systematic surveillance of waterbird diseases although these are developing as significant conservation priorities, especially for globally threatened waterbirds, and *Further Aware* that systematic approaches to developing capacity to respond to HPAI H5N1 may thus have wider benefits;

Aware that long-term success of disease control measures will depend critically on developing better public awareness of and education about relevant issues, especially with stakeholders in particular poultry keepers, the media, the public, wetland site managers and those within government;

Welcoming AEWA's active participation in the Scientific Task Force on Avian Influenza and Wild Birds, which has provided an important means of information exchange between international organisations; and *Especially Welcoming* the international workshop on Practical Lessons Learned in responding to HPAI (Scotland, UK, June 2007), the conclusions and recommendations from which are appended to this Resolution; and

Recalling the request from MoP 3 to develop advice to assist countries to respond to this serious and rapidly developing situation, and to report this to MoP 4.

The Meeting of the Parties:

Calls on Contracting Parties and other governments to further strengthen efforts to integrate responses to across government departments, ministries and agencies both with regard to HPAI contingency planning and in responding to outbreaks;

Strongly Encourages Contracting Parties and other governments, and using the guidance appended to this Resolution, to establish arrangements to involve those with specialist ornithological expertise to advise governments on the gathering, use and interpretation of relevant data and information in developing risk assessments, wild bird surveillance strategies and programmes, appropriate response strategies and the implementation of epidemiological investigations in the event of outbreaks of HPAI, so that such responses are made on the basis of best available information;

Advocates the development of communication programmes aimed at promoting balanced understanding and awareness of actual risks and appropriate responses in a range of stakeholder groups including poultry keepers (to reduce risks to human health and increase early disease diagnosis); the public and media to reduce inappropriate responses; and the public to aid in public reporting for surveillance programmes; and wetland site managers to improve contingency planning;

Strongly Urges the further development of information tools for decision makers that collect and then synthesize relevant data and information on waterbirds and wetlands (such as preparation and use of wetland inventories, information on distribution, abundance and movements of birds), as well as that related to the movements of poultry and poultry products as a critical part of preparing risk assessments at various scales, as well as a part of essential contingency planning;

Calls on Contracting Parties and other governments to develop strategic approaches to enhance their national capacity to detect and respond to emergent and re-emergent waterbird diseases, involving both relevant specialists, institutions and non-governmental organisations, and using, *inter alia*, experience gained in responding to the spread of HPAI H5N1;

Welcomes the broad consensus on approaches and responses developed between UN agencies, international conventions and other international organisations; *Accordingly Strongly Encourages* the continuing work of the Scientific Task Force on Avian Influenza and Wild Birds to

keep this developing situation under review especially as regards waterbirds, and *Instructs* the Secretariat to continue to contribute to the Task Force, engaging with relevant expertise within AEWA's Technical Committee and Contracting Parties; and

Urges Contracting Parties, other governments and organisations to use the guidance appended to this Resolution and to further disseminate it to other interested parties (including its translation into local languages); and *Further Requests* the Secretariat and Technical Committee to work, with the Scientific Task Force on Avian Influenza and Wild Birds and others, to continue to collate guidance that will assist countries effectively to respond to the continued spread and re-emergence of HPAI H5N1, making this available via the Task Force website (www.aiweb.info), and to report progress to the Standing Committee and MoP 4.

Appendix: Guidance on responding to HPAI H5N1

Contents

Appendix 1. Avian Influenza and Wildlife Workshop 'Practical Lessons Learned'. Aviemore, Scotland, UK, 26-28 June 2007

Conclusions and Recommendations

KEY RECOMMENDATIONS FOR FUTURE ACTION

An international workshop was convened by the Scientific Task Force on Avian Influenza and Wild Birds, and organised by the Convention on Migratory Species (CMS) and Scottish Natural Heritage. The Task Force was established in 2005 to create a liaison mechanism between those international organisations and intergovernmental environmental agreements engaged in activities related to the spread of H5N1 Highly Pathogenic Avian Influenza (HPAI) of Asian lineage. It comprises representatives and observers from 14 international organisations, including four UN bodies.

The Task Force was set up out of a need for information on wild birds to be better reflected in the debate about H5N1 HPAI and its spread around the world. The activity of the multi-agency Task Force has been crucial to help develop collaborations and joint multidisciplinary work programmes, analyse findings, and enhance the effectiveness of responses. Since the Task Force's first meeting in 2005, there have been achievements in many areas.

The Aviemore workshop identified a number of important conclusions and recommendations for future action. A central theme running through most of these is the continuing need to further develop national inter-ministerial capacities within governments and inter-disciplinary collaborations elsewhere to respond to the challenges posed by H5N1 HPAI — not only in reacting to cases of disease occurrence, detection of infection, or outbreaks, but also preparing for these through contingency planning and risk assessment. Central to this activity is the close and integrated working of various elements of the governmental and non-governmental sectors, bringing together the complementary expertise of epidemiologists, veterinarians, virologists, biologists and ornithologists.

Whilst much attention has been focussed on H5N1 HPAI, other H5 and H7 HPAI subtypes, as well as other avian-borne diseases, also pose major risks for the poultry industry. Developing wildlife surveillance programmes and enhancing biosecurity in relation to avian influenza raises issues common to risks from other zoonoses[1]. The workshop stressed the need to take longer-term, inter-disciplinary and integrated perspectives in responding to the challenges posed by all these diseases.

Contingency planning, risk assessment and response strategies

1. The workshop condemned the continued misplaced practice of actively killing wild birds or destroying their nest sites and wetland habitats in response to disease detection or perception. This is contrary to the recommendations of the UN Food and Agriculture Organisation (FAO), the World Organisation for Animal Health (OIE), World Health Organisation (WHO) and also of the Contracting Parties to intergovernmental treaties such as the Ramsar Convention on wetlands, the Convention on Migratory Species (CMS) and the African-Eurasian Waterbird Agreement (AEWA). Such approaches to the prevention or control of HPAI are wasteful, damaging to conservation and have no scientific basis. They may also exacerbate the problem by causing further dispersion of infected birds. It highlights the need for policy and management decisions to be based on evidence.

[1] such as Japanese encephalitis, West Nile virus infections, Crimean-Congo haemorrhagic fever, Equine encephalidities (Venezuelan, Eastern or Western).

2. There is an important and urgent need to develop national preparedness plans through drafting broad-ranging contingency measures. These should involve not only statutory and other regulatory authorities but also those of the non-governmental sector. Scenario-setting and training exercises are critical to enhance understanding of issues and the responses that will be necessary in the event of disease or infection detection in the country.

3. National contingency planning and preparedness require strong inter-agency/ministry collaboration as well as political support within governments from the highest levels possible. The inter-disciplinary joint collaboration of different ministries (to include at a minimum, Agriculture, Environment, Forestry, and Health), and organisations directly results in greater capacity and complementary expertise. Specifically, those ministries and agencies with authority and expertise with wild bird science and management need to be included in contingency planning.

4. Guidance on best practice contingency planning should be further developed by relevant international organisations including FAO and OIE. The collation and publication of 'best practice' case studies would be valuable.

5. There continues to be a need to learn from each case of infection by H5N1 HPAI. This would greatly assist with developing better understanding of the epidemiology of H5N1 HPAI. It is important that there should be routine inclusion of ornithological experts in field outbreak investigation or response teams, including at poultry farms. The development of national and international registers of experts able to assist in such missions would be valuable. There is a need to add from a wildlife perspective, protocols that supplement current outbreak investigations at poultry farms, in order to evaluate the role that wild birds may play in disease introduction there, or the potential for disease to be spread from farms into wild bird populations.

6. There is a need to develop international best practice guidance related to responses to cases or outbreaks of infection in wild birds with specific considerations for those events occurring in protected areas or nature reserves. This includes guidance on measures to reduce risks at sites of conservation importance for susceptible birds. The Task Force should help stimulate such guidance.

7. A 'lessons learnt' review should always be undertaken following the application of an HPAI contingency plan and/or outbreak of infection, and any conclusions concerning how better to improve responses or preparedness subsequently implemented.

8. There is a need to integrate responses and strategies for avian influenza and similar zoonoses into Agreements and Action Plans developed under the Convention on Migratory Species, such as *inter alia*, the African-Eurasian Waterbird Agreement and the Siberian Crane Memorandum of Understanding.

Surveillance and early warning systems

9. Poor identification and reporting to the OIE remains a major concern. Analysis of recent reports to OIE where wildlife are part of the outbreak or die-off records, often lack species identification using binomial standard nomenclature, information on the precise location and timing of infection, as well as the means by which cases are detected. These deficiencies constrain improved analysis in understanding of the H5N1 HPAI epidemiology. Task Force members should draft a letter to the OIE Scientific or Standards Committee for submission by the Task Force Chair to request the OIE in enhancing member country's reporting in these respects and so improve the quality of data registered and disseminated. Photographic documentation of affected species should be strongly promoted. The European Commission has developed valuable standards related to the photography of wild birds as an aid to

identification. These should be considered for inclusion in relevant FAO and OIE best-practice manuals and other international guidelines. Furthermore, exact reporting of outbreak locations rather than the location of the reporting institute or ministry should be strongly promoted.

10. Openly accessible data and information on the location and extent of avian influenza surveillance, and results in wild birds is important to help build international understanding of the ecology of this virus. To this end, there would be clear benefit to expanding the use of the Global Avian Influenza Network for Surveillance (GAINS) open database and mapping system to be included as the desirable wild bird module of the Global Early Warning System (GLEWS) for transboundary animal diseases, including zoonoses— a joint initiative of FAO, OIE and WHO. Additionally, the GAINS information management system has the potential to serve the needs of many stakeholders and would benefit from more widespread mandates for its use and recognition by the relevant major organisational stakeholders, in particular FAO, OIE, WHO, UNEP, Wetlands International and Birdlife International.

11. Understanding shared data is only possible if these represent the same information. In this respect the development of international common standards is particularly important, not only as these relate to field-based methodologies (*e.g*. different types of sampling) but also to laboratory diagnostic techniques. The continued development of guidance from FAO and others is essential.

12. It is highly desirable that long-term programmes for avian influenza surveillance (H5N1 HPAI and other LPAI) are established against precisely defined objectives. These will help give a better understanding of incidence of AI in healthy wild birds. Establishment of such programmes will be difficult (*e.g*. in relation to the expected very low prevalence of AI viruses) but nonetheless continuity is an important objective.

13. FAO guidance on the planning and execution of avian influenza surveillance programmes should be further developed, possibly producing separate products for different target audiences. This might also include simplified publications for field audiences.

14. Whilst historically most research into avian influenza has related to ducks, geese, swans and waders, surveillance in the Far East has increasingly detected H5N1 HPAI in a number of other dead birds, traded birds, scavengers and predators. Some of these species, especially those that live in association with people, have the potential to act as 'bridge' species and as foci of infection. Whilst maintaining focus on waterbird surveillance, it is important that such species are included in surveillance programmes where risks are high or disease occurrence is entrenched in the poultry sector, or the disease has become endemic in the country or region.

15. The development of more strategic approaches to surveillance at regional or wider scales should be encouraged through appropriate mechanisms. Parameters to be considered in such developments include *inter alia* migratory patterns of higher risk species and the risk of such species mixing either with other wild species and/or with poultry. This should be followed up by capacity development in terms of establishing logistic as well as human resource competence. In the short-term, this is perhaps most feasible for developed countries, from where learning and programmes can be transferred to other regions.

Epidemiology: tracing sources of infection

16. The ultimate objective of structured epidemiological investigations of outbreaks in domestic poultry should be to identify the most likely source of infection so that the population attributable risk can be quantified. This allows assessment of the population attributable risks as related to the potential means of introduction of infection to domestic flocks so that this can then be used to estimate the proportionate rôle of the various potential means of

introduction of infection, *e.g.* poultry, poultry products, fomite transmission, wild birds, *etc*. This allows the most relevant and efficient control measures to be put in place.

17. A central element of national contingency planning should be the establishment of multi-disciplinary epidemiological teams which should involve epidemiological, veterinary, virological, biological and ornithological expertise. There are good examples of the success of this approach which demonstrates the advantage of bringing together expert ornithologists so as to be able to advise veterinarians and epidemiologists. The establishment of such national Ornithological Expert Panels is strongly recommended.

18. There are massive international movements of poultry and poultry products, although full details of these are poor, especially for informal or illegal trade. It remains an important priority to develop better information about the national and international trade in poultry and poultry products at various scales, including transparency issues in industry – which calls for a healthy dialogue to be promoted. As part of the process of tracing bird movements it would be valuable to undertake more field research on market chains and sales so as to better understand the nature and extent of the poultry or ornamental bird trade, fighting cock exhibits, and the like, as well as giving special emphasis to trade through wet (live bird) markets.

19. The Task Force should stimulate the development of accessible guidance which gives general principles for epidemiological investigations related to a range of different outbreak and infection scenarios, as well as best practice case studies, which would have educational value.

20. Training in epidemiological principles is important, especially where there is limited national capacity. Organisations represented on the Task Force should consider how they might assist the development of such training.

21. In regions where synthesized information on the distribution and movements of wild birds do not exist, there remains an important need to gather, collate and provide such information to aid both epidemiologists and decision makers. This should include tools that summarize the likely bird movements at various scales and for various periods.

22. Telemetry provides a valuable tool for better understanding of temporal and spatial movements of wild birds especially in relation to epidemiological investigations. The further use of this technology should be promoted.

23. To more readily understand the spread of infection it is crucial that there is accurate knowledge of the timing and sequence of events ('time-lines'). Time-lines, together with an understanding of which species are involved and exact locational information are all crucial to the generation of hypotheses that can then be used to direct subsequent epidemiological investigations and conduct meaningful phylogenetic studies based on genome sequencing data. The importance of rapid, official reporting to OIE was stressed.

24. The results of epidemiological investigations should always be published, including where these are inconclusive. Awareness of these would be facilitated by establishing hyperlinks to an international register of such investigations maintained on OIE's web-site. All organisations involved in the Task Force should continue to encourage transparency in reporting and openness in data sharing. The reporting of negative data is crucially important.

Communication, education and public awareness

25. Those involved with avian influenza should proactively work with the media to enhance the accuracy of their reporting of science, thus improving public understanding. This should particularly involve the communication of positive messages as well as responses to negative

ones. To this end, targeted briefings of journalists are helpful. The development of much more effective communication strategies is necessary to give policy makers, stakeholders and the general public more balanced information on the real levels of risk and appropriate responses.

26. Organisations should identify specific, informed members of their staff who are responsible for media briefings and who work on a contingency and communications planning. They should expect the unexpected and prepare for it. They should stick to areas of expertise and avoid comment about other issues. Briefing of media should always be evidence-based and avoid speculation in the absence of evidence. The accuracy of facts supplied by others should be repeatedly checked before passing these to the media. Much useful information is available on the Task Force web-site (www.aiweb.info).

27. Task Force members should use the booklet *Avian Influenza and Wild Birds* for media briefings and promote its use by others. It should be reviewed and updated as necessary. English, French, Spanish, Russian, Chinese and Arabic versions are now available. However, the Task Force should also develop a media 'tool kit' that brings together national and organisational media best practice and Frequently Asked Questions. This should include factual information that may be adapted for specific national needs and uses.

28. At present much guidance related to H5N1 HPAI is published in a limited range of languages. It is important to translate guidance into a wider range of other, and more local, languages so as to facilitate its dissemination.

29. The Task Force should stimulate the publication of simple bird identification guides in local languages so as to assist field-based staff responses to cases of infection. A web-based list or directory of experts that could assist (at a distance) in identification of bird species based on photographs would also be highly desirable.

30. The degradation of the health of ecosystems as documented by the Millennium Ecosystem Assessment and especially in the decline in extent and condition of wetlands is considered to have had a rôle in the evolution and spread of H5N1HPAI. This environmental change has created the conditions where there is closer contact and mixing between people, livestock (including poultry and domestic ducks), and wild waterbirds, potentially resulting in cross-infections. Reducing the opportunities for such contacts through preventing further loss of wetlands, improving mechanisms for the maintenance and wise use of wetlands is an important long-term requirement. To this end it would be valuable to develop and disseminate practical guidance, *inter alia* in collaboration with the Ramsar Convention.

Research and data needs

31. There remains a need to develop a better understanding of the behaviour and ecology of 'bridge' species, as well as other means of the local or short distance spread of HPAI infection, such that this information might be used to develop enhanced guidance on biosecurity and contribute to risk analysis

32. It would be valuable to have a better understanding of the duration of viral shedding by bird species likely to be held in captivity. This would inform possible response strategies for zoos and collections in the event of infection outbreaks.

33. Better monitoring and surveillance for avian influenza within markets that trade in wildlife, is highly desirable. This should include research into which species are traded, their origins and movements.

34. There remains a need for better information on relevant cultural and religious practices, such as the widespread purchase and release into the wild of birds at certain times of the year (*e.g.* merit releases), and how those practices might be safeguarded but at the same time, minimize the risk of disease spread to humans, wild birds, and poultry.

35. H5N1 HPAI has affected several non-avian species, although knowledge of its ecology in these taxa is particular poor. Those species that have been infected are thought to be accidental, dead-end hosts, and there is no current evidence for them being involved in the maintenance of infection in any area. However, there is a need to continue to assess this issue during epidemiological investigations as it is possible that in the future a mammalian species may become a maintenance host and thus spread H5N1 HPAI locally.

36. Knowledge of the degree to which H5N1 HPAI may be passed between different bird species (and whether this happens asymptomatically or not) is important information that could help refine risk assessments. Research which leads to the development of serological tests for avian influenza antibodies in different species of birds will ultimately provide the most useful epidemiological information. Serological testing in past LPAI outbreaks has given important insights. Basic research on the immunological responses to H5N1 HPAI infection by birds (possibly using a representative avian model in one species) is important. A current priority is to develop validated serological diagnostic tests for the full range of bird species potentially at risk.

37. There remains a need to continue to gather, collate and co-ordinate data and information on wild bird distributions, their movements, stop-over sites and flyways. Satellite telemetry is a particularly valuable tool for this work. It is also important to continue to gather data at site level, since such local information is very limited in many parts of the world.

38. For many, access to the most recent scientific literature is constrained by inability to subscribe to expensive on-line journals, thus hindering understanding. The Task Force should help tackle this issue, possibly by working with authors to make the most relevant scientific literature available on AIWeB and web-based resources, or by investigating the potential for corporate sponsorship.

Finances

39. Recent events with respect to avian influenza have focused attention on the need for resources to develop national veterinary capacity and programmes of surveillance and monitoring for wildlife diseases, especially zoonoses, but also to develop background information on wild birds, and especially their movements. A good start has been made, but there remains the need for further investments, particular to allow the development of the wildlife disease sector.

40. The Scientific Task Force on Avian Influenza has provided a valuable co-ordination function between its many collaborating organisations. Financial resources are required to facilitate its continued operation.

Avian Influenza and Wildlife Workshop
'Practical Lessons Learned'

Aviemore, Scotland, UK
26-28 June 2007

1. Introduction

An international workshop was convened by the Scientific Task Force on Avian Influenza and Wild Birds, and organised by the Convention on Migratory Species (CMS) and Scottish Natural Heritage. The Task Force was established in 2005 to create a liaison mechanism between those international organisations and intergovernmental environmental agreements engaged in activities related to the spread of H5N1 Highly Pathogenic Avian Influenza (HPAI) of Asian lineage. It comprises representatives and observers from 14 international organisations, including four UN bodies.

The Task Force was set up out of a need for information on wild birds to be better reflected in the debate about H5N1 HPAI and its spread around the world. It has had eight teleconferences and works also by e-mail and meetings. The activity of the multi-agency Task Force has been crucial to help develop collaborations and joint work programmes, and has thus enhanced the effectiveness of responses.

The objective of the Aviemore workshop in June 2006 was specifically to review practical issues arising, and lessons learnt, from recent outbreaks. The Aviemore workshop identified a number of important conclusions and recommendations for future action. It also brought together a summary of available guidance on a range of relevant topics (Annex 1). It reviewed also progress since the first meeting of the Task Force in Nairobi in April 2005 as detailed in Annex 2.

A central theme running through most of these conclusions and recommendations is the continuing need to further develop national capacities within government and elsewhere to respond to the challenges posed by H5N1 HPAI — not only in responding to outbreaks, but also preparing for these through contingency planning and risk assessment. Central to this activity is the close and integrated working of both governmental and non-governmental sectors — specifically the bringing together of the complementary expertise of epidemiologists, veterinarians, virologists, biologists and ornithologists.

Whilst much attention has been focussed on H5N1 HPAI, other H5 and H7 HPAI subtypes also pose major risks for the poultry industry. Indeed, developing wildlife surveillance programmes and enhancing biosecurity raise issues common to responses to other zoonoses. The workshop stressed the need to take longer-term and integrated perspectives in responding to the challenges posed by these diseases.

2. Contingency planning, risk assessment and response strategies

Conclusions

- The UN Food and Agriculture Organisation's (FAO) *Manual on the preparation of national animal disease emergency preparedness plans* recommends the development of four sets of complementary technical contingency plans:

    1. specific disease contingency plans that document the strategies to be followed in order to detect, contain and eliminate the disease;

2. standard operating procedures that may be common to several or all emergency disease campaigns;
3. enterprise manuals that set out zoosanitary guidelines for enterprises that may be involved in an emergency animal disease outbreak; and
4. simple job description cards for all individual officers.

- It remains a pressing issue to build the capacity and develop appropriate organisational structures for veterinary services in developing countries so as to be able effectively to respond to outbreaks of H5N1 HPAI outbreaks, particularly in domestic poultry. Indeed, there has been considerable past investment in trying to develop national veterinary capacity. Recognizing the central importance of this need, the meeting identified however that governance issues historically had meant that such investments had not always delivered anticipated benefits. Good governance and the elimination of corruption are crucial to maximise return on investments in capacity development, and thus allow the delivery of more effective responses. It is crucial that the further development of veterinary capacity should be undertaken against specifically defined objectives and should result in change.

- In developing national contingency planning, it is essential that countries put in place effective and flexible mechanisms for inter-agency co-ordination and action backed at the highest possible political/Ministerial level. This should especially co-ordinate between the various government ministries and departments likely to be involved (typically of Agriculture and Environment).

- Countries should be encouraged to name a central Avian Influenza focal point for liaison with the Task Force, so that when outbreaks occur, the Task Force can then disseminate relevant information to the focal point (and *vice versa*).

Poultry holdings

- Integrated analyses that relate distribution and numbers of poultry to that of waterbirds have considerable potential to maximise the likelihood of identifying higher risk areas where surveillance of wild birds can then be focused. A good example of such an integrated study was presented from the UK, and this approach has also been undertaken in some other European countries. In doing this, dialogue with the poultry industry is important to understand and fully reflect the appropriate risk factors for poultry holdings. FAO's Technical Co-operation Programmes have undertaken similar attempts for Africa and Latin America but data limitations related to wild birds still give challenges.

- Ornithologists and ecologists should always be involved in outbreak response teams, as well as with surveillance programmes. Experience has repeatedly demonstrated that their technical expertise can provide valuable insights into possible epidemiological lines of investigation. The Task Force should strategically address how best to convince veterinary authorities of this need and the resulting benefit to them.

- Where stamping out occurs, particular care needs to be taken in the biosecure disposal of infected carcasses (and other sources of virus contaminated fomites), so as to avoid the risk of the infection of scavenging birds or mammals.

- The potential spread of infection by professionals and others risk (*e.g.* vaccination or veterinary investigation teams) moving between infected and uninfected holdings is also a major risk.

- Practical experience in Africa has shown that early reporting of outbreaks will be encouraged by rapid payment of compensation, which should be uniform across a country or region to

avoid encouraging the movement of (infected) poultry to areas which have higher rates of compensation. An adequate level of financial compensation is important if early reporting of infection is to be encouraged, and these rates should be regularly reviewed against market prices.

- Sustained public sensitisation and awareness programmes are essential to any control and containment programme.

- The experience of some Asian countries, where H5N1 HPAI is now endemic, suggests that it is unlikely that this virus will be readily eliminated in the poultry sector unless concerted action is taken at many levels. As documented elsewhere, a range of responses are available to reduce levels of infection: "In tackling this disease, countries should adopt integrated control programs using the combination of measures best suited to the local environment[2]."

Nature reserves and wild birds

- The workshop learnt with great concern of continued misplaced responses in some countries, including the active killing of wild birds in response to infection within a country. To further highlight the inappropriateness of such practices, in many cases extensive killing has occurred in places remote from any poultry potentially at risk.

- There would be benefit in developing and disseminating international good practice guidance related to risk assessment and outbreak response planning at nature reserves and other protected areas, especially for sites of conservation importance for birds. These assessments are best undertaken in the context of site management plans, aiming to identify and manage risks towards key conservation values (*e.g.* threatened species) at such sites. Ideally, risk assessment and management measures should be linked to the wide range of existing relevant guidance developed by the Ramsar Convention on wetlands. In particular, stakeholder communication and participation is critical.

- There is limited FAO guidance related to the dealing with outbreaks or identification of isolated cases of H5N1 HPAI infection in wild birds. It is recommended that guidance on this complementary to that already existing be issued urgently.

- The unnecessary closure of nature reserves and other protected areas when no outbreaks have occurred at the site should always be avoided. This is in accordance with much of the scientific data available on the low frequency of the H5N1 HPAI occurrence within wild bird populations, and the lack of evidence that wild birds play a significant rôle in the spread and transmission of infection of H5N1 to humans.

Zoos and animal collections

- Highly pathogenic avian influenza poses a particular risk to zoological collections in terms of: staff and visitors health and safety issues; threats to susceptible captive animals of conservation importance; the animal welfare implications of both the disease and disease control actions; and in terms of financial impact (expenditure for contingency planning and potential reduction of income from, for example, reduced visitation). There have been cases of H5N1 HPAI infection reported from within zoos in at least seven countries[3] since 2003. In some cases, infected poultry products fed to carnivores were the most likely source of infection, but the source of most introductions remains unknown.

- Potential impacts can be minimized by rigorous risk assessments and thorough contingency planning. It is essential that zoos and collections develop detailed contingency plans using a

[2] Sims, L.D. 2007. Lessons learned from Asian H5N1 outbreak control. *Avian Diseases* 50: 174-181.

[3] Thailand, Viet Nam, Indonesia, Pakistan, Kuwait, Ukraine and Germany.

dedicated multidisciplinary team. Such plans should address the multiple sources of risk faced, as well as planning necessary responses. These include:

- Staff and visitor health and safety based on minimizing contact between humans and birds or their products, and/or improving hygiene measures.
- Protection of captive stock by means of enhanced biosecurity and possible vaccination although the latter option raises a number of issues that need careful consideration.
- Communication strategies for staff, visitors, external stakeholders and the media.
- Operational aspects *e.g.* guides, educational staff, shops, restaurants, sales, *etc.*
- Access to site *e.g.* staff living on site, contractors, other site-users, *etc.*
- Closure of zoo if necessary plus a strategy for re-opening.
- Business aspects to redress financial impact.

Plans need continued review and updating particularly in light of new information regarding epidemiology, changing legislation and to reflect internal organisational changes.

- Scenario setting, staff training and formal exercises involving relevant statutory and other organisations or veterinary authorities that are engaged with private or public collections are absolutely essential to developing preparedness plans. Such exercises should include follow-up activities with those involved to develop lessons-learnt and the corrective measures to be taken (including mechanisms to ensure compliance).

- It is particularly important to establish good communication networks *before* infection crises occur, such that there is clear understanding of the issues related to a specific zoo or animal collection by all those potentially involved in responses.

- A fundamental aspect of good biosecurity in zoos and collections is a ban on the feeding of actually, or potentially, diseased/infected poultry to carnivores.

Key recommendations for future action

1. The workshop condemned the continued misplaced practice of actively killing wild birds or destroying their nest sites and wetland habitats in response to disease detection or perception. This is contrary to the recommendations of the UN Food and Agriculture Organisation (FAO), the World Organisation for Animal Health (OIE), World Health Organisation (WHO) and also of the Contracting Parties to intergovernmental treaties such as the Ramsar Convention on wetlands, the Convention on Migratory Species (CMS) and the African-Eurasian Waterbird Agreement (AEWA). Such approaches to the prevention or control of HPAI are wasteful, damaging to conservation and have no scientific basis. They may also exacerbate the problem by causing further dispersion of infected birds. It highlights the need for policy and management decisions to be based on evidence.

2. There is an important and urgent need to develop national preparedness plans through drafting broad-ranging contingency measures. These should involve not only statutory and other regulatory authorities but also those of the non-governmental sector. Scenario-setting and training exercises are critical to enhance understanding of issues and the responses that will be necessary in the event of disease or infection detection in the country.

3. National contingency planning and preparedness require strong inter-agency/ministry collaboration as well as political support within governments from the highest levels possible. The inter-disciplinary joint collaboration of different ministries (to include at a minimum, Agriculture, Environment, Forestry, and Health), and organisations directly results in greater capacity and complementary expertise. Specifically, those ministries and agencies with authority and expertise with wild bird science and management need to be included in contingency planning.

4. Guidance on best practice contingency planning should be further developed by relevant international organisations including FAO and OIE. The collation and publication of 'best practice' case studies would be valuable.

5. There continues to be a need to learn from each case of infection by H5N1 HPAI. This would greatly assist with developing better understanding of the epidemiology of H5N1 HPAI. It is important that there should be routine inclusion of ornithological experts in field outbreak investigation or response teams, including at poultry farms. The development of national and international registers of experts able to assist in such missions would be valuable. There is a need to add from a wildlife perspective, protocols that supplement current outbreak investigations at poultry farms, in order to evaluate the role that wild birds may play in disease introduction there, or the potential for disease to be spread from farms into wild bird populations.

6. There is a need to develop international best practice guidance related to responses to cases or outbreaks of infection in wild birds with specific considerations for those events occurring in protected areas or nature reserves. This includes guidance on measures to reduce risks at sites of conservation importance for susceptible birds. The Task Force should help stimulate such guidance.

7. A 'lessons learnt' review should always be undertaken following the application of an HPAI contingency plan and/or outbreak of infection, and any conclusions concerning how better to improve responses or preparedness subsequently implemented.

8. There is a need to integrate responses and strategies for avian influenza and similar zoonoses into Agreements and Action Plans developed under the Convention on Migratory Species, such as *inter alia*, the African-Eurasian Waterbird Agreement and the Siberian Crane Memorandum of Understanding.

3. Surveillance and early warning systems

Conclusions

- The development of practical programmes of training and capacity development by FAO, Wetlands International, the UK Wildfowl & Wetlands Trust (WWT), the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and others has been a very welcome step forward. Such programmes need to be sustained and further developed, recognising that single training courses by themselves are insufficient to develop significant long-term capacity. Follow-up is essential.

- The development of FAO guidance on the development of surveillance programmes is welcome but needs to be further developed based on lessons learnt from practical experience.

- Whilst differing national circumstances and capacity will dictate the exact arrangements for national surveillance programmes, the experience of some countries demonstrates significant benefits if surveillance is systematically organised through a single organisation. This can lead to high efficiency in organisation and quality assurance, facilitates logistic support and effective supply chains, and allows for rapid communication with all those involved.

- The issue of species identification of birds affected by AI remains problematic, with significant numbers of apparently misidentified species being reported. This remains also a problem with the quality of formal national reporting to, and international reporting by, OIE — possibly caused by the fact that higher quality information is provided in free text fields, which are not included in the standard OIE reports. Rather, in these reports the strongly

categorized standard 'questionnaire' is used as the main source and this system is not the most useful one in gathering precise information on species identify.

- Inclusion of photographs are essential to assist confirmation of cage-birds which are usually non-native to the country concerned. It is important that birds either captured for active AI surveillance, or reported by the public in the context of AI, are identified by trained ornithologists. In the event of doubts as to identity, digital photographs should be taken and these stored with reference to the sample until virological testing is completed. (If such information was not collected at the time of capture, this allows additional information such as age and sex of birds to be assessed). Where trained ornithologists are not present (for example dead birds sent direct to laboratories for testing), photographs should ***always*** be taken to allow identification by knowledgeable personnel. The European Commission has published technical guidance as to how best to take such photos (Annex 3B). There would be benefits in this guidance being translated and more widely promulgated as an international best practice.

- To begin to develop a better understanding of what comprises 'unusual mortality' — often used as a trigger for the collection and sampling of carcasses — it would be valuable for surveys of waterbirds to start to collect data on the numbers of dead birds found during routine surveys to obtain baseline values in a given ecosystem during a given time of the year.

- In some countries the public have been involved in the reporting of dead birds. Experience has demonstrated benefit in developing clear guidance to help agencies to respond to such reports: having a clear, rule-based system helps reduce public misunderstandings.

Key recommendations for future action

1. Poor identification and reporting to the OIE remains a major concern. Analysis of recent reports to OIE where wildlife are part of the outbreak or die-off records, often lack species identification using binomial standard nomenclature, information on the precise location and timing of infection, as well as the means by which cases are detected. These deficiencies constrain improved analysis in understanding of the H5N1 HPAI epidemiology. Task Force members should draft a letter to the OIE Scientific or Standards Committee for submission by the Task Force Chair to request the OIE in enhancing member country's reporting in these respects and so improve the quality of data registered and disseminated. Photographic documentation of affected species should be strongly promoted. The European Commission has developed valuable standards related to the photography of wild birds as an aid to identification. These should be considered for inclusion in relevant FAO and OIE best-practice manuals and other international guidelines. Furthermore, exact reporting of outbreak locations rather than the location of the reporting institute or ministry should be strongly promoted.

2. Openly accessible data and information on the location and extent of avian influenza surveillance, and results in wild birds is important to help build international understanding of the ecology of this virus. To this end, there would be clear benefit to expanding the use of the Global Avian Influenza Network for Surveillance (GAINS) open database and mapping system to be included as the desirable wild bird module of the Global Early Warning System (GLEWS) for transboundary animal diseases, including zoonoses— a joint initiative of FAO, OIE and WHO. Additionally, the GAINS information management system has the potential to serve the needs of many stakeholders and would benefit from more widespread mandates for its use and recognition by the relevant major organisational stakeholders, in particular FAO, OIE, WHO, UNEP, Wetlands International and Birdlife International.

3. Understanding shared data is only possible if these represent the same information. In this respect the development of international common standards is particularly important, not only

as these relate to field-based methodologies (*e.g*. different types of sampling) but also to laboratory diagnostic techniques. The continued development of guidance from FAO and others is essential.

4. It is highly desirable that long-term programmes for avian influenza surveillance (H5N1 HPAI and other LPAI) are established against precisely defined objectives. These will help give a better understanding of incidence of AI in healthy wild birds. Establishment of such programmes will be difficult (*e.g.* in relation to the expected very low prevalence of AI viruses) but nonetheless continuity is an important objective.

5. FAO guidance on the planning and execution of avian influenza surveillance programmes should be further developed, possibly producing separate products for different target audiences. This might also include simplified publications for field audiences.

6. Whilst historically most research into avian influenza has related to ducks, geese, swans and waders, surveillance in the Far East has increasingly detected H5N1 HPAI in a number of other dead birds, traded birds, scavengers and predators. Some of these species, especially those that live in association with people, have the potential to act as 'bridge' species and as foci of infection. Whilst maintaining focus on waterbird surveillance, it is important that such species are included in surveillance programmes where risks are high or disease occurrence is entrenched in the poultry sector, or the disease has become endemic in the country or region.

7. The development of more strategic approaches to surveillance at regional or wider scales should be encouraged through appropriate mechanisms. Parameters to be considered in such developments include *inter alia* migratory patterns of higher risk species and the risk of such species mixing either with other wild species and/or with poultry. This should be followed up by capacity development in terms of establishing logistic as well as human resource competence. In the short-term, this is perhaps most feasible for developed countries, from where learning and programmes can be transferred to other regions.

4. Epidemiology: tracing sources of infection

Conclusions

Integrated epidemiological investigations of occurrences of HPAI infection are fundamental to a better understanding of the natural history of H5N1 HPAI with the objective of reducing the risk of further infection: thus alleviating consequent social and economic impacts. These should explore the multiple possible paths by which this viral infection is known to be transmitted. The following issues are of high priority:

- As a component of national contingency planning, multi-disciplinary teams involving veterinary, epidemiological, biological, ornithological and other relevant expertise should be established in advance of cases of infection. These should include expertise from both governmental and non-governmental sectors.

- There remains an urgent need for better data related to the national and international trade in, and movements of, poultry and poultry products so that this information can be used in epidemiological modeling. Relevant data-bases related to poultry trade covering a range of scales from local to national and international should be established in liaison with the industry. In collecting such data, it will be important to explain to relevant stakeholders why it is required and seek their engagement.

- Avian influenza has been detected within captive birds in wildlife markets, highlighting a general lack of information about these areas as potential sources of infection. Better

information on wildlife trade together with enhances surveillance within markets is highly desirable.

- Epidemiological investigations should consider linkages to wild birds as one of the possible sources of infection. Given that common things happen more frequently, such considerations should not emphasize exceptional or unlikely possibilities.

- There is a need for better epidemiological quantification of the numbers of outbreaks in domestic birds related to the various potential means of the introduction of infection.

- In regions where synthesized information on the distribution and movements of wild birds do not exist, there remain important needs to provide such information to aid both epidemiologists and decision makers. This should include tools that summarize likely movements at various scales and for various periods.

- To more readily understand the spread of infection it is crucial that there is accurate knowledge of the timing[4] and sequence of events ('time-lines'). Time-lines, together with an understanding of which species are involved and exact locational information, are crucial to the generation of hypotheses that can then be used to direct subsequent epidemiological investigations. The importance of rapid and accurate official national reporting to OIE was stressed.

- The interpretation of cases of infection in wild birds is greatly aided by the collection of contextual information. The European Commission has published guidance which summarizes key information which should be collected (Annex 3A).

- The open sharing of data and information of data related to infection — both positive and negative — is critical. Yet it was recognised that in some countries and cultures there can often be strong pressures which militate against such transparency for various motives, including potential negative impacts on inward investment, or for commercial advantage. Overcoming such difficult barriers to the ready exchange and reporting of data (both within and between countries) is a crucially important issue that will require sustained and concerted efforts from all those involved.

- The provision of specialist ornithological advice to epidemiologists and other government officials responding to outbreaks is essential. Better international understanding of the various national advisory groups would allow rapid communication between national ornithological advisory groups at a regional scale (*e.g.* within Europe) so that specialist assessments and other information can be rapidly shared between countries.

- The development of epidemiological expertise in countries with limited relevant capacity would be greatly aided both by the development of guidance which outlines basic principles, together with case studies which demonstrate good practice. Care should be taken to avoid making such guidance too prescriptive so as to avoid limiting the creativity of epidemiological teams — given that many outbreaks may have unique features. There may be a need to develop different forms of guidance for developed and developing countries, and/or to differentiate between data-rich and data-poor countries.

Examples were given of a situation where the combination of several improbable events had combined to result in a case of infection. In investigating sources of infection, it is important not to jump to conclusions in the absence of thorough epidemiological investigations.

[4] To this end, the importance of clearly understanding what activities reported dates relate to was stressed. Different dates may be reported for the same samples depending on whether this refers to the date on which the sample was collected, the date it was submitted for laboratory testing, when it was tested, or even when the results were finally reported.

The international reporting of low quality data and information especially related to species identification continues to be a major issue. The situation has not improved over the last three years, with only 36% of all 1,671 OIE official reports identified to species level in 2006[5]. This involves issues related both to how information is collected by countries and reported to OIE, as well as how some of this information is then subsequently reported by OIE. The meeting identified several simple ways by which aspects of quality assurance could readily be built into the reporting chain[6] and strongly recommended that OIE take an initiative to enhance the quality of data-reporting, working with Task Force members. In doing this, consideration needs also to be given as to how countries can be better motivated to report higher quality, and more precise data and information.

Key recommendations for future action

1. The ultimate objective of structured epidemiological investigations of outbreaks in domestic poultry should be to identify the most likely source of infection so that the population attributable risk can be quantified. This allows assessment of the population attributable risks as related to the potential means of introduction of infection to domestic flocks so that this can then be used to estimate the proportionate rôle of the various potential means of introduction of infection, *e.g.* poultry, poultry products, fomite transmission, wild birds, *etc*. This allows the most relevant and efficient control measures to be put in place.

2. A central element of national contingency planning should be the establishment of multi-disciplinary epidemiological teams which should involve epidemiological, veterinary, virological, biological and ornithological expertise. There are good examples of the success of this approach which demonstrates the advantage of bringing together expert ornithologists so as to be able to advise veterinarians and epidemiologists. The establishment of such national Ornithological Expert Panels is strongly recommended.

3. There are massive international movements of poultry and poultry products, although full details of these are poor, especially for informal or illegal trade. It remains an important priority to develop better information about the national and international trade in poultry and poultry products at various scales, including transparency issues in industry – which calls for a healthy dialogue to be promoted. As part of the process of tracing bird movements it would be valuable to undertake more field research on market chains and sales so as to better understand the nature and extent of the poultry or ornamental bird trade, fighting cock exhibits, and the like, as well as giving special emphasis to trade through wet (live bird) markets.

4. The Task Force should stimulate the development of accessible guidance which gives general principles for epidemiological investigations related to a range of different outbreak and infection scenarios, as well as best practice case studies, which would have educational value.

5. Training in epidemiological principles is important, especially where there is limited national capacity. Organisations represented on the Task Force should consider how they might assist the development of such training.

6. In regions where synthesized information on the distribution and movements of wild birds do not exist, there remains an important need to gather, collate and provide such information to aid both epidemiologists and decision makers. This should include tools that summarize the likely bird movements at various scales and for various periods.

[5] R. Lee, WWT (unpublished)

[6] for example by having one form specifically for the reporting of avian influenza, which is specifically designed to avoid ambiguity and which would allow for the assessment of data quality.

7. Telemetry provides a valuable tool for better understanding of temporal and spatial movements of wild birds especially in relation to epidemiological investigations. The further use of this technology should be promoted.

8. To more readily understand the spread of infection it is crucial that there is accurate knowledge of the timing and sequence of events ('time-lines'). Time-lines, together with an understanding of which species are involved and exact locational information are all crucial to the generation of hypotheses that can then be used to direct subsequent epidemiological investigations and conduct meaningful phylogenetic studies based on genome sequencing data. The importance of rapid, official reporting to OIE was stressed.

9. The results of epidemiological investigations should always be published, including where these are inconclusive. Awareness of these would be facilitated by establishing hyperlinks to an international register of such investigations maintained on OIE's web-site. All organisations involved in the Task Force should continue to encourage transparency in reporting and openness in data sharing. The reporting of negative data is crucially important.

5. Communication, education and public awareness

Conclusions

There remains keen interest by the media in the spread of H5N1 HPAI and its impacts. Unfortunately, much reporting remains inaccurate. This can create political pressure for ill-advised and disproportionate policies such as the culling of wild birds and/or the destruction of their nests and wetland habitats. Conversely, an informed public can more readily assess levels of relative risk.

Communication of clear scientific messages is the key to better public understanding. Explaining issues of relative risk to the public is particularly important and the use of simple comparisons can help (*e.g.* compared to risk of a plane crashing, or a person being struck by lightening, *etc*.).

The meeting identified the following good practice on the basis of practical experience:

- Conservation organisations, scientists and veterinary services all need to work actively with the media to enhance the accuracy of reporting on this issue. This should include the development of much more effective communication strategies to give policy makers, stakeholders, and the general public more balanced information on real levels of risk and appropriate responses.
- The AIWEb site now provides a range of resources for media, and journalists should be encouraged to use this information, including the Task Force's booklet *Avian Influenza and Wild Birds*. The website and booklet should be further developed and updated.
- Do not be tempted to avoid awkward facts even if others do.
- Web-based organisational position statements should be regularly reviewed to ensure that they accurately present the current situation.
- Organisations should identify specific, informed members of staff who are responsible for media briefings and who work to a contingency and communications plan. That plan should think through, and prepare responses to potentially difficult questions.
- The provision of quotes for e-News Groups (Science Media Service) is a useful means of disseminating organisational positions.

There are several readily available guides for relating to the media, including the extensive guidance published by IUCN's Species Survival Commission which, *inter alia*, stresses **the five Fs of media relations**:

1. Fast
Respect journalists' deadlines. Return calls as pledged. An unreturned call is an incalculable 'faux pas'.

2. Factual
Be factual. But make the facts interesting. Journalists appreciate facts stated with some literary flourish.

3. Frank
Be candid. Never mislead journalists. Be as open as possible and respond to their questions.

4. Fair
Be fair to journalists if you expect them to be fair to you. Favouring one news outlet consistently will lose you the confidence of others.

5. Friendly
Like everyone else, journalists appreciate courtesy. Remember their names. Read what they write. Know their interests. Thank them when they cover your issues.

Maps and graphical representations
'A picture paints a thousand words'. Maps and graphical representations are powerful means of communication, although they also can distort reality. Particular issues which have the potential to misrepresent include:

- the inaccurate mapping of locations of infection (sometimes represented as the capital cities of the countries in which infection occurs);
- the shading of whole territories to depict the presence of infection, in situations where infection is actually restricted to perhaps one or two specific locations in one part of a territory; and
- that maps can dangerously simplify issues since they typically only show where infection is known, and not where it may be present yet unknown.

There would be benefits in the development of simple, but accurate illustrations that communicate AI-related information more accurately. These should include information on the movements and international trade in poultry and poultry products as well as of wild birds.

Key recommendations for future action

1. Those involved with avian influenza should proactively work with the media to enhance the accuracy of their reporting of science, thus improving public understanding. This should particularly involve the communication of positive messages as well as responses to negative ones. To this end, targeted briefings of journalists are helpful. The development of much more effective communication strategies is necessary to give policy makers, stakeholders and the general public more balanced information on the real levels of risk and appropriate responses.

2. Organisations should identify specific, informed members of their staff who are responsible for media briefings and who work on a contingency and communications planning. They should expect the unexpected and prepare for it. They should stick to areas of expertise and avoid comment about other issues. Briefing of media should always be evidence-based and avoid speculation in the absence of evidence. The accuracy of facts supplied by others should be repeatedly checked before passing these to the media. Much useful information is available on the Task Force web-site (www.aiweb.info).

3. Task Force members should use the booklet *Avian Influenza and Wild Birds* for media briefings and promote its use by others. It should be reviewed and updated as necessary. English, French, Spanish, Russian, Chinese and Arabic versions are now available. However, the Task Force should also develop a media 'tool kit' that brings together national and organisational media best practice and Frequently Asked Questions. This should include factual information that may be adapted for specific national needs and uses.

4. At present much guidance related to H5N1 HPAI is published in a limited range of languages. It is important to translate guidance into a wider range of other, and more local, languages so as to facilitate its dissemination.

5. The Task Force should stimulate the publication of simple bird identification guides in local languages so as to assist field-based staff responses to cases of infection. A web-based list or directory of experts that could assist (at a distance) in identification of bird species based on photographs would also be highly desirable.

6. The degradation of the health of ecosystems as documented by the Millennium Ecosystem Assessment and especially in the decline in extent and condition of wetlands is considered to have had a rôle in the evolution and spread of H5N1HPAI. This environmental change has created the conditions where there is closer contact and mixing between people, livestock (including poultry and domestic ducks), and wild waterbirds, potentially resulting in cross-infections. Reducing the opportunities for such contacts through preventing further loss of wetlands, improving mechanisms for the maintenance and wise use of wetlands is an important long-term requirement. To this end it would be valuable to develop and disseminate practical guidance, *inter alia* in collaboration with the Ramsar Convention.

6. Research and data needs

Conclusions

- There remains an important need to make data and information more readily available for decision makers and others who lack a technical understanding of ornithological information. Integrated syntheses of ringing and waterbird count data in the form of flyway atlases are important means by which this can be undertaken. Availability of information on birds at the level of the individual site is also important in responding to outbreaks and should always be included in response planning.

- Collaboration with existing waterbird research programmes would provide a cost-effective means of taking forward the implementation of satellite telemetric and other studies that aim to better understand waterbird migration and movements.

- Understanding better the behaviour and ecology of 'bridge' species that live in close proximity to man and poultry remains a priority area of research. This research is directly relevant to risk assessments and developing practical guidance for enhancing biosecurity.

- There remains a need to develop better understanding of levels of normal mortality levels in waterbirds.

Key recommendations for future action

1. There remains a need to develop a better understanding of the behaviour and ecology of 'bridge' species, as well as other means of the local or short distance spread of HPAI infection, such that this information might be used to develop enhanced guidance on biosecurity and contribute to risk analysis

2. It would be valuable to have a better understanding of the duration of viral shedding by bird species likely to be held in captivity. This would inform possible response strategies for zoos and collections in the event of infection outbreaks.

3. Better monitoring and surveillance for avian influenza within markets that trade in wildlife, is highly desirable. This should include research into which species are traded, their origins and movements.

4. There remains a need for better information on relevant cultural and religious practices, such as the widespread purchase and release into the wild of birds at certain times of the year (*e.g.* merit releases), and how those practices might be safeguarded but at the same time, minimize the risk of disease spread to humans, wild birds, and poultry.

5. H5N1 HPAI has affected several non-avian species, although knowledge of its ecology in these taxa is particular poor. Those species that have been infected are thought to be accidental, dead-end hosts, and there is no current evidence for them being involved in the maintenance of infection in any area. However, there is a need to continue to assess this issue during epidemiological investigations as it is possible that in the future a mammalian species may become a maintenance host and thus spread H5N1 HPAI locally.

6. Knowledge of the degree to which H5N1 HPAI may be passed between different bird species (and whether this happens asymptomatically or not) is important information that could help refine risk assessments. Research which leads to the development of serological tests for avian influenza antibodies in different species of birds will ultimately provide the most useful epidemiological information. Serological testing in past LPAI outbreaks has given important insights. Basic research on the immunological responses to H5N1 HPAI infection by birds (possibly using a representative avian model in one species) is important. A current priority is to develop validated serological diagnostic tests for the full range of bird species potentially at risk.

7. There remains a need to continue to gather, collate and co-ordinate data and information on wild bird distributions, their movements, stop-over sites and flyways. Satellite telemetry is a particularly valuable tool for this work. It is also important to continue to gather data at site level, since such local information is very limited in many parts of the world.

8. For many, access to the most recent scientific literature is constrained by inability to subscribe to expensive on-line journals, thus hindering understanding. The Task Force should help tackle this issue, possibly by working with authors to make the most relevant scientific literature available on AIWeB and web-based resources, or by investigating the potential for corporate sponsorship.

6. Finances

Key recommendations for future action

1. Recent events with respect to avian influenza have focussed attention on the need for resources to develop national veterinary capacity and programmes of surveillance and monitoring for wildlife diseases, especially zoonoses, but also to develop background information on wild birds, and especially their movements. A good start has been made, but there remains the need for further investments, particular to allow the development of the wildlife disease sector.

2. The Scientific Task Force on Avian Influenza has provided a valuable co-ordination function between its many collaborating organisations. Financial resources are required to facilitate its continued operation.

Annex 1. Guidance and key sources of information

Contingency planning and risk assessment

General

- Opinion of European Food Safety Authorities' (EFSA) Panel on Animal Health and Welfare and their *Scientific report on migratory birds and their possible role in the spread of Highly Pathogenic Avian Influenza.* Risk assessment for the EU regarding the potential for the arrival and spread of H5N1 in the EU by European Food Safety Authority (2006).
- EFSA Opinion adopted by the AHAW Panel related to *Animal health and welfare risks associated with the import of wild birds other than poultry into the European Union* European Food Safety Authority (2006).
- National web-sites of EU Member States dealing with H5N1
- *Manual on the preparation of national animal disease emergency preparedness plans*. FAO (1999).
- National contingency and avian/human pandemic influenza preparedness plans. Web-links to 35 national plans compiled by FAO.
- Wildlife trade and global disease emergence. (Karesh, W.B. *et al.* 2005).

Poultry holdings

- *Preparing for Highly Pathogenic Avian Influenza: a manual for countries at risk*. FAO & OIE (2006).
- *Avian Influenza Incursion Analysis (through wild birds).* British Trust for Ornithology Research Report No. 448. (2006) (12.2 MB file)

Nature reserves and wild birds

- *Urgent preliminary assessment of ornithological data relevant to the spread of Avian Influenza in Europe*. Wetlands International, (2006).
- Methodology for rapid assessment of ornithological sites Wetlands International (2006). See also example assessments of example European wetlands.
- *Guidelines for Reducing Avian Influenza Risks at Wetland Protected Areas of International Importance for Migratory Waterbirds.* R.C. Prentice (in prep). Available from the web-site of the UNEP/GEF Siberian Crane Wetlands Project from September 2007.
- Ramsar Convention Resolution IX.23 on Highly pathogenic avian influenza and its consequences for wetland and waterbird conservation and wise use (November 2005).
- The Ramsar Wetland Risk Assessment Framework. (Adopted by Ramsar Resolution VII.10; 1999).
- The Ramsar "Toolkit" 3rd Edition (Ramsar Handbooks for the Wise Use of Wetlands).

Zoos and collections

- Advice from the British and Irish Association of Zoos and Aquariums on avian influenza.
- BIAZA guidelines on vaccinating birds against Avian Influenza. British and Irish Association of Zoos and Aquariums (September 2006).

- Risk assessment: avian influenza in public parks/parkland & open waters due to wild bird exposure. (UK Health Protection Agency/Department for Environment Food and Rural Affairs, 2006).

Responding to avian influenza infection

- Prevention and Control of Avian Flu in Small-scale Poultry: A guide for veterinary paraprofessionals. *A guide for veterinary paraprofessionals in Vietnam* and *A guide for veterinary paraprofessionals in Cambodia.* FAO [Also available in French, Indonesian, Kyrgyz, Laoatian, Russian, Spanish and Vietnamese].
- Summary record of the Joint meeting of the Standing Committee on the Food Chain and Animal Health and of the Ornis Committee, Brussels, 1 December 2006. (Includes a review of HPAI outbreaks in the EU 2005-2006).
- Interim Guidance for Protection of Persons Involved in U.S. Avian Influenza Outbreak Disease Control and Eradication Activities. US Centers for Disease Control and Prevention (2006).
- Avian Influenza: Protecting Poultry Workers at Risk. US Safety and Health Information Bulletin. U.S. Department of Labor, Occupational Safety and Health Administration (2004).

Surveillance and early warning systems

- EU Guidelines for AI surveillance in wild birds and poultry in 2007. European Commission, DG SANCO (2007).
- Guidelines on the implementation of survey programmes for avian influenza in poultry and wild birds to be carried out in the Member States in 2007. European Commission, DG SANCO (2006).
- *Guiding Principles for Highly Pathogenic Avian Influenza Surveillance and Diagnostic Networks in Asia*. FAO (2004).
- *Wild Bird HPAI Surveillance: sample collection from healthy, sick and dead birds*. FAO (2006).
- Wild birds and Avian Influenza in Africa: summary of surveillance and monitoring programmes. Wetlands International, CIRAD & FAO.
- Global Avian Influenza Network for Surveillance (GAINS)
- Results of EU avian influenza surveillance. European Commission, DG SANCO.
- EU Animal Disease Notification System. European Commission, DG SANCO.
- Emergency assistance for early detection and prevention of Avian Influenza; Terms of Reference for Participants in Field Sampling Missions. Wetlands International internal guidance (2006).

Health and safety guidance

- Diseases from birds, with particular reference to Avian Influenza. UK guidance to bird ringers; British Trust for Ornithology (March 2006).
- Working with highly pathogenic avian influenza virus. UK Health and Safety Executive guidance.

- Risk assessment: avian influenza in public parks/parkland & open waters due to wild bird exposure. UK Health Protection Agency/Department for Environment Food and Rural Affairs (2006).

Epidemiology: tracing sources of infection

- Epidemiology of H5N1 Avian Influenza in Asia and implications for regional control. (2005).
- Outbreaks of H5N1 HPAI virus in Europe during 2005/2006: an overview and commentary. UK Department for Environment Food and Rural Affairs (2006). [3.4 MB]
- Guidelines on the implementation of survey programmes for avian influenza in poultry and wild birds to be carried out in the Member States in 2007. European Commission, DG SANCO (2006).
- Summary epidemiological report on a H5N1 HPAI case in turkeys in England, January 2007 which illustrates the modus operandi of the UK Ornithological Expert Panel in a structured epidemiological investigation. UK Department for Environment Food and Rural Affairs (2007).

Communication, education and public awareness

- IUCN Species Survival Commission Media Guide
- Science and Development Network: Dealing with the media
- Green Guide to effective PR
- Civicus Toolkit on handling the media
- AIWEb media pages

Annex 2. Progress since the 2006 Scientific Task Force on Avian Influenza seminar in Nairobi

Contingency planning and risk assessment

- Many national risk assessments and contingency plans have now been developed. However, full implementation of these remains an issue in some countries, and further, many such assessments relate more to human pandemic influenza contingency planning than to other aspects of avian influenza assessments in poultry or wildlife populations. There remains a need to better collate such risk assessments, through either a clearing house mechanism or an active collaboration between agencies or institutions.

- Wetlands International and EURING have produced, with funding from the European Commission, a synthesis of data and information related to waterbird distribution, numbers and movements in Europe and analyses to predict migratory patterns is being produced at the moment. This has helped to develop risk assessments for the EU, including those related to species and locations. There remains a pressing need for similar assessments to be undertaken for Neotropical, African and Asian flyways for which such assessments remain lacking.

- There has been growing awareness of eco-health issues and the unsustainable nature of intensive poultry production processes.

Surveillance and early warning systems

- There has been generally good development of more strategic programmes of surveillance in wild bird populations partly based on risk assessments within the European Union, although progress elsewhere has been more limited. The recommended establishment of long-term AIV surveillance programmes in strategically important mixing/staging areas used by migratory birds has still to be developed.

- The funding of the NEWFLUBIRD programme by the European Commission has been a significant development. This provides a multidisciplinary network for early warning system for influenza viruses in migratory birds in Europe. The network includes ornithological studies and sampling, virus detection, isolation and characterisation and data processing for early warning and risk evaluation, and it brings together a multi-disciplinary consortium involving virologists, epidemiologists, modellers and ornithologists, liaising with relevant international organisations and policy makers. It is a potential model for other geographical regions.

- The development of the Global Avian Influenza Network for Surveillance (GAINS) has valuably started to provide wider international perspectives on the extent and location of current surveillance for avian influenza viruses.

- There remains a need to develop regional 'hubs' for AI reporting (such as for example is provided by the EU and COMESA). Regional overview of reporting continues to be desirable in other parts of the world, for example in East, South-East and Central Asia, and the Neotropics.

- The Global Early Warning System (GLEWS) for transboundary animal diseases, including zoonoses— a joint initiative of FAO, OIE and WHO — has been developed. As highlighted

in Nairobi, it remains desirable to augment GLEWS such that it has the capability to better track and report on H5N1 HPAI in populations of wild birds.

- The development of capacity to undertake national programmes of surveillance for avian influenza remains a major issue. Significant progress has been made in the framework of the FAO Technical Co-operation Programmes (Africa, Middle East and Eastern Europe) including the implementation of surveillance programmes by CIRAD and Wetlands International in Africa which have had a training element.

- Programmes of satellite telemetry of migratory waterbirds in Africa, Mongolia and China by FAO, the US Geological Service, CIRAD and Wetlands International have combined to make a better understanding of migration patterns.

Communication, education and public awareness

- The development of the AIWEb site has been a major development in providing a access to a wide range of information about avian influenza targeted as a number of separate audiences.

- A leaflet on avian influenza and wild birds has been developed by the Task Force and published in Chinese, English, French, Spanish, Russian and Arabic versions.

Annex 3. Recommended ornithological information to be collected during surveillance programmes or the field assessment of mortality events in wild birds

A. Useful information to be collected:

1. All birds from which samples are taken should be identified to species. Where clearly distinguishable sub-species or discrete populations exist as for some geese, this information should also be collected and reported[8]. Age[9] and sex should be recorded wherever possible.

2. Close collaboration with ornithologists in the capture and sampling of live birds not only facilitates identification of birds but also gives the opportunity to collect additional information on the sampled live birds (such as weight, age, sex and condition), important to developing better understanding of viral ecology and epidemiology. Standard protocols exist for the collection of such data through national ringing schemes (details of which are available via EURING[10]). Recording individual ring numbers[11] in the reporting spreadsheet provides a means of accessing these data for future analysis.

3. To provide an audit of identification, it is highly desirable that a clear digital photograph[12] is taken of each sampled bird (especially those found dead and/or not identified by ornithologists) and stored at least until confirmation of laboratory tests. In the event of positive results further examination of such photos can provide additional information on the age and sex of the bird, in addition to proving the identity of the species beyond doubt and thus allowing the case to be correctly put into context. To facilitate this, each individual bird should be given a code that is used on the cloacal and oro-pharyngeal swabs taken, and this code should be on a piece of card that is visible in each photograph taken.

4. Especially related to sampling in the vicinity of outbreaks, it is desirable to collect a range of contextual information so as to better understand the viral epidemiology of H5N1 HPAI in wild bird populations. Such information should include:

    a. clear locational and descriptive data about the catching site, ideally GPS co-ordinates, and including habitat description (*e.g.* lake, river, village pond, fish farm, *etc.*) and distance to human settlement, agricultural land, and poultry farms;

    b. record of the numbers of each species of other live birds in the sampling area that were not sampled;

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[7] Based on Guidelines on the implementation of survey programmes for avian influenza in poultry and wild birds to be carried out in the Member States in 2007. European Commission, DG SANCO, 2006.

[8] Wetlands International's publication *Waterbird Population Estimates* [Wetlands International 2006. *Waterbird Population Estimates - Fourth Edition*. Wetlands International, Wageningen, The Netherlands. 239 pp.] should be used as a source of information on the taxonomy and populations of waterbirds.

[9] Waterbirds are aged mainly by the size and shape of their wing feathers (mainly on greater covert and tertial shape - www.bto.org/ringing/ringinfo/resources/topography.pdf) and their tail feathers (juveniles having notched tail feathers).

[10] www.EURING.org

[11] Records of previously ringed or colour-ringed birds provide especially valuable information and should always be reported to national ringing offices or to EURING - www.ring.ac. Colour-rings on birds should always be photographed *in situ.*

[12] In order to facilitate identification of bird species (which can sometime vary in quite minor plumage details, especially at certain times of the year), photographs should be taken according to the guidance given in part B of this Annex.

c. if available, records of bird movements (arrivals/departures) which occurred at the sampling site prior to the sampling;

d. assessment of the numbers of each species of live bird in the sampling area that were not sampled but that were showing signs of ill health; and

e. given that birds of some species (such as Mallards *Anas platyrhynchos*) can occur either as free-living birds which are able to move between sites, or occur in a feral state, habituated to foods provided by man, distinguishing between these categories would be useful. Sometimes the presence of unusual plumage patterns - indicating domestication - is useful in this respect.

B. Guidance on taking photographs of dead birds for identification purposes

The following simple guidance will assist non-specialists in taking photographs, especially of dead birds, that will allow subsequent identification to species. Different bird species are identified by differing characteristics, so it is difficult to provide universal guidance applicable in all situations. However, the following is a minimum standard that should be followed.

All wild birds collected for analysis for HPAI should have digital photographs[13] taken as soon as possible after collection. The bird should fully fill the photograph and wherever possible include a ruler or other scale measure.

Photographs should be taken of:

- the whole bird, dorsal side, with one wing stretched out and tail spread and visible;
- the head in profile clearly showing the beak;
- close-up photos of the tips of wing feathers can often determine whether the bird is an adult or a juvenile (bird in its first year);
- ideally photographs of both dorsal and ventral views of the bird should be taken[14]; and
- any ventral photographs should show the legs and feet (since leg colour is often an important species diagnostic). If any rings (metal or plastic) are present on the legs, these should be photographed *in situ* as well as recording ring details.
- Any conspicuous markings/patterns should be photographed.

At certain times of the year, such as late summer (July - late August in the northern hemisphere) many waterbirds, and especially ducks and geese, undergo moult and can be especially difficult to identify by non-specialists. At such times clear photographs are especially important to aid identification of (duck) carcasses. The patch of colour on the open wing (called the "speculum") is often especially useful. The identification of young gulls at any time of the year is also difficult and typically they will also need to be photographed and identified by specialists.

[13] Each photograph should be taken at the highest resolution possible and if the camera has a 'date stamp' feature then this should be enabled so that the image is saved with a time reference – this may help verify the sequence of images taken at a site on a day. Images should be downloaded to a computer as soon as possible and information about location and date added to the file properties.

[14] Photographs of the upper and under surfaces of the wing and spread tail will facilitate aging and sexing of birds (*e.g.* Northern Pintail *Anas acuta*).

Photographs should be retained, linked to an individual specimen, at least until laboratory tests are returned as negative for avian influenza.

Photographs can be used immediately if identification of the species of bird is in any doubt, and for subsequent checking of the identification if necessary.

A unique code or reference number, which is the same as the code or reference number of any samples taken from the birds should be visible in each photograph so as to link samples and photographs.

Glossary

AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
AI	Avian influenza
AIV	Avian influenza virus
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
CMS	Convention on the conservation of Migratory Species
COMESA	Common Market for Eastern and Southern Africa
FAO	UN Food and Agriculture Organisation
GAINS	Global Avian Influenza Network for Surveillance
GLEWS	Global Early Warning System for transboundary animal diseases, including zoonoses (FAO, OIE, WHO)
GPS	Global Positioning System
HPAI	Highly Pathogenic Avian Influenza
LPAI	Low Pathogenic Avian Influenza
NEWFLUBIRD	Network for Early Warning of Influenza Viruses in Migratory Birds in Europe
OIE	World Organisation for Animal Health
WWT	The Wildfowl & Wetlands Trust, UK

Appendix 2. Ornithological Expert Panels

Several Contracting Parties have found it valuable to establish advisory panels involving best available ornithological expertise as a means of responding to the call in Resolution IX.23 to integrate ornithological expertise within government disease response processes. Such panels can provide specialist advice to veterinarians, epidemiologists and others in response to outbreaks. The following guidance is based on these experiences.

Whether or not a separate panel is established, or alternatively that ornithological expertise is instead integrated within other governmental processes, will depend on the nature of existing organisational structures. This should be determined nationally. However, ideally any Ornithological Expert Panel (OEP) should be part of the epidemiological team that has the responsibility to investigate HPAI outbreaks as such integration greatly assists in the identification of achievable scientific objectives.

Table 2.1 lists further sources of information and guidance as to how expert specialist advice can be integrated within government responses.

Composition

Ornithological Expert Panels should comprise best available ornithological expertise drawn from both governmental and non-governmental sectors, including – as relevant – ornithological experts from research institutes or universities. Staff from national bird ringing centres and national or other relevant waterbird monitoring schemes, where these exist, should be involved so as to facilitate rapid analysis of data and information drawn from relevant databases and other information sources

Establishment

OEPs or other advisory bodies should be established in advance of disease outbreaks as part of forward national contingency planning. There is value to all involved in explicitly establishing the formal relationship between OEP (or similar) within other government disease response processes and structures.

Scale and federal states

The scale at which advice is sought will depend on how government is structured. If animal disease responses are co-ordinated within federal states at sub-national scales, then typically, specialist ornithological advice should be available to decision-makers at that scale.

Mode of working

In order to facilitate the rapid convening of advisory expertise, contingency planning should plan means of bringing together relevant experts at short notice so as to provide advice to decision makers immediately after confirmation of infection outbreaks. Where possible, the experts should be made aware and kept up to date on the epidemiological features of any outbreak involving

domestic poultry and the progress of the epidemiological investigations. It should be anticipated that experts will be scattered, and thus may not be able physically to assemble, thus necessitating the use of teleconferencing or other similar arrangements which should be planned for.

Emergency ornithological field assessments

In order to assist epidemiological investigation, and to help better to reduce risk of disease spread, contingency planning should address the need for emergency field assessments so as to establish the nature of, and collect information on, populations of wild birds near an outbreak site. These field assessments are usually driven by outbreak specific objectives, but can include local wild bird movements and the degree of access to domestic poultry. Ornithological advice on additional and specific surveillance is frequently sought following these assessments. One possible format for such evaluations is provided by Wetlands International (2006).

Field assessments should be complemented by desk based rapid ornithological data assessments which seek to interrogate available data sources and thus to inform risk assessments. Even if available data in birds near outbreaks may be limited, it will always assist decision-making to systematically collate relevant information.

International networking

It is very valuable to be able to share risk assessments, and ornithological data and evaluations between neighbouring countries (or within wider geographic regions). To this end, national OEPs should collaborate together at regional scales to develop collective international assessments and understanding.

Lessons learnt

Following the activation of the OEP in the event of an outbreak, it is essential afterwards to then undertake a formal 'lessons learnt' review, to identify any problems or areas of operation where there may be scope for improvement of activity. The outcome of such a review should then be implemented by modifying contingency arrangements (and/or formal Terms of Reference).

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Appendix 3. Scientific summary of highly pathogenic avian influenza H5N1 of Asian lineage: wildlife and conservation considerations

Definition of avian influenza

Avian influenza is a contagious disease caused by influenza A viruses, affecting many species of birds. Avian influenza is classified according to disease severity into two recognized forms: low pathogenic avian influenza (LPAI) and highly pathogenic avian influenza (HPAI). LPAI viruses are generally of low virulence, while HPAI viruses are highly virulent and result in nearly 100% mortality in infected domestic flocks (CIDRAP 2007). The natural reservoir of LPAI viruses is in wild waterbirds – most commonly in ducks, geese, swans, waders and gulls (Hinshaw & Webster 1982; Webster *et al.* 1992; Stallknecht & Brown 2007).

To date, influenza A viruses representing 16 hemagglutinin (HA) and 9 neuraminidase (NA) subtypes have been described in wild birds and poultry throughout the world (Rohm *et al.* 1996; Fouchier *et al.* 2005). Viruses belonging to the antigenic subtypes H5 and H7, in contrast to viruses possessing other HA subtypes, may become highly pathogenic when transmitted from wild birds to poultry (Senne *et al.* 1996).

Notifiable avian influenza is defined by the World Organization for Animal Health (OIE) as "an infection of poultry caused by any influenza A virus of the H5 or H7 subtypes or by any avian influenza virus with an intravenous pathogenicity index (IVPI) greater than 1.2 (or as an alternative at least 75% mortality)" (OIE 2004).

Genesis of highly pathogenic avian influenza viruses

In wild waterbirds, LPAI viruses are a natural part of the ecosystem. They have been isolated from over 90 species of wild bird, and are thought to have existed alongside wild birds for millennia in balanced systems. In their natural hosts, avian influenza viruses generally do not cause disease; instead, the viruses remain in evolutionary stasis as indicated by low genetic mutation rates (Gorman *et al.* 1992, Taubenberger *et al.* 2005). When LPAI viruses are transmitted to vulnerable poultry species, only mild symptoms such as a transient decline in egg production or reduction in weight gain (Capua & Mutinelli 2001) are induced. However, where a dense poultry environment supports several cycles of infection, the viruses may mutate, adapting to their new hosts, and for the H5 and H7 subtypes these mutations can lead to generation of a highly pathogenic form. Thus, HPAI viruses are essentially products of intensively farmed poultry (GRAIN 2006; Greger 2006). They should be viewed as something artificial, made possible by human modification of a naturally balanced system.

After an HPAI virus has arisen in poultry, it has the potential both to re-infect wild birds and to cause disease in other non-avian taxa, with different subtypes showing varying predilection for horses, pigs, humans, mustelids, felids, and even seals and cetacea. If influenza A viruses adapt inside these new hosts to become highly transmissible, there can be devastating consequences, such as the human influenza pandemics of the 20th century (Kilbourne 2006). The conditions necessary for cross-infection are provided by agricultural practices that bring together humans, poultry and other species in high densities in areas where there is also the potential for viral

transmission from wild birds to domestic ducks on shared wetlands and in 'wet' (*i.e.* live animal) markets (Shortridge 1977; Shortridge *et al.* 1977).

Highly pathogenic avian influenza H5N1 of Asian lineage (HPAI H5N1)

HPAI H5N1 of Asian lineage has infected domestic, captive and wild birds in more than 60 countries in Africa, Asia and Europe. By November 2005, over 200 million domestic birds had died from disease or been slaughtered in attempts to control its spread; the economies of the worst affected countries in southeast Asia have suffered greatly, with lost revenue estimated at over $10 billion (Diouf 2005), and there have been serious human health consequences. By February 2008, the World Health Organisation (WHO) had confirmed more than [350] human cases, [over 60%] of those fatal.

Sporadic deaths in wild birds have been reported since 2002 and the first outbreak involving a large number of wild birds was reported in May 2005, in Qinghai province, China (Chen ; Lui). Between 2002 and the present, the virus has infected a variety of wild bird species (Gilsdorf 2006; Lee unpublished; Olsen 2006; USGS 2008), but which species are important in H5N1 HPAI movement and whether the virus will become enzootic in wild bird populations is still unknown (Brown *et al.* 2006).

The virus has also infected a limited number of domestic, captive and wild mammals, including captive Tigers *Panthera tigris* and Leopards *Pathera pardus* and domestic pigs in southeast Asia, and domestic cats and a wild Stone Marten *Martes foina* in Germany. These cases were the result of 'spillover' infection from birds. There is no known reservoir of HPAI H5N1 virus in mammals and no current evidence that the virus can be readily transmitted from mammal to mammal.

Emergence of HPAI H5N1 in poultry in southeast Asia (1996 – 2005)

HPAI H5N1 first received widespread recognition following a 1997 outbreak in poultry in Hong Kong SAR with subsequent spread of the virus to humans. During that outbreak, 18 human cases were recognized and six patients died. The outbreak ended when all domestic chickens held by wholesale facilities and vendors in Hong Kong were slaughtered (Snacken 1999). A precursor to the 1997 H5N1 strain was identified in Guangdong, China, where it caused deaths in domestic geese in 1996 (Webster 2006).

Between 1997 and 2002, different reassortments (known as genotypes) of the virus emerged, in domestic goose and duck populations, that contained the same H5 HA gene but had different internal genes (Guan *et al.* 2002; Webster 2006).

In 2002, a single genotype emerged in Hong Kong SAR and killed captive and wild wildfowl in nature parks there. This genotype spread to humans in Hong Kong in February 2002 (infecting two, killing one) and was the precursor to the Z genotype that later became dominant (Sturm-Ramirez *et al.* 2004; Ellis *et al.* 2004).

Between 2003 and 2005, the Z genotype spread in an unprecedented fashion across southeast Asia, affecting domestic poultry in Vietnam, Thailand, Indonesia, Cambodia, Laos, Korea, Japan, China and Malaysia. Later analysis showed that the H5N1 viruses that caused outbreaks in Japan and

Korea were genetically different from those in other countries (the V genotype) (Mase *et al.* 2005; Li *et al.* 2004; Webster *et al.* 2006).

In April 2005, the first major outbreak in wild birds was reported. Some 6345 wild birds were reported dead at Qinghai Lake in central China. Species affected were Great Black-headed Gull *Larus ichthyaetus*, Bar-headed Goose *Anser indicus*, Brown-headed Gull *Larus brunnicephalus*, Great Cormorant *Phalacrocorax carbo* and Ruddy Shelduck *Tadorna ferruginea*.

Geographical spread of HPAI H5N1 out of southeast Asia (2005 – 2006)

In July 2005, Russia reported its first outbreaks; domestic flocks were affected in six regions of western Siberia and dead wild birds were reported in the vicinities of these outbreaks. Kazakhstan reported its first outbreak in August 2005 in domestic birds. In the same month, 89 wild birds described as migratory species were reported infected at two lakes in Mongolia.

Europe reported its first outbreaks in October 2005 when infection was detected in domestic birds in Romania and Turkey. In the same month, Romania reported sporadic cases in wild birds as did Croatia and European parts of Russia. In November, the virus spread to domestic birds in Croatia and the Ukraine, and the Middle East reported its first case: a flamingo kept as a captive bird in Kuwait. During December, two outbreaks were reported in European Russia in wild swans (species unreported) in regions near the Caspian Sea.

In the first half of 2006, the spread of HPAI H5N1 continued across Europe (Sabirovic *et al.* 2006; Hesterberg *et al.* 2007) and the Middle East and into Africa. Between January and May, infection was reported in 24 European countries with the majority of cases occurring in February and March in wild birds. During the same period, outbreaks were reported across central Asia and the Middle East, affecting domestic birds in Azerbaijan, India, Bangladesh, Pakistan, Iran and Iraq, with Azerbaijan also reporting infected wild birds. The first reported outbreak in Africa occurred in January in poultry in Nigeria, and by the end of April, seven other African nations[15] had reported outbreaks.

By May 2006, outbreaks in Europe, the Middle East and Africa had for the most part decreased in frequency. Small numbers of cases of infection were reported in Hungary, Spain and the Ukraine in June; Pakistan and Russia in July; and one case was identified in a captive swan in Germany in August. Egypt was exceptional, continuously reporting outbreaks throughout 2006. It is also considered likely that outbreaks continued in poultry in Nigeria.

Throughout the time HPAI H5N1 was spreading across central Asia, Europe, the Middle East and Africa, it maintained a stronghold in poultry in southeast Asia. In 2006, outbreaks were reported in Cambodia, China, Hong Kong, Indonesia, Korea, Laos, Malaysia, Myanmar, Thailand and Vietnam.

Outbreaks of HPAI H5N1 since 2006 and the current situation

Compared with 54 countries reporting 1,470 outbreaks to the OIE in 2006, 30 countries reported 638 outbreaks in 2007. In Europe, eight countries reported sporadic and relatively isolated

[15] List countries if possible

outbreaks in poultry that were quickly controlled; infected wild birds were reported in Germany, France, United Kingdom and the Czech Republic; and birds at a rehabilitation centre were affected in Poland. In the Middle East and central Asia, poultry outbreaks occurred throughout 2007 in Egypt and Bangladesh with over 350 outbreaks reported to the OIE from these two countries alone. Poultry (and in some countries captive birds) were also affected in India, Kuwait, Saudi Arabia, Pakistan, Afghanistan and Israel with most outbreaks occurring between February and April, and again between October and December. In Africa, HPAI H5N1 was reported in domestic birds in Togo, Ghana and Benin; and is considered to have become enzootic in Nigeria. Again, as in 2006, poultry outbreaks continued across southeast Asia. Sporadic cases in wild birds were reported in Japan and Hong Kong.

At present, in January 2008, a small number of wild bird cases are being detected in the United Kingdom; large numbers of poultry outbreaks are occurring in India and parts of southeast Asia; and the virus is considered to be enzootic in poultry in Egypt, Indonesia and Nigeria; and possibly enzootic in Bangladesh and China.

Major outbreaks of HPAI H5N1 in wild birds

Prior to HPAI H5N1, reports of HPAI in wild birds were very rare. The broad geographical scale and extent of the disease in wild birds is both extraordinary and unprecedented. The following table (Table 1) summarises the known major outbreaks of HPAI H5N1 in wild birds.

Table 1. Major outbreaks of highly pathogenic avian influenza H5N1 in wild birds

Year	Month(s)	Location(s)	Description of affected birds
2005	April	Qinghai Lake in central China	6345 waterbirds, the majority of which were Great Black-headed Gulls, Bar-headed Geese and Brown-headed Gulls
	August	Lake Erhel & Lake Khunt in Mongolia	89 waterbirds including ducks, geese and swans
	October – November	Romania & Croatia	Over 180 waterbirds, mainly swans
2006	January	Coastal area in the vicinity of Baku, Azerbaijan	Unspecified number of birds reported to the OIE as “various migratory birds”
	January – May	23 countries in Europe including Turkey and European Russia	The majority of cases occurred in ducks, geese and swans but a wide variety of species were infected including other waterbirds & raptors
	February	Rasht, Iran	153 wild swans
	May	Multiple locations in Qinghai province, China	Over 900, mainly waterbirds, the majority of which were Bar-headed Geese
	May	Naqu, Tibet	Over 2300 birds – species composition unclear but 300 infected Bar-headed Geese were reported
	June	Lake Hunt in Bulgan, Mongolia	12 waterbirds including swans, geese and gulls

Year	Month(s)	Location(s)	Description of affected birds
2007	June	Germany, France and the Czech Republic	Over 290, mainly waterbirds, found mostly in Germany

* Data sources include OIE disease information reports and the German Friedrich-Loeffler Institute epidemiological bulletins – dates, locations and numbers may differ slightly in other sources.

Are wild birds involved in the spread of HPAI H5N1?

Numerous species of wild birds, especially waterbirds, are susceptible to infection by the HPAI H5N1 virus. Close contact between wild birds and poultry can lead to cross-infection, from poultry to wild birds and from wild birds to poultry. The loss of wetlands around the globe may force many wild birds onto alternative sites like farm ponds and paddy fields, bringing them into direct contact with chickens, ducks, geese, and other domestic fowl. Additionally, species that live in and around poultry farms and human habitations may serve as "bridge species" that could potentially transmit the virus between poultry and wild birds. Genetic analysis and other indirect evidence suggests that in at least some cases wild migratory birds are likely to have contributed to spread in some areas. The relative importance of this mechanism, however, is unclear in the present state of knowledge. Poor planning in response to development pressures has led to the increasing loss or degradation of wild ecosystems, which are the natural habitats for wild birds. The displaced wild birds increasingly seek to feed and live in areas populated by domestic poultry (and humans). This provides greater opportunities for the spread of HPAI H5N1 between wild and domestic birds, and thence to humans. This issue of "ecohealth" highlights the interplay between agriculture, animal (domestic and wild) health, human health, ecosystem health, and socio-cultural factors. However, it is unlikely that wild birds play a major role in spreading avian influenza (Kilpatrick *et al.* 2006; Gauthier-Clerc *et al.* 2007). The total number of wild birds affected has so far been small and although billions of wild birds cross continents regularly during their migrations they do not seem to have a significant impact on spreading the virus on a large scale.

Wildlife conservation implications

Prior to HPAI H5N1, reports of HPAI in wild birds were very rare. The broad geographical scale and extent of the disease in wild birds is both extraordinary and unprecedented, and the conservation impacts of HPAI H5N1 have been significant.

It is estimated that between 5-10% of the world population of Bar-headed Goose *Anser indicus* died at Lake Qinghai, China in spring 2005. At least two globally threatened species have been affected: Black-necked Crane *Grus nigricollis* in China and Red-breasted Goose *Branta ruficollis* in Greece. Approximately 90% of the world population of Red-breasted Goose is confined to just five roost sites in Romania and Bulgaria, countries that have both reported outbreaks, as also have Russia and Ukraine where they also over-winter.

However, the total number of wild birds affected has been small in contrast to the number of domestic birds affected, and many more wild birds die of commoner avian diseases each year. Perhaps a greater threat than direct mortality is the development of public fear about waterbirds resulting in misguided attempts to control the disease by disturbing or destroying wild birds and their habitats. Such responses are often encouraged by exaggerated or misleading messages in the media.

Avian influenza and wetlands

Given the ecology of the natural hosts of LPAI viruses, it is unsurprising that wetlands play a major role in the natural epidemiology of avian influenza. As with many other viruses, particles survive longer in colder water (Lu *et al.* 2003; Stallknecht *et al.* 1990b), and the virus is strongly suggested to survive over winter in frozen lakes in Arctic and sub-Arctic breeding areas. Thus, as well as the waterbird hosts, these wetlands are probably a permanent reservoir of LPAI virus (Rogers *et al.* 2004; Smith *et al.* 2004) (re-)infecting waterbirds arriving from southerly areas to breed (shown in Siberia by Okazaki *et al.* 2000 and Alaska by Ito *et al.* 1995). Indeed, in some wetlands used as staging grounds by large numbers of migratory ducks, avian influenza viral particles can be readily isolated from lake water (Hinshaw *et al.* 1980).

An agricultural practice that provides ideal conditions for cross-infection and thus genetic change is used on some fish-farms in Asia: battery cages of poultry are placed directly over troughs in pig-pens, which in turn are positioned over fish farms. The poultry waste feeds the pigs, the pig waste is either eaten by the fish or acts as a fertiliser for aquatic fish food, and the pond water is sometimes recycled as drinking water for the pigs and poultry (Greger 2006). These kinds of agricultural practices afford avian influenza viruses, which are spread via the faecal-oral route, a perfect opportunity to cycle through a mammalian species, accumulating the mutations necessary to adapt to mammalian hosts. Thus, as the use of such practices increases, so does the likelihood that new influenza strains lethal to humans will emerge (Culliton 1990; Greger 2006).

As well as providing conditions for virus mutation and generation, agricultural practices, particularly those used on wetlands, can enhance the ability of a virus to spread. The role of Asian domestic ducks in the epidemiology of HPAI H5N1 has been closely researched and found to be central not only to the genesis of the virus (Hulse-Post *et al.* 2005; Sims *et al.* 2005), but also to its spread and the maintenance of infection in several Asian countries (Shortridge & Melville 2006). Typically this has involved flocks of domestic ducks used for ‘cleaning’ rice paddies of waste grain and various pests, during which they are exposed to wild ducks using the same wetlands. Detailed research (Gilbert *et al.* 2006; Songserm *et al.* 2006) in Thailand has demonstrated a strong association between the HPAI H5N1 virus and abundance of free-grazing ducks. Gilbert *et al.* (2006) concluded that in Thailand “wetlands used for double-crop rice production, where free-grazing duck feed year round in rice paddies, appear to be a critical factor in HPAI persistence and spread”.

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