Chapter 3
General Management Practices

In this chapter you will find:

A standardised procedure for completing a disease risk assessment.

Guidance on how to incorporate disease management into management plans for wetlands.

Guidance for reducing the risk of emerging disease.

Guidance for detecting, assessing and responding to disease outbreaks.

Guidance for managing disease.

Case studies: descriptions and photos of wetland managers' experiences responding to disease problems.

Chapter contents

3.1 Assessing risk and planning for the future

Many ecological and anthropogenic factors may affect the risk of disease emergence or re-emergence in wetlands, including:

- presence of human populations
- presence of domestic livestock
- presence of non-native species
- seasonal influxes of wild or domestic species
- trade
- industry
- agricultural activities
- habitat loss or modification
- weather
- impacts of climate change.

Dealing with such a diversity of factors can seem daunting. However, a risk assessment approach can be used to quantify and/or qualify risks and so help the wetland manager to identify an appropriate course of management actions.

The wetland manager is not expected to be a disease expert. Understanding diseases of wildlife and domestic stock, and their public health implications, within wetlands requires a multidisciplinary approach. Advisory groups reflecting a diverse range of knowledge and understanding for specific or general issues, can significantly improve risk assessments and advise on best courses of actions that safeguard both livestock interests and wildlife protection appreciating that these may sometimes seem to be at odds. This is illustrated by the use of advisory groups to deal with highly pathogenic avian influenza H5N1 where it is important to appreciate human health issues, poultry trade and economic issues, alongside factors relating to wildlife such as the behaviour and movements of migratory birds.
►Case study 3-1. UK Ornithological Expert Panel – integrated expertise for dealing with highly pathogenic avian influenza H5N1.

To ensure the principles and specific actions for disease management and control are embedded within the management practices at a wetland site, they should be written into management plans and updated, as and when, disease risks change.

Disease control in endemic disease situations depends upon engagement of all key stakeholders together with their sustained participation and cooperation. Disease control in outbreak situations is similarly dependent on stakeholder engagement but also requires preparedness for a rapid response. Appropriate contingency planning helps to reduce response times and promotes the likelihood of an effective resolution. Contingency plans should be developed in 'peacetime' *i.e*. in advance of disease problems, when it is possible to fully consider current or potential issues, determine appropriate courses of action, develop relationships and communication channels, and test plans (*e.g.* by means of exercises) to evaluate whether or not they are fit-for-purpose. It is sensible to build a degree of flexibility into contingency plans as unexpected local conditions may be important in determining the action to take. Following implementation of contingency plans, they should be critically reviewed and updated.

This section contains further information on the following topics:

- *Risk assessment*
- *Advisory groups*
- *Integrating disease into wetland management plans*
- *Contingency planning*

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- To ensure consideration for **disease prevention and control** is **at the heart of wetland management**, activities need to be **integrated into wetland management plans**. Clearly defined roles and responsibilities are required to ensure effective management which can deliver a range of benefits to stakeholders.
- **Risk assessments are valuable tools for animal health planning** and serve to identify problems/hazards and their likely impact thus **guiding wetland management practices**. From these assessments, risk management and communication actions can be taken. **Good** local, national and regional **surveillance data** are needed **for robust risk assessments**. Risk assessments are living documents which require regular revision.
- **Multidisciplinary advisory groups provide a broad range of benefits** for disease prevention and control. Their role is to review epidemiological and other disease control information, inputting to the activation of agreed contingency plans and advising the appropriate decision makers on future contingency planning. As appropriate, wetland managers can play a key role in these groups.
- **Contingency plans aim to consider possible emergency disease management scenarios** and to integrate **rapid cost effective response actions** that allow the disease to be prevented and/or controlled. It is advisable to develop bespoke contingency plans for specific high-risk/high-priority diseases and also generic standard operating procedures (SOPs) that may be common to many situations. Plans and SOPs should be documented and tested with a broad range of stakeholders in 'peacetime' (*i.e*. outwith any emergency situation), and subjected to periodic review.

3.1.1 Risk assessment

Risk assessment is a tool for the identification of potential problems and/or hazards, evaluation of their likelihood and probable magnitude. Risk assessments provide data to permit the effective management of risks.

Risk assessments should be based on the best available data, which may be quantitative or qualitative. Quantitative assessment of risks associated with wildlife diseases is often difficult due to complex disease dynamics and absence of robust biological data. Qualitative assessments of risk are more usual, within which, risks may be described as "extreme", "high", "medium" or "low" or a simple scoring system may be employed. Risk assessments should be revised in the light of new data or changing circumstances.

The Ramsar Convention's Wetland Risk Assessment Framework (Ramsar Convention Secretariat 2010) provides a mechanism for predicting and assessing change in the ecological character of wetlands. This framework (Figure 3-1) provides an appropriate general approach to problem identification, impact prediction, estimation of the extent of impacts, and overall assessment of the risk of adverse impacts.

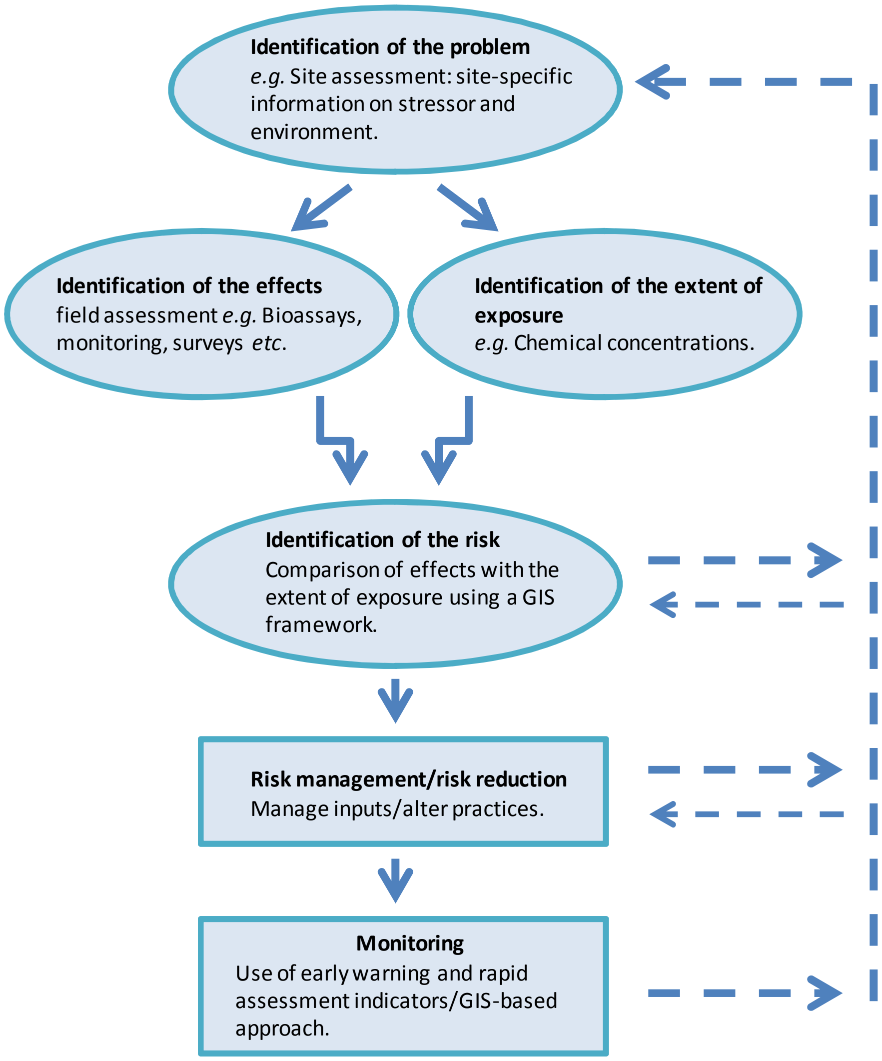

Figure 3-1. Model for wetland risk assessment (*Ramsar Convention Secretariat 2010*)

Problem or hazard identification

A system to help identify potential problems or hazards including current disease trends and outbreaks should be put in place. This may include site-specific information or surveillance data, or searching scientific literature and using sources of contemporary disease information and outbreaks, such as:

- The World Organisation for Animal Health (OIE), which provide up to date disease information and annual disease reports. Information for diseases and associated findings can be found at http://www.oie.int/our-scientific-expertise/reference-laboratories/annual-

reports/ and information on aquatic diseases can be found at http://www.oie.int/international-standard-setting/specialists-commissions-groups/aquatic-animal-commission-reports/.
- Food and Agriculture Organization (FAO), which can provide additional disease intelligence, for example in the EMPRES transboundary animal diseases bulletin, which is published quarterly at http://empres-i.fao.org/empres-i/home.
- The Programme for Monitoring Emerging Disease (ProMED) which is a forum for rapid dissemination of official and unofficial information on animal, plant and human disease occurrences globally (available as Internet server and mailing service) at http://www.promedmail.org/pls/apex/f?p=2400:1000.

Useful key information relating to potential disease problems includes:

- Species known or likely to be affected.
- If infectious, the pathogenicity of the pathogen or parasite (and *e.g.* how this varies across species).
- If toxic, the nature of the toxin.
- Zoonotic potential.
- Potential for transmission between domestic/captive and wild animals.
- Routes of transmission.
- Potential for pathogen or toxin persistence in the environment.
- Presence and movements of vulnerable wildlife in and around the site.
- Activities of vulnerable domestic animals in and around the site.
- Human activities contributing to potential problems or hazards in and around the site (*e.g.* agriculture, tourism, industry).

Identification of the adverse effects and/or extent of the problem

For each problem or hazard identified, the effect and extent of the potential impact needs to be evaluated and described. This process can be difficult in view of the scarcity of information relating to wetland disease epidemiology, however, the following sections help to provide a general framework for making these evaluations:

What sort of effects may occur and to what extent?

For example:

- The most obvious consequences may be direct mortalities or morbidities of varying scales.
- There may be indirect mortalities and morbidities, *e.g.*, loss of prey may impact on predator populations.
- Livestock losses may impact livelihoods.
- There may be possible economic consequences.
- If the problem is an OIE- notifiable disease outbreak, a site may be subject to severe restrictions including possible closure.
- There may be possible welfare issues.
- Tourism revenue may be affected.
- If the disease is zoonotic then measures may have to be put in place to reduce human exposure.

Which species or individuals are at risk and to what extent?

For example:

- Range of species potentially affected (including domestic animals, wildlife and humans).
- Species at higher risk due to behaviours (*e.g.* congregating at water holes) or ecological characteristics (*e.g.* residing in certain areas at particular times of the year).
- Status of hosts present (*e.g.* some diseases may only have an adverse impact on hosts in poor condition).
- Threatened species (present in low numbers and/or fragmented populations) may be at particular risk from disease.

When and for how long is the problem likely to occur

For example:

- Disease risks may be seasonal and the range of wild or domestic species present may vary accordingly (*e.g.* there may be seasonal grazing of domestic livestock; wild populations may be residents, breeding visitors, non-breeding visitors, passage migrants, nomadic or irruptive species).
- There may be relatively predictable times of increased risk due to human and livestock activities. For example, during times of livestock movements, when people or vehicular access to the site is greater or when there is application of fertilizer which may contain potentially infected manure.

Where is the problem likely to occur and how widespread would it be?

For example:

- Wetlands tend to be connected so potential for aquatic spread of toxins or pathogens needs to be assessed.
- Species are likely to be unevenly distributed within a site due to different habitat preferences and daily behavioural patterns (feeding, roosting, resting, bathing/drinking). Some species will be present in dense flocks or herds, some in loose aggregations, and others as small groups or individuals, and different species may mix with one another to varying degrees.
- For infectious diseases it is worth appreciating how infection may be moved into and out of a wetland into surrounding areas by animal movements. For example, waterbirds may feed on adjacent agricultural fields and fish-eating birds like cormorants may commute between wetlands, rivers, farmed fishponds and coastal areas. So called ‘bridge species’ (*e.g.* birds and mammals, such as rodents associated with human habitation) have the potential to carry disease between wetlands and agricultural premises and have been speculated to be involved in spread of avian influenza.
- Some wildlife species will remain far from human habitation whilst others are attracted as it offers benefits such as food sources, shelter, nesting and safety from predators.

Identification of the risk

This involves integrating the results from the assessment of likely effects with those from the assessment of the likely extent of the problem and generating an overall assessment of the level of risk, for example:

Risk	Impact
Negligible	Impact so low so does not merit consideration
Very low	Impact very low but cannot be excluded
Low	Impact low but requires consideration
Medium	Impacts and requires consideration
High	Impacts and requires great consideration and mitigation
Very high	Impacts greatly and requires great consideration and mitigation

A range of techniques exist for estimating risks, including spatial approaches using Geographic Information Systems (GIS) to link different components (*e.g.* poultry facilities on or near the site, other human activities, distribution of key species at the site across different seasons, seasonal changes in water levels leading to concentrations of wild bird species or other wild and domestic animals, important resting/roost sites, wetland margins and crop patterns in adjacent landscapes).

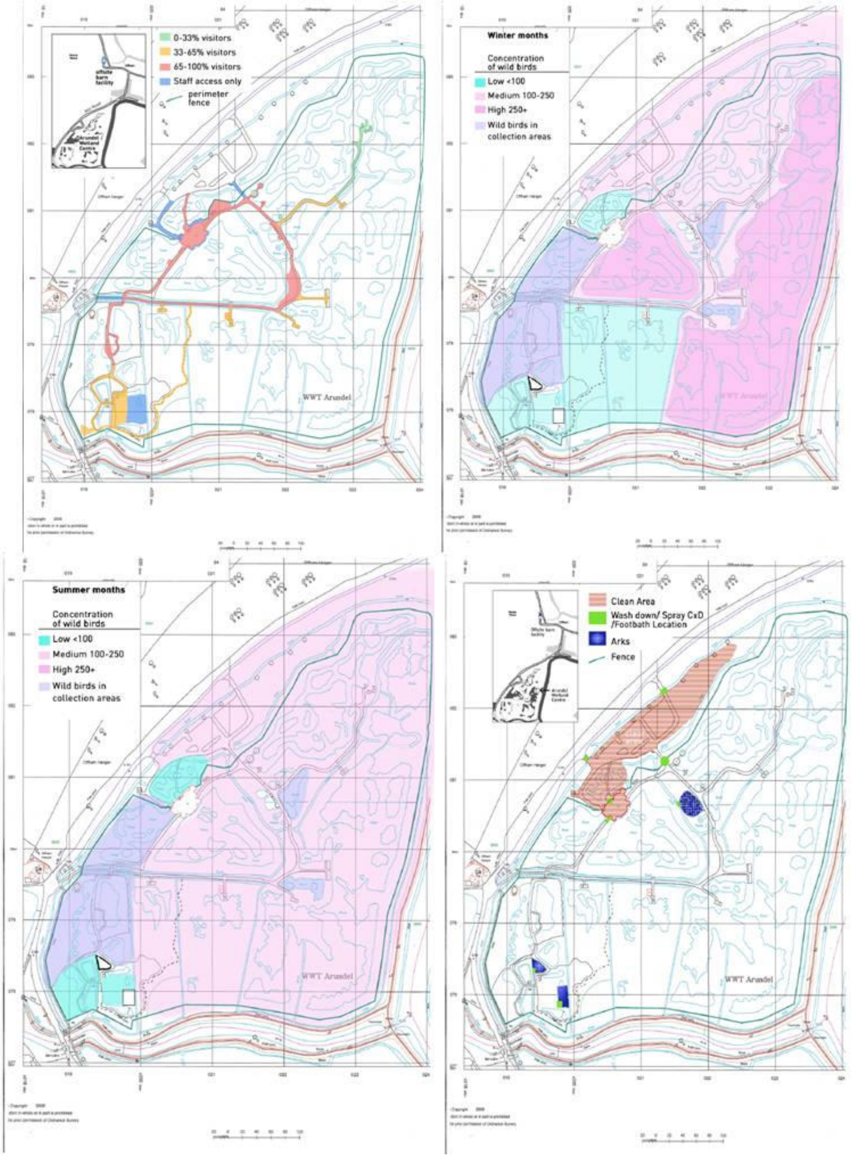

Figure 3-2. GIS maps of a wetland site indicating layers for seasonal bird densities, people movements and specific facilities: GIS offers a valuable tool to aid development of risk assessment.

Risk management is the practice of identifying, documenting and implementing measures to reduce risks and their associated consequences. Although risks can rarely, if ever, be totally eliminated the aim is to implement actions that reduce the risks to an acceptable level. These following sections illustrate the types of practical risk management practices that can be implemented at wetland sites:

►**Section 3.2 Reducing risk of disease emergence.**
►**Section 3.3 Detecting, assessing and responding to a new disease.**
►**Section 3.4 Managing disease**.

Risk communication is the route for stakeholders (everybody that could be affected) and risk analysts to exchange information and outlooks on risks. Stakeholders should be consulted throughout each process to ensure ownership of decisions.

Public health communication may require knowledge of points of contact and a strategy to disclose information.

Further information and sources

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3.1.2 Advisory groups

Dealing with outbreaks of disease in wetlands, particularly where wildlife is involved, requires a multidisciplinary approach. Multidisciplinary advisory panels of 'experts' (or perhaps, in the absence of a panel, a small number of personnel providing a range of expertise) can help to fulfil this requirement. Advisory groups should be integrated with any government (local or national) disease response, where appropriate.

The role of the advisory group is:

- to review epidemiological and other disease control information
- to input to the activation of agreed contingency plans
- to maintain oversight of the disease campaign
- to advise the appropriate decision makers on future contingency planning and on implementation of the plans.

Such groups may include expertise from human, animal and wildlife health professions, together with wildlife managers and the wetland manager. The scale at which advice is sought will depend on how government/local authorities are structured but advice should be available to key decision makers whether they are at national or sub-national (*e.g.* provincial) scales.

Composition

Advisory groups should comprise best available expertise drawn from both governmental and non-governmental sectors, including wetland managers, experts from research institutes, universities and other key groups as appropriate. There should be close collaboration with relevant species monitoring schemes, in order to facilitate rapid analysis of data and information from relevant databases and other information sources.

Establishment

Advisory groups should be established in advance of disease outbreaks as part of forward contingency planning and should be integrated into existing governmental processes or disease control systems.

The group should preferably be part of any epidemiological team that has responsibility to investigate disease outbreaks, or sufficient communication structures to allow easy and rapid information exchange. The relationship between the advisory group within other government disease response processes and structures should be explicitly established from the outset.

Modes of working

Contingency planning should include means of bringing together relevant experts at short notice in order to provide timely advice to decision-makers. Experts on advisory groups should be kept informed on the epidemiological features of any outbreak involving impacts on wetland wildlife, livestock and humans, and on the progress of such investigations. Planning should include alternative mediums of communication, such as teleconferencing, in anticipation that not all experts will be able to physically attend meetings.

Emergency field assessments

Emergency field assessments may be necessary to rapidly establish the nature and extent of a disease outbreak and their requirement should be considered in contingency plans. Such assessments may involve collecting information on animals affected by disease and disease-carrying vectors. Field assessments should be complemented by rapid desk-based data assessments that aim to analyse available data sources and thus to inform risk assessments.

International networking

Risk assessments, evaluations and relevant data should be shared between neighbouring countries or within wider geographic regions. Therefore, national advisory groups should collaborate together at regional scales to develop collective international assessments and understanding.

Lessons learned

Following the activation of the advisory group in the event of an outbreak, it is important afterwards to undertake a formal review to identify any problems or areas of operation where there may be scope for improvement of activity. The outcomes of such a review should inform future contingency arrangements.

CASE STUDY 3-1. UK Ornithological Expert Panel – integrated expertise for dealing with highly pathogenic avian influenza H5N1.

The spread of highly pathogenic avian influenza H5N1 of Eurasian lineage towards Europe in late 2005 and early 2006 stimulated the UK's Ministry responsible for animal health issues (Department for Environment, Food and Rural Affairs – DEFRA) to set up an 'Ornithological Expert Panel' (OEP) made up of ornithologists and others from the statutory conservation agencies and relevant non-government organisations to provide technical advice to DEFRA on a continuing basis. It operates responsively, with members being available at any time to provide advice and information on wild birds and their movements in the context of avian influenza. Among other tasks, the OEP has advised on:

- the risk of HPAI H5N1 occurring in the UK given known presence in nearby countries[1];
- the significance of risk factors, such as periods of extreme cold weather, which may heighten the risk of movements of birds carrying HPAI H5N1 to the UK;
- the development of risk-based national surveillance programmes for avian influenza (*e.g.* Snow *et al.* 2007);
- the generic design of routine ornithological assessment procedures to be undertaken at locations where infection with HPAI H5N1 may be suspected;
- the undertaking of emergency ornithological field assessments as part of immediate epidemiological investigations at suspected infection sites;
- interrogating organisational databases and other information sources to provide summaries of bird species most likely to be in the area of outbreak sites, and/or moving to or from that area; and
- using networks of personal contacts in neighbouring countries to provide 'real-time' information on movements of birds and other relevant international information and contexts to the developing situation within the UK.

Seeing outbreak sites with ornithologists' eyes

In order to assist epidemiological investigation, emergency field assessments were undertaken to establish the nature of, and collect information on, populations of wild birds near outbreak sites. Two examples are summarised below:

Turkeys in Eastern England, 2006

An outbreak of HPAI was reported on 1 February 2006 from a turkey production facility associated with a slaughterhouse and two large processing plants for poultry products in eastern England. Genetic sequencing of the virus showed it to be virtually identical (almost 100% homologous) to that recovered from a Hungarian outbreak in farmed geese the previous month. This level of similarity suggested the virus was either transferred directly between the Hungarian geese and the eastern England turkey outbreak, or that they shared a common source.

Rapid consultation with the OEP confirmed a lack of known mid-winter movements of wild birds between Hungary and England that might have been a vector for the infection.

An emergency field assessment of the infected premises identified the following factors:

- lack of proximity of the infected premises to areas used by migrant waterbirds;
- however, potential access to the infected premises by small non-migrant birds, rats and mice, and use of the area by a significant local population of gulls (*Larus spp*.); and
- presence of waste meat from the processing plant, and potential access to it by gulls that were moving between the factory area and roofs of the production sheds.

The final epidemiological assessment was that infected turkey meat had been transported from Hungary

[1] 'Qualitative Risk Assessments' - for example at http://webarchive.nationalarchives.gov.uk/20080108002802/http://defra.gov.uk/animalh/diseases/monitoring/pdf/hpai-h5n1-developments060706.pdf. [Accessed March 2012].

to England in January 2006, with discarded meat being scavenged by local gulls, probably carrying infected scraps onto the roof of a nearby turkey production shed. Heavy rain then washed virus into the shed (which was in a poor state of maintenance) infecting young turkey poults.

Ornithological assessments both of the site and through desk studies of the surrounding area were critical to rapidly ruling out wild birds as the vector which transferred the virus from Hungary to England, and also to identifying the probable means by which the virus was transferred from external waste meat containers at the factory to turkey sheds *via* the agency of gulls, rats or mice[2] — an ultimate consequence of poor biosecurity.

Mute swans on The Fleet, England, 2008

HPAI H5N1 was confirmed from three dead mute swan *Cygnus olor* carcases collected in late December 2007 and January 2008 from a population of 750 largely resident swans using a lagoon known as The Fleet on the coast of southern England. The virus was later detected in several further swan carcases from the same area.

Key elements of OEP advice were that:

- swans, and/or other wildfowl using The Fleet could potentially move within the lagoon to adjacent nature reserves and poultry, but that, as the hinterland of this wetland was rather dry, movements of >3 km were unlikely. This influenced the shape and size of the statutory control zones (Wild Bird Control and Wild Bird Monitoring Areas)(Figure 3-3);
- analysis of the movement records of the infected swans (shown by previously reported observations of individual rings) showed little evidence of off-site movements, thus indicating that they were unlikely to have been the vectors which bought the virus to the area;
- that there was potential for human exposure in some areas used by gulls which potentially may have carried the virus. This led to the erection of warning signs in those areas where people may have come into contact with gull faeces;
- there was a potential risk that local wildfowling might disturb and disperse infected birds. This led to the establishment of a no-shooting area centred on The Fleet (Figure 3-3).

The mute swans present were largely resident and so were unlikely to have been the vectors that brought the virus to The Fleet and unfortunately, the ultimate vector was never determined[3]. However, the disease control operation was successful and the statutory control zones were appropriate as no cases were found outside these areas.

Lessons learnt from the UK experience

- **Establishment and organisational placement:** the OEP was established in advance of disease outbreaks as part of forward national contingency planning and as part of the wider epidemiological team that had the responsibility to investigate HPAI outbreaks. This integration greatly assisted in the identification of achievable objectives, and in making explicit the formal relationship between the OEP and other UK government disease response processes and structures.

- **Composition:** the OEP comprised best available ornithological expertise drawn from both governmental and non-governmental sectors, including ornithological experts from research institutes. Staff from the UK national bird ringing and waterbird monitoring schemes were involved to facilitate rapid analysis of data and information drawn from relevant databases and other information sources.

[2] http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/ai/documents/epid_findings070405.pdf. [Accessed March 2012].
[3] http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/ai/documents/epireport-080212.pdf. [Accessed March 2012].

- **Mode of working:** in order to facilitate the rapid convening of advisory expertise from multiple geographically separated experts, teleconferencing was used extensively and successfully. A significant effort was made by DEFRA to ensure that OEP members were made aware and kept up to date on the epidemiological features of outbreaks involving domestic poultry and the progress of the epidemiological investigations. This helped the quality of the advice provided by OEP to the benefit of refining epidemiological assessments.

- **Field assessments:** these proved invaluable in assessing local concentrations of wild birds and their degree of access to domestic poultry and so focussed wider epidemiological investigations. In some cases field assessment enabled the rapid exclusion of wild birds as probable sources of infection and the more rapid identification of other factors (*e.g.* trade in poultry meat, as described above) as the vector for HPAI H5N1 infection. Further ornithological advice on additional and specific surveillance was frequently sought following these assessments.

- **Desk-based assessments:** field assessments should be complemented by desk-based rapid ornithological data assessments that seek to interrogate available data sources and, thus, to inform risk assessments.

- **Reviewing lessons learnt:** following the activation of the OEP in the event of an outbreak, formal 'lessons learnt' reviews were undertaken to identify any problems or areas of operation where there was scope for improvement of activity[4]. The outcomes of such reviews were then implemented by modifying contingency arrangements. This enabled progressive 'learning from experience'.

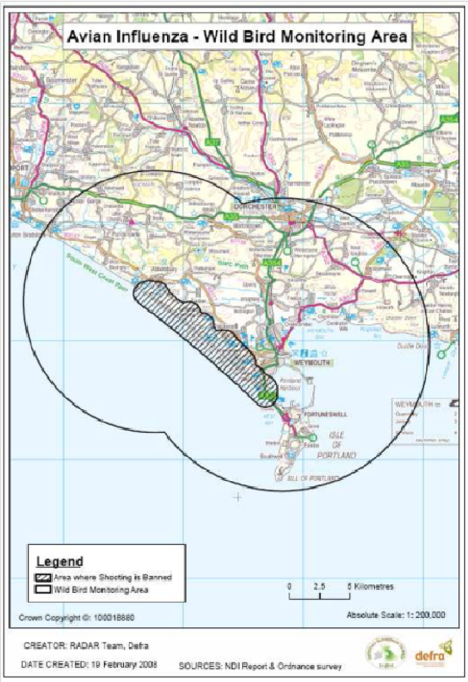

Figure 3-3. Extent of the statutory Wild Bird Monitoring Area established in January 2008, and of the area where shooting was banned, both centred on The Fleet, England (*Defra*).

Reference

Snow, L.C., Newson, S.E., Musgrove, A.J., Cranswick, P.A., Crick, H.P.Q. & Wilesmith, J.W. (2007). **Risk-based surveillance for H5N1 avian influenza virus in wild birds in Great Britain**. *Veterinary Record,* 161: 775-781.

Case study provided by David Stroud, Joint Nature Conservation Committee, UK

[4] for example, http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/ai/documents/holtonlessonslearned-070803.pdf. [Accessed March 2012].

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3.1.3 Integrating disease management into wetland management plans

Wetland management plans are usually 'living' documents tailored to a specific site and aimed at delivering a clear set of objectives. Figure 3-4 provides a recommended structure and content for such a plan (Ramsar Convention 2002).

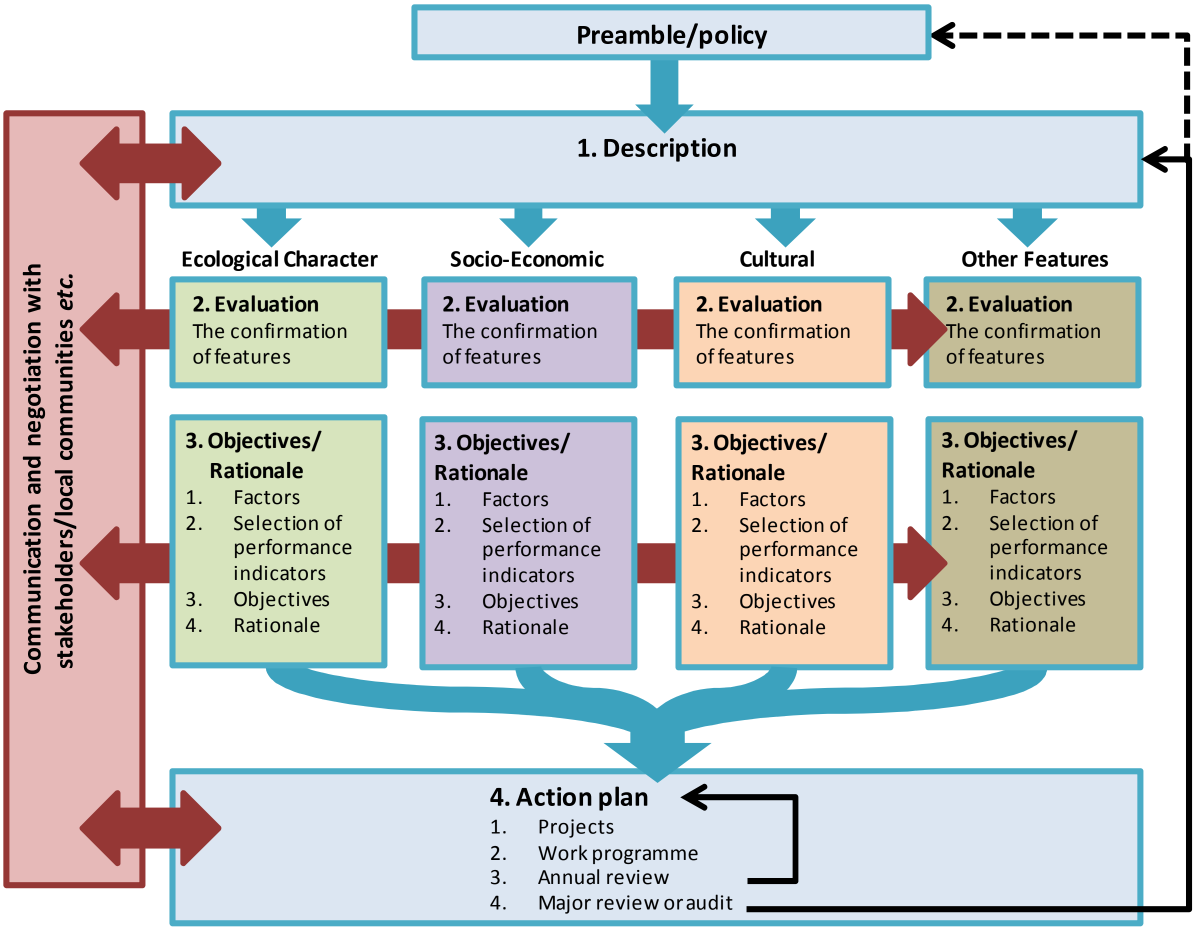

Figure 3-4. Recommended structure and content of a management plan for a Ramsar site or other wetland (*Ramsar*).

Why integrate disease management into management plans?

This bringing together within one document of information about biological characteristics, (*e.g.* climate, geology, hydrology, habitat type, biodiversity, ecological linkages), socio-economic factors (*e.g.* agriculture, consumptive use), cultural factors (*e.g.* recreational activities) and other attributes (*e.g.* boundaries, legal land ownership, surrounding land use *etc.*) of sites for the purpose of management, also provides a framework for informing disease risk assessments and contingency plans. Integration within the management plan ensures that disease management is at the heart of site management by a wide range of stakeholders.

Integrating disease management within a wetland management plan brings a number of benefits:

1. It ensures that disease management is not, nor is it perceived as, a set of activities that are distinct from site management.

2. It identifies disease prevention as a specific objective of site management.
3. As such plans are often used by other stakeholders (*e.g.* land users, and local and regional decision makers) in addition to wetland managers, it ensures that disease management is brought to their attention.
4. As management plans are not static documents they allow for updating in response to changes in the risk of disease and lessons learned. This can then inform the review of risk assessments, contingency plans and disease surveillance activities.
5. A single integrated document is useful for informing specific 'problem disease' contingency plans.
6. Integrating disease management within the management plan reduces the likelihood of new activities being incorporated which are at odds with disease control objectives.
7. As such plans are used to inform budgetary requirements for a site, incorporation of disease management objectives increases the likelihood that these activities will be routinely funded.
8. As such plans are used to inform personnel workplans for a site, to incorporating disease management increases the likelihood that the required activities will be routinely scheduled into work planning.
9. As such plans are used to inform training requirements for a site, incorporation of disease management increases the likelihood of investment in building capacity and maintaining appropriate expertise.

Figure 3-5. Wetlands provide the interface for wildlife and domestic stock: managing the diseases of both should form part of an integrated site management plan (*Sally MacKenzie*).

How to integrate disease management into management plans

When integrating disease management into wetland management plans, the following practical aspects should be included:

What: Ensure the disease management objectives are clearly defined (*e.g.* prevention of specific diseases, or maintenance of status of particular diseases). The management plan should specifically describe those diseases of known concern or with potential for emergence. It is also important to specify which activities should be avoided or amended if the disease management objectives are to be met.

Who: Within the management plan, ensure it is clear who is responsible for each disease management activity, both in terms of project management and implementation. Also, it is important to highlight which stakeholders are involved in activities with key roles to play in disease prevention and control (*e.g.* farmers with livestock using the wetland). The authorities involved in disease control should also be identified within the management plan.

How: The management plan should describe the specific disease management practices required. The logistics and practicalities of their implementation should be explicit or sources of this information should be provided.

When: The timing of disease management activities should be described, both in terms of when to be implemented and their duration. For example, specific disease management activities may be required to coincide with seasonal use of the wetland by domestic livestock or migratory wild animals, or in response to 'seasonal' diseases. Similarly it should be explicit when to cease or reduce other activities which might have a negative impact on disease prevention or control. For example, during periods where there is a high risk of disease outbreak, anthropogenic stressors should be reduced or restricted to less sensitive areas of a site. Consideration should be given to when extra vigilance for disease is required.

CASE STUDY 3-2. Managing avian botulism at Wildfowl & Wetlands Trust reserves in the UK

The nine UK WWT wetland reserves are sites managed for their biodiversity and raising awareness of wetlands and their value with the visiting public. Following a number of outbreaks of avian botulism at two WWT wetland reserves the following activities were integrated into management plans.

Staff awareness and training

The outbreaks are seasonal in nature (in response to factors including hot weather) hence a training presentation is provided to all grounds staff (*i.e.* those working in and managing the wetland sites), one month prior to the highest risk period in the (northern hemisphere temperate) summer. Training includes information about the disease, recognising disease signs in the field, principles of disease control and the annual action plan. All appropriate staff with a role to play in the prevention and/or control of outbreaks are, therefore, aware of the actions to be taken and their responsibility for their implementation.

Figure 3-6. Paralysis of the neck muscles is a common sign of avian botulism and results in an inability to hold the head erect. (*USGS Field Manual of Wildlife Diseases*).

Summary of management actions

During the next eight weeks (or whatever period is considered appropriate *i.e.* 'high risk') staff should:

1. Prevent environmental conditions that can lead to an outbreak
   - Keep water levels stable.
   - Maintain sufficient flow of water/oxygenation.
   - Wherever possible prevent addition of organic matter to water bodies.

2. Break carcase-maggot cycle by immediate removal of carcases.
   - Thorough daily searches to collect carcases.
   - Collection of maggots associated with carcases.
   - Daily search for sick/dead birds and other animals.

- Cut back vegetation at the water's edge to aid searches.
- Document findings: dates, species, numbers, location, *etc.*
- Searches to begin two weeks before previous outbreak date.

3. If an outbreak occurs be prepared to remove birds/scare birds away from the site.

Specific details of management actions at one wetland site - WWT Slimbridge, Gloucestershire, UK

1. Environmental factors
   - Maintain water pump in 'South Lake' (area of high risk and previous disease outbreak).
   - Keep high volume of water moving through the 'South Lake' (replace in-flow pipe with one of larger diameter).
   - Efforts to be made to keep water levels stable in 'South Lake' area.
   - The pipe bringing water from the canal to the 'Swan Lake' to be continued to be kept clear, including regular clearing of grids at either end.
   - A portable oxygenating pump to be made available for problem areas.
   - Care to be taken when strimming/cutting vegetation to prevent organic matter entering water bodies.
   - Wherever possible, care to be taken to eliminate excess organic input to water.

2. Carcase and maggot removal
   - Vegetation at water's edge will be strimmed/cut to allow easier searches for sick and dead animals.
   - Active searches for carcases of all species (including fish) to begin immediately, with extra searches in priority areas. Searches to be done early in the morning to reduce effects of the disturbance on visitors. Frequency to be increased in the face of an outbreak.
   - All grounds staff and volunteers to be extremely vigilant – looking for any birds showing early stages of paralysis, obviously sick birds and carcases.
   - Sick birds to be reported immediately to staff capable of catching birds.
   - All grounds staff to carry basic equipment *e.g.* plastic bags with them for picking up any carcases immediately.
   - Double bagging to collect carcases (a single bag can be knotted, inverted and knotted again to create double bag).
   - Recording: details of species, ring number and location of sick and dead birds to be recorded. Bags containing carcases, maggots and substrate containing maggots to be put into freezer to kill maggots.
   - Reserve Manager to ensure canoes are available for use in carcase searches.
   - Consideration given to scaring techniques in case birds need to be scared from specific sites.
   - If the need arises, one half of isolation area to be set up to as a hospital unit for sick birds. Animal Health Officer to ensure supplies available for treating birds.

Case study from the Wildfowl & Wetlands Trust, UK

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3.1.4 Contingency planning

Project and site managers should develop site specific contingency plans to address disease problems that could arise at any time. The aim is to consider possible emergency disease scenarios and to integrate rapid cost effective response actions that allow outbreaks to be controlled and prevented in the future. Contingency plans should be considered, 'bought into' and agreed upon by all major stakeholders, and have appropriate resources and legislative backing where necessary.

It is important that these plans are practiced in 'peacetime' (*i.e.* before disease problems occur) both as desktop exercises and also in a practical sense so site personnel are familiar and experienced at response activities. Regular simulation exercises will also serve to highlight any modifications required in contingency plans where aspects are subject to change such as incorporating new staff, new emerging disease threats and legislation and regulations [**►Section 3.5.2 Building capacity by education and training**]. Plans should include clear objectives and guidelines and be written in language that is understandable to all relevant stakeholders. Above all, plans should provide sufficient information to allow the relevant authorities and managers to make informed decisions on appropriate policies and measures used to control a disease outbreak.

It is advisable to develop contingency plans for specific high-risk/high priority diseases which incorporate generic standard operating procedures that may be common to several different specific plans. These should be supported by additional financial and resource plans and supportive legislation to ensure enforcement of contingency plans when needed. Ethical issues should also be considered when creating a plan. The following contingency plan structure is recommended by the Food and Agricultural Organization of the United Nations (FAO).

Technical contingency plan

Specific disease contingency plans detail the management measures that should follow detection of an outbreak in order to control spread. These documents are likely to need to make reference to generic operating procedures for activities and programmes that may be common to several or all disease management strategies, such as modes of internal and external communication and organised public awareness campaigns [**►Section 3.5 Communication, education, participation and awarness**], plans for compensation for wetland stakeholders affected by disease control activities and biosecurity measures [**►Section 3.2.4 Biosecurity**], and methods for surveillance and monitoring [**►Section 3.3.1 Surveillance and monitoring**]. Reference may also be made to manuals that provide zoosanitary guidelines for enterprises deemed at risk of a disease outbreak (*e.g.* areas where animals congregate such as wildlife parks, poultry or other farming around and within wetlands, markets, and fisheries). The contingency plan should clearly identify assigned roles and responsibilities of personnel taking part in the response to a disease outbreak.

A contingency plan should be developed for each of the diseases that have been identified as being of high risk in a particular wetland site [**►Section 3.3.2 Identifying a disease problem**]. Although the format and content of a contingency plan should be tailored to suit the needs of each site and disease, the following factors should be considered for inclusion in the plan:

1. Nature of the disease

- Aetiology (cause).
- Susceptible domestic and wildlife animal species.
- Distribution and history of occurrences in the country and wetlands.
- Epidemiology (including likely pathways for introduction and transmission). An epidemiological investigation will help determine the impact of a disease and understand the infection risks to others and the environment. Outcomes will help determine the extent of infected areas/zones and guide disease prevention and control measures in each area/zone.
- Clinical signs and pathology.

2. Risk assessment

►Section 3.1.1 Risk assessment

- Risk 'profile' of the disease.
- Likely methods of introduction and transmission and defined areas at high risk.
- Potential consequences for people, wildlife and livestock, including food security and poverty alleviation, production losses, trade losses and public and animal health.

3. Diagnosis and surveillance

►Section 3.3 Detecting, assessing and responding to new disease

- Early warning mechanisms for disease introductions and outbreaks.
- Disease reporting procedures.
- Field and laboratory diagnostic strategies.
- Linkages with national and international reference laboratories.
- Surveillance strategies during different phases of a disease management programme.

4. Principles and standard operating procedures for control and elimination

►Section 2.6 Strategies for managing animal diseases
►Section 3.4 Managing disease

- Methods for preventing and controlling disease spread and eliminating disease from the target area. Detailed instructions for disease control activities should be included where possible.
- Factors that may affect control and elimination.
- Feasibility of control and elimination in the target area.

5. Communication

►Section 3.5 Communication, education, participation and awareness

- Identification of key stakeholders needing to be informed and/or involved in a disease outbreak and control action.
- Means by which these stakeholders can be contacted and engaged.
- Strategy for dealing with specific stakeholder groups such as the media.
- Procedures by which stakeholder groups can be engaged in lessons learnt assessments following an outbreak.

6. Policy and rationale

- Overall policy.
- Zoning policy where appropriate [►**Section 3.2.2 Disease zoning, barriers and buffer zones**].
- Disease prevention, control and elimination strategies and activities in defined areas/zones.
- Alternate disease control and elimination strategies and the general circumstances in which these other options would be used.
- Strategies for dealing with special circumstances (*e.g.* disease in wildlife or feral animals, areas with nomadism, and difficult or relatively inaccessible areas).
- Criteria for proof of disease-free designation.

7. Appendixes/annexes

- Full contact details of personnel needed before, during and after a disease outbreak.
- Full contact details of relevant bodies involved in outbreak responses (*e.g.* local and national veterinary authorities and diagnostic laboratories).
- Full contact details of relevant stakeholders.
- Criteria for defining infected areas and disease control zones.
- Justification for chosen methods through assessments of their cost and benefits.
- Summary of disease control actions in infected areas and other zones.
- Relevant national and international legislations and regulations for the disease if applicable (*e.g.* OIE International Animal Health Code).

Annex 2. Activities which need regulating / implementing with HPAI H5N1 in the UK.

	Visitor Activities					WWT Activities						Access										Biosecurity				
	Hand-feeding birds	Pond dipping	Waterbird ringing demos	Passerine ringing demos	Decoy demos	Non-waterbird ringing	Waterbird ringing including for AI surveillance	Wild bird scaring	Entering water bodies	Dead bird surveillance patrols/vigilance	Pest control	Media entry to bird areas at WWT centres	Contractor access to WWT centres	Feed lorry access to WWT centres	Tenant access to WWT reserves	Staff access to WWT reserves	Non-groundstaff access to grounds	Bird movements between centres	Staff movements between centres	Staff access to poultry farms	Staff access to zoos and waterfowl collections	Bird arking plan	Bird vaccination plan	CENTRE CLOSURE PLAN	Only essential staff on site	Fieldwork
HPAI H5N1 not known to be in UK																										
HPAI H5N1 on UK mainland, but:						INC	INC			↑		C						•*		•						F
Centre within Wild Bird Monitoring Area	•*	•*	•*	•*	•*	•*	INC			↑		C	INC	INC	INC	INC		•*	E	•	•	I*	D			F
Centre in Surveillance Zone/WBCA	•	•	•	•	•	•	INC	•		↑	INC	C	INC	INC	INC	INC	•	•	E	•	•	I*	I*	I*		•
Centre suspected/confirmed Infected Premise or H5N1 in wild bird at centre	•	•	•	•	•	•	INC	•	•	↑	•	•	INC	INC	INC	INC	•	•	E	•	•	I	I	I*	•	•

Key: • – Activity ceased; •* – Activity ceased if AITAG consider necessary; INC – activity continues with increased PPE and disinfection; **INC** – only emergency access with increased PPE and disinfection; ↑ - increase, C – no access to captive or wild bird areas but assess on a case-by-case basis; E – essential staff only; D – depends on advice from Defra; I – implement plan; I* - implementation of plan dependent on AITAG response, F – depends on AITAG approval, WBCA – Wild Bird Control Area.

Figure 3-7. An example annex from a contingency plan for avian influenza at a Ramsar Site. The plan includes activities to be initiated or stopped (columns) according to level of risk (rows) ranging from absence of known disease (white) to outbreak at the site (black).

Contingency support plans

Support plans are vital for ensuring that sufficient money, resources and legislative instruments are available to make the implementation of disease contingency plans possible. Although they can be specific for each region or country, they should contain broadly similar components.

1. Financial plans

Ensuring that you have sufficient funds to finance your disease management strategy is of critical importance as any delay in obtaining finances will hinder the speed of response to an emergency disease outbreak. The rapid implementation of disease control activities will ultimately reduce the overall cost of the disease control campaign.

Financial plans must include the immediate provision of funds to respond quickly to an outbreak but also provide for other phases of the disease management strategy, where necessary. Where appropriate, funds should be approved at governmental level. Criteria should be agreed for the release of funds, for example, when an outbreak has been identified or the presence of disease is strongly suspected, when effective control and/or elimination of the disease is possible and when there are approved plans to implement such measures.

If the funding and resources of a disease management strategy is limited in a country or area, potential international donor sources should be identified (*e.g.* support from the FAO or appropriate international agencies). It may be wise to include procedures for applying for funding from various 'back-up' sources in the financial plan. If possible, funds for compensation of wetland stakeholders who have incurred financial losses as a result of disease control activities should also be included where this is national policy.

2. Resource plans

It is important to make an inventory which lists all the resources that will be needed during a disease outbreak, including capacity of personnel (their qualifications, expertise and experience) and equipment (quantities, specifications and locations). This should be compared with an inventory list of existing resources and any deficiencies should be rectified. Resources for each stage of a disease outbreak should be incorporated into plans.

All staff should be thoroughly trained in their roles, duties and responsibilities, and a contingency plan should allow for 'back-up' staff [►**Section 3.5 Communication, education, participation and awareness**].

Legislation

A contingency plan should include information on legislation and regulations that may or may not give permissions to conduct various disease prevention and control activities, in the event of an outbreak at or around your site. This should include information about the compulsory notification of certain animal diseases and may also include authorisations for the declaration of infected areas and disease control zones, movements of animals and people, the destruction and safe disposal of infected or potentially infected animals and objects, compensation for those financially affected by disease control activities and authorisation for any other relevant activities.

Simulation exercises

It is important to ensure that your contingency plan is practically achievable and for this, simulation exercises should be carried out in advance of their implementation. Lessons learnt from such exercises should be used to further refine and improve your contingency plan. These exercises are essential for building effective teams, ensuring that there are adequate resources and for training staff [►**Section 3.5.2 Building capacity by education and training**].

Disease outbreak scenarios should be realistic and real data should be used if possible. Each stage of an outbreak response may need to be tested before a full-scale disease scenario is attempted.

Reviewing and refining your contingency plan

Above all, contingency plans should be working documents that are subject to periodic review. Changing circumstances may require that a contingency plan be updated to retain its effectiveness in preventing and controlling disease. The effectiveness of a contingency plan in preventing and/or controlling a disease in a wetland should be thoroughly evaluated after a disease outbreak response has ended, and recommendations for improvement should be incorporated where necessary.

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3.2 Reducing risk of disease emergence

An understanding of patterns of the use of a wetland by people, livestock and wildlife, coupled with an appreciation of risk factors for disease emergence, can provide a sound foundation for disease risk management. Disease surveillance and monitoring [▶**Section 3.3.1**] may identify diseases of particular concern for the wetland. The specific actions required to reduce risks associated with these diseases should be identified within risk assessments [▶**Section 3.1.1**] and included in wetland management plans [▶**Section 3.1.4**]. More generally, 'healthy habitat management' and reducing stressors at a site will benefit disease prevention and/or control [▶**Section 3.2.1**]. Additionally, following standardised protocols for releasing and moving animals into, within and out of wetlands will help to mitigate disease risks [▶**Section 3.2.3**] as will the consistent application of sensible precautionary biosecurity measures [▶**Section 3.2.4**].

This section contains further information on the following topics:

- *Reducing stressors*
- *Disease zoning, barriers and buffer zones*
- *Standards for releasing and moving animals*
- *Biosecurity*

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- An **understanding by the wetland manager of the uses** of a wetland and its catchment by people, industry, agriculture including livestock, and wildlife, coupled with an appreciation of risk factors for disease emergence, can **provide a sound foundation for disease risk reduction**.
- It is **important that wetland managers identify stressor risks** within their site and the broader catchment/landscape, and understand that these may change over time. Once these factors are identified, **they can be managed and/or their impact mitigated,** as appropriate.
- **Disease zoning** (although challenging in wildlife and/or aquatic systems) **can help control some infectious diseases** through the delineation of infected and uninfected zones defined by sub-populations with different disease status. Buffer zones separating infected and uninfected zones may consist of physical barriers, an absence of hosts, an absence of disease vectors or only immune hosts *e.g*. following ring vaccination. **Appropriate levels of surveillance are required** to accurately define zones and for prevention of disease spread to occur, the movements of animals between zones needs to be restricted.
- **The movement of infected animals to new areas and populations represents the most obvious potential route for introduction of new/novel infections**. The risk of transmission and spread of disease can be **minimised by conducting risk assessments and following certain standardised national and international guidelines and regulations** for moving, relocating and/or releasing animals. A disease risk analysis should be conducted for any translocations for conservation purposes.
- **Biosecurity** in wetlands refers to the **precautions taken to minimise the risk of introducing infection (or invasive alien species)** to a previously uninfected site and, therefore, preventing further spread. Infectious animal diseases are spread not only through movement of infected hosts but also their products *e.g*. faeces, saliva *etc*. or *via* human and fomite (inanimate object) contact with animals and their products. **Constructed treatment wetlands can assist greatly in reducing risks** from contaminated wastewaters.
- Where possible, **biosecurity measures should be implemented routinely** as standard practice whether or not an outbreak has been detected. A regional/supra-national approach to biosecurity is important for trans-boundary diseases, particularly those where domestic and international trade are considered as important pathways for disease spread, *e.g*. trans-boundary aquatic animal diseases.
- **If wetland stakeholders understand the principles and value of biosecurity** and what measures to take, this will **encourage the development of an everyday 'culture' of biosecurity** which can help disease prevention and control.
- **Implementing biosecurity measures in the natural environment can be extremely challenging**, particularly in aquatic systems, and although eliminating risk will be impossible, **a substantial reduction in risk may be achievable**, particularly where several complementary measures are employed.

3.2.1 Reducing stressors

Stress in its various forms can affect the ability of the immune system to protect the host from infection and disease. Stressors may not in themselves cause disease but their effects can be subtle and can influence disease dynamics and the likelihood of a disease outbreak. Stressors can be additive or synergistic, working together to shift the balance between health and disease within individual hosts or populations.

Consequently, stressors at wetland sites should be identified and managed to reduce disease susceptibility. Identification of potential stressors requires a thorough knowledge of the site and a reasonable understanding of the biology and ecology of the animal species present. It is important to periodically re-assess the stressors at a given site as they may change over time.

Common stressors

Toxins: environmental pollution (*e.g.* heavy metals and pesticides) may become concentrated in certain areas with negative impacts on vertebrate physiology and immune function. Mitigation measures need to focus on eliminating or reducing such effects.

Nutrition: malnutrition (deficiency, excess or imbalance of nutrients) of animals may result in increased disease susceptibility. Consideration can be given to providing supplementary high quality food and/or water, although artificial provisioning brings its own disease risks (*e.g.* concentrating wildlife at 'unnaturally' high population densities and hence increasing opportunities for transmission of infection).

Human disturbance: ideally this should be reduced/kept to a minimum where possible, especially at sensitive times in the life cycles of wildlife, at times when other stressors are known to occur or when risks of disease outbreaks are high. Consideration could be given to closing public footpaths/access during key times. Zoning human activities such as recreation and agriculture may also be of value in managing human disturbance. Herding and capturing animals (*e.g.* chemical immobilisation, corralling, netting, holding, transport, and restraint and sampling) are generally considered acutely stressful activities, so careful planning and preparation, and the use of established protocols and well trained teams are essential.

Predators: depending on the management priorities of a site, measures could be considered to minimise stress from predators (*e.g.* by methods of deterrence).

Interspecific and intraspecific competition: depending on the management priorities of a site, measures could be considered to reduce competition from other animals (*e.g.* by controlling stocking density to reduce psychological and nutritional stress).

Con-current disease: if it is known (*e.g.* from surveillance activities) that significant con-current disease is present, particular attention should be given to reducing other stressors.

Extreme weather and other environmental perturbations: during periods of extreme potential stress (*e.g.* extreme hot or cold weather, drought, flood) other stressors should be kept to a minimum to help to reduce the likelihood of disease outbreaks. For example, a voluntary ban on shooting activities during extended periods of cold weather may be advisable. Such actions need to be the subject of advance agreement amongst site managers and other stakeholders.

CASE STUDY 3-3. Nutritional and other stressors? Common Eider *Somateria mollissima* mortality in the spring and winter of 1999/2000 in the Wadden Sea.

Although debatable, there is evidence to suggest the 1999/2000 mass mortality of common eider ducks in the Wadden Sea was due to nutritional stress and simultaneous heavy parasite loads. It has been suggested that the eiders suffered starvation resulting from poor foraging conditions linked to over exploitation of mussels by the commercial industry. This disrupted food intake combined with parasite loads two to three times higher than apparently healthy eiders may have led to compromised body condition and function.

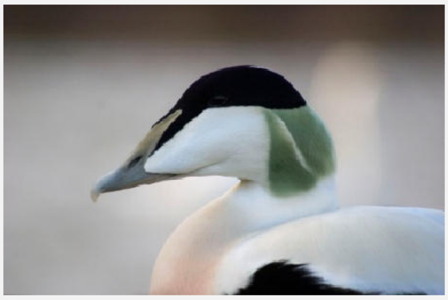

Figure 3-8. Common eider (*WWT*)

One explanation for the elevated parasite loads could be derived from the shore crabs which the eiders were apparently ‘forced’ to prey upon given the scarcity of mussels. Shore crabs harbour multiple parasites and, therefore, present higher risk of infection to eiders. Although in this case the high parasite loads were not directly correlated with poor body condition they may have contributed as an accelerating or secondary factor. Parasitic infections may have increased energetic costs for eiders and enhanced their susceptibility to other stressors such as con-current nutritional disease and environmental conditions.

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3.2.2 Disease zoning, barriers and buffer zones

Disease zoning

Disease zoning can be used to control infectious diseases by delineating infected and uninfected zones, and allowing measures to be implemented to prevent the spread of infection between them. An infected disease zone is an area or local population in which disease has been detected. Zoning may be particularly useful where disease elimination is not feasible [►**Section 3.2.4 Biosecurity**].

Buffers and barriers

A buffer zone is an area of uninfected status (under surveillance) which surrounds the infected zone. Its purpose is to facilitate prevention of disease spread into an uninfected sub-population.

The buffer zone may be identified on the basis of:

- an absence of hosts
- an absence of disease vectors
- only immune hosts (*e.g.* following ring vaccination).

An effective buffer zone may take the form of a geographical, hydrological or climatic barrier. These barriers may be natural such as rivers and lakes (for terrestrial hosts) or terrestrial habitat (for aquatic hosts), or unnatural features in the landscape such as roads, fences or cleared habitat. Such barriers have been shown to be effective in control of disease by either slowing or preventing spread. Complications are introduced when dealing with highly mobile hosts (*e.g.* migratory, semi-migratory or nomadic animals), and where the epidemiology of a disease (particularly the identification of reservoir species) is poorly understood.

Artificial barriers can also be used to inhibit movements of hosts but can themselves have adverse ecological consequences, such as the prevention of movements of wild animals caused by foot and mouth disease fences in parts of southern Africa.

Specific considerations for water-borne diseases

Within wetlands, zoning for the control of water-borne diseases is particularly challenging but may still be a useful approach. Wetland zones may be defined by catchment areas and rivers and coastal zones. The simplest zone is that of an area that derives its incoming water from an unshared source and thus may continue to function independently of any infected areas. In the instance of an inland area that shares common water sources, the minimum zone would apply to the entire catchment area. Larger catchment areas may require multi-national and transboundary cooperation and jurisdictions as disease management relies on all aspects of the water catchment zone being managed accordingly.

Surveillance for defining zones

The definition of 'infected' and 'uninfected' zones relies on adequate surveillance and the effective use of zones for disease control relies on an understanding of modes of transmission. Restrictions on domestic and international trade of animals and derived products, may apply to infected zones. Continued surveillance is needed to confirm the absence of infection in uninfected areas.

Movement of animals between zones

Conditions applying to the movement of animals (either domestic or translocated wildlife) between zones should be comprehensively described in a zoned management strategy. Conditions should also apply to movement of other materials which could facilitate mechanical transfer (*e.g.* slurry, bedding substrates, other fomites or animal products).

Examples of barriers and buffer zones

Foot and Mouth Disease: Several countries including Botswana and Zimbabwe have implemented effective disease control strategies which include dividing the country into risk zones. These zones are managed by means of appropriate disease surveillance, movement restrictions, livestock identification and vaccination. Ring vaccination may be required as an emergency measure for animals within a certain radius of a confirmed outbreak.

Anthrax: Following an outbreak in cattle a buffer zone of a specified width can be established around infected areas. All animals inside this area which have been exposed can then be vaccinated and quarantined.

Further information and sources

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3.2.3 Standards for releasing and moving domestic animals or translocating wildlife

Movements of wildlife and domestic animals may facilitate the spread of disease by introduction of pathogens to formerly disease-free areas. In order to control disease spread, it is therefore crucial to understand movement patterns of potential disease hosts at a national and international level and the associated disease risks. The risk of transmission and spread of disease can be minimised by following certain guidelines for releasing and moving animals. Such measures should be supplemented by an efficient surveillance network involving the health screening of animals, particularly when they are to be moved to another area. Given the global scale of animal movements in wildlife populations and the livestock and pet trades, international cooperation in maintaining standards of moving and releasing animals is vital in preventing and controlling disease spread and reducing the risk of outbreaks.

Legislation and regulations

National and international legislation and regulations are in place to control the movement of animals, although disease outbreaks still occur regularly as a result of both legal and illegal movements. It is, therefore, important to familiarise yourself with legislation and regulations and their enforcing regulatory bodies, where they relate to not only a wetland site, but also to the exporting country, the transit country and the importing country [►**Section 3.1 International regulations and standards**].

Certification requirements for moving animals should also be fulfilled and should clearly outline the wishes of the importing country. For this, prior consultation between veterinary authorities of importing and exporting countries may be needed. Special permits or licences may be required for moving and/or releasing wildlife. For example, CITES-listed species will require licences for movements of the whole animal, or derivatives thereof, across trans-national boundaries of signatory countries.

INTERNATIONAL REGULATIONS AND STANDARDS 3-1. Movement and trade.

The following international organisations and regulatory bodies are concerned with the movement and trade of animals and may be able to provide further guidance.

International organisations

- Food and Agriculture Organization (FAO): www.fao.org
- World Health Organisation (WHO): www.who.int
- World Organisation for Animal Health (OIE): www.oie.int
- World Trade Organisation (WTO): www.wto.int
- African Union-Inter African Bureau for Animal Research: www.au-ibar.org
- Organization for Economic Co-operation and Development: www.oecd.org

International regulatory bodies

- Convention on International Trade in Endangered Species of Wild Fauna and Flora: www.cites.org
- World Conservation Union: www.iucn.org
- Convention on Biological Diversity: www.biodiv.org
- International Air Transport Association: www.iata.org
- Council of Europe: www.coe.int
- European Union: europa.eu

TABLE 3-1. Legislation, regulations and guidance relevant to the trade and movement of domestic and wild animals (from Fèvrea *et al.* 2006).

Level	Animal health	Animal welfare	Endangered species
International	World Trade Organisation and Sanitary and Phytosanitary Agreement International Animal Health Code and International Aquatic Animal Health Code (World Organisation for Animal Health – OIE)	International Air Transport Association regulations International Animal Health Code and International Aquatic Animal Health Code (World Organisation for Animal Health – OIE)	Convention on the International Trade in Endangered Species (CITES) Convention on Biological Diversity (CBD) IUCN guidelines
Regional	European Union directives (numerous)	European Union Regulation (transport of animals) Council of Europe Convention (transport of animals)	European Union and CITES regulations
National	Laws on control of disease and movement	Anti-cruelty laws, welfare codes	Laws implementing CITES and CBD, species protection
Sub-national	Local restrictions on animal movement		

Source: Fèvrea et al. 2006

Protocols for relocating animals

Prior to any relocation of wild animals a risk assessment should be conducted [►**Section 3.1.1 Risk assessment**]. Information should be available from government agencies, as well as other sources, to help inform the risk assessment and protocols for relocation. The latter may include:

1. Thorough examination and **health screening** of animals prior to their relocation and routine surveillance and monitoring of animals for the early detection of disease [►**Section 3.3.1 Surveillance and monitoring**].

2. **Movement restrictions** for diseased/susceptible animals to prevent the spread of infection. This may include **quarantine** of animals before their release to ensure that they are disease-free. Once animals have been moved to a new area, a routine 'standstill' period may also apply, preventing the movement of certain animals on and off that site for a specified number of days [►**Section 3.4.7 Movement restrictions**].
3. **Methods to protect** animals to be translocated from exposure to infection at their destination (*e.g.* through vaccination).
4. Methods to ensure **animal welfare** during transportation. Animals must be moved in a way that will not cause them injury or unnecessary suffering and additional stress that may affect their health. When transporting animals:
    a. plan journeys well and keep the duration to a minimum
    b. ensure that animals are fit to travel and check them frequently
    c. ensure vehicles are designed to avoid injury and suffering
    d. handlers should be experienced and competent and understand the behaviour patterns of animals
    e. provide sufficient floor space and height
    f. provide water, feed and rest as needed.
    g. It is advisable not to transport animals that are considered unfit to travel, and it is illegal to do so in many countries. This includes individuals which are sick or injured, newly-born, heavily pregnant or have recently given birth.
    h. It is important to **avoid mixing of animals from different sources.**

5. Methods for **recording animal movements** which will make it easier to trace and identify infected animals in the event of a disease outbreak.

In some countries, it is a legal requirement that livestock keepers retain individual records and notify authorities of livestock movements, births and deaths. Animals can be individually identified by a variety of methods (*e.g.* ringing, tagging, micro-chipping). Government agencies may visit premises or require records be sent to them directly. Licenses may be used to record the movements of livestock (*e.g.* where animals are kept, where they originated and, if appropriate, the final destination) which in turn are logged onto a national database that records and monitors the movement of all animals across a country. In the event of a disease outbreak such as foot and mouth disease or avian influenza, movement records will inform the investigation and so it is vital they are accurate and up to date.

Tools for recording animal movements may significantly improve the effectiveness of the management of disease outbreaks and food safety incidents, vaccination and animal medication programmes, animal husbandry, zoning, surveillance, early response and notification systems, animal movement controls, and animal inspection and certification.

Most importantly, **follow guidelines** as outlined in the relevant regulations and legislation to ensure that standards for releasing and moving animals are effective and maintained. Further information can be found in the OIE's Terrestrial Animal Health Code (2010).

Specific considerations for conservation translocations

All of the above guidance is applicable to conservation translocations including reintroductions.

Every translocation project should be accompanied by a comprehensive disease risk analysis [►**Section 3.1.1 Risk assessment**] aimed at summarising and managing the risks to wild source populations, captive populations, the released population and any species present in the release area or likely to encounter the released population in other areas.

Temporarily captive or captive-reared animals involved in conservation translocations may be particularly vulnerable to disease due to the stresses of both captivity and transport, and due to reduced genetic diversity often found in threatened species, and captive populations thereof. Thus, extra care must be taken to reduce stressors throughout any translocation [►**Section 3.2.1 Reducing stressors**].

The range of diseases to screen for and manage will be outlined in the disease risk analysis. The soft release technique of temporarily holding released animals within a release enclosure allows a period of time in which released animals can acclimatise to the new environment and endemic diseases (to some extent), and provides a period of time, during which, veterinary intervention can be given, if necessary.

The risks of disease translocation together with the logistical and administrative aspects, and potential for delays, may provide sufficient reason to attempt to rear animals *in situ* within natural disease range and within country of origin.

Figure 3-9. A release enclosure for the UK's Great Crane Project: in addition to standardised health monitoring, this soft release measure allows a period of time during which birds can encounter some 'endemic' diseases and allows veterinary intervention if necessary (*WWT*).

Further information and sources

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3.2.4 Biosecurity

Biosecurity refers to the precautions taken to minimise the risk of introducing infection to a previously uninfected site and, therefore, preventing further spread. In the context of this guidance it refers to measures taken to reduce the likelihood of introducing infection into a wetland. Infectious animal pathogens are usually spread through movement of infected hosts or their products (*e.g.* faeces, saliva *etc.*) or *via* human and fomite contact with animals and their products.

Robust surveillance [**►Section 3.3.1 Surveillance and monitoring**] can provide early warning of emerging risks and inform the level of biosecurity required. Routine cleansing and disinfection regimes [**►Section 3.4.1 Disinfection and sanitation**] can minimise opportunities for the introduction and spread of diseases *via* infected animals or contaminated objects such as clothes, boots, vehicles, equipment and water.

Biosecurity measures should be implemented routinely as standard practice whether or not an outbreak has been detected. However, the stringency of biosecurity measures may be altered in response to changes in the perceived level of risk. A regional/supra-national approach to biosecurity is important for trans-boundary diseases, particularly those where domestic and international trade are considered to be important pathways for disease spread.

Biosecurity in 'wild' settings can in some circumstances seem impossible to attain; although the *elimination* of risk is unlikely to be attainable, *reduction* of risk may be sufficient to make a significant contribution to disease control.

It is important that wetland stakeholders understand the principles and value of biosecurity. Developing a 'culture' of biosecurity in managed wetlands can make a substantial contribution to disease control.

General biosecurity measures

Wetland managers should try to ensure that the movement and/or introduction of livestock, people, vehicles or equipment into wetland areas is minimised or at least controlled, particularly so during periods of increased risk. Attention should also be focused on hazardous/high risk substances such as slurry and faecal-contaminated materials.

Information on the diseases present within a wetland and its surrounding area, and the routes by which these are spread, will help to dictate the level of risk and, therefore, the biosecurity required. Ideally, when entering and leaving a wetland area (within reason), vehicles, equipment, and protective footwear and clothes should be cleaned and disinfected [**►Section 3.4.1 Disinfection and sanitation**]. This is particularly important for those items in contact with animals and their products. Where appropriate or possible, footwear and equipment should also be disinfected before being used again on a different part of the wetland site. Facilities for disinfection should be available on entry to and exit from the area.

In some circumstances it may be appropriate for protective clothing and footwear to be worn (*e.g.* rubber boots and gloves). Items must be easily cleaned (*e.g.* waterproof clothing and boots) or disposable. If practicable, equipment should be protected with plastic bags. Where possible, vehicles should be parked on hard standing ground, away from animals, and kept visibly free of mud, slurry and animal products.

Other means by which infection risk can be reduced involve: 'resting' domestic animal holdings to allow a period of time in which contaminated materials can decompose; and reducing stocking density to reduce likelihood of disease transmission.

Artificial water supplies for domestic animals (*e.g.* cattle in enclosed areas and fish and shellfish in aquaculture) should be clean and waste effectively disposed of where possible, through efficient treatment systems. New domestic animals should be quarantined before being introduced to a wetland area. Where possible, domestic animals should be sourced from specific pathogen-free certified stock or following pre-movement testing.

During an outbreak of infectious disease, only essential persons should visit areas with infected animals and they should adhere to appropriate biosecurity measures. Non-essential visits, including public access, should be suspended at such times.

Wetland treatment systems

Both natural wetlands and specifically designed constructed wetlands, can play an important role in sanitation and treating wastewater, sewage and run-off. They function through a combination of physical, chemical, and biological processes, reducing pathogenic agents such as helminth eggs, bacteria, viruses, and heavy metals, as well as removing and storing nutrients. As such, they can provide a sustainable, and highly effective, means by which to reduce risks from both point-source and diffuse contaminated wastes. If designed and managed correctly, as well as treating wastewater, they can also provide additional benefits in terms of maximising biodiversity, providing stormwater and floodwater detention, and providing livelihoods. It should be recognised that if using an area of natural wetland for treating waste, this designated area must be monitored and managed appropriately to ensure no detriment to the wider wetland environment.

Expert guidance should be sought to ensure the wetland type is fit for the waste treatment purpose required, as effectiveness of such wetlands to treat contaminated wastewater, will depend on a number of factors including:

- Plant and substrate type.
- Type of wetland or constructed wetland (whether it is a surface flow wetland or a constructed sub-surface flow wetland as the latter is more efficient at pollutant removal per m^2).
- Hydrological regime (including the wetland water balance as wastewater needs to remain within the wetland for sufficient time to allow 'cleansing' processes to occur).
- Wetland background water quality (the ability of the wetland to treat wastewater will be dependent on the existing water quality).
- Area and depth of wetland (generally the larger the wetland the more treatment it can provide but if the wastewater flows directly through the wetland rather than spreading across the wetland then even a large wetland may not provide total treatment).
- Climate (higher temperatures and UV radiation levels provide more treatment but even in cold temperatures wetland treatment systems can be effective).

- The volume of wastewater and type and concentration of pollutants and suspended solids within the wastewater input (high concentrations may 'overload' the capability of the wetland).
- Management of the wetland (poor management will reduce the capacity to treat wastewater).

Figure 3-10. Constructed treatment wetlands are an effective means of treating contaminated wastewaters (*Martin Senior*).

Further information and sources

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CASE STUDY 3-4. Protocol to protect amphibian populations from chytridiomycosis by disinfection of workers and equipment on WWT reserves.

Within the UK, chytrid fungus *Batrachochytridium dendrobatidis* has now been found in a number of separate locations.

The following protocol applies to WWT sites.

1. Disinfection of work-related equipment and footwear

To prevent infection being introduced to a WWT site, people* (staff, students, contractors, *etc*.) who will be coming into contact with water or amphibians on a wetland site, *e.g.* during surveying, must first disinfect (see disinfection protocol below) both footwear and sampling equipment (*e.g.* footwear, boats and nets) if they have been previously used at another site.

To prevent infection being carried from one WWT site to another wetland site (including WWT sites), the same disinfection protocol (below) should be followed for footwear and equipment coming into contact with water or amphibians.

Figure 3-11. Natterjack toad *Epidalea calamita*: biosecurity protocols are being followed at wetland sites to reduce risk of spread of chytrid fungus (*WWT*).

Where possible footwear and equipment should be disinfected before being used again on a different part of the reserve.

2. Disinfection of personal equipment and footwear

Members of staff that use their own hiking boots *etc.* at work must take care if they have either entered any water bodies or travelled to high risk areas such as the Lake District or Yorkshire (infected sites) on leisure trips. Boots should be fully disinfected (below) before being used back on a WWT reserve.

Ideally staff should try to use one set of footwear for the site on which they work and have a separate set for use at home or on other sites.

3. Animal release and movement

There is a standard protocol not to accept or release amphibians/spawn or pond plants onto sites and those currently on our sites should not be moved elsewhere.

DISINFECTION PROTOCOL

To properly clean footwear and equipment:

- First use a brush to clean off organic material (*e.g.* mud and grass).
- Rinse with clean water.
- Soak in fungicidal disinfectant for one minute.
- Rinse with clean water and allow to dry. Drying thoroughly is important and will act to kill any chytrid fungus present.
- If any clothing is particularly soiled during fieldwork, then washing at 40°C with detergent will be sufficient to remove any contamination with chytrid fungus.

*Only people coming into direct contact with the water or amphibians need to disinfect their boots *etc.* so this does not apply to farmers coming onto land to check stock. Similarly this does not currently apply to staff/visitors in the public areas and on paths.

Further information for fieldworkers is available at: www.arguk.org/advice-and-guidance/view-category

Source: Wildfowl & Wetlands Trust, UK

3.3 Detecting, assessing and responding to new disease

Globalisation and climate change have greatly enhanced opportunities for the emergence and spread of diseases throughout the world, giving rise to serious threats to human and animal health. The mobility of wildlife also increases the potential for infectious disease to spread to new locations and populations. It is, therefore, becoming increasingly important to not only reduce the risk of disease emergence, but to effectively detect, assess and respond to new diseases as they arise. Timely and accurate diagnosis of a disease problem and appropriate actions during the first stages of an outbreak are especially critical to achieving effective disease control and prevention. The importance of enabling rapid responses cannot be over-emphasised.

Disease control would of course not be possible without its detection in the first instance. Disease surveillance and monitoring programmes enable a greater understanding of disease patterns, therefore enhancing capacity to detect and control infectious diseases that may emerge in the future [►**Section 3.3.1 Surveillance and monitoring**]. Such programmes are critical for the 'early warning' of disease presence and the planning and monitoring of disease control programmes thereafter and will be more cost-effective than managing a large scale disease outbreak [►**Section 3.3.2 Identifying a disease problem**].

Surveillance and monitoring for diseases in wildlife in and around wetland areas should be considered, as wildlife are inherently at risk of negative impacts from emerging diseases and can serve as reservoirs of pathogens important to human and livestock health. Given that many diseases that have emerged in recent years have originated in wildlife, surveillance and monitoring of wild animals may be an important tool for the protection of public health, livestock health and the conservation of endangered populations. Therefore, although programmes for surveillance and monitoring diseases in wildlife are less likely to be as well developed as programmes for livestock, they are nevertheless recognised as being of increasing importance. Samples taken during routine and targeted surveillance and monitoring are valuable resources so it is essential that they are stored, preserved and transported appropriately [►**Section 3.3.3 Sample collection and preservation** and ►**Section 3.3.4 Sample transport and shipment**].

Following a disease outbreak, it is likely that animal health professionals will conduct an epidemiological investigation to try to determine why the disease has arisen and where it may occur next. The wetland manager will not be responsible for this investigation but has an important role to play in recording as much relevant information as possible during a suspected outbreak [►**Section 3.3.5 What data to collect at a suspected outbreak**] as this represents a unique opportunity to collect potentially valuable epidemiological evidence.

Following the detection of a disease in a wetland, the next challenge may lie in assessing whether or not it constitutes a 'real' problem. Disease is a part of our natural world and may not always pose a risk to people and/or animals. However, measures must be in place to help identify when a particular disease becomes a problem and these are discussed here.

This section contains further information on the following topics:

- *Surveillance and monitoring*
- *Identifying a problem*
- *Sample collection and preservation*
- *Sample transport and shipment*
- *What data to collect at a suspected outbreak*

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- The **detection** of new, emerging disease, robust **risk assessments**, and effective **disease control** in and around wetlands, **all rely on effective disease surveillance and monitoring**. Surveillance programmes should be well designed with clearly defined aims and objectives. Robust surveillance requires appropriate methods for sample collection, recording, storage and transportation, which in turn depend on well trained personnel and adequate resourcing.
- **Timely and accurate diagnoses and early warning systems for disease emergence are critical for swift responses**, achieving effective disease control and minimising losses and costs. Early warning systems may depend on a comprehensive understanding of a wetland site and catchment, good disease intelligence from a range of stakeholders (including crucially the wetland manager, as well as data from local and national disease surveillance programmes), and clear systems and networks for communication and reporting.
- **Identifying** when a disease presents a '**problem**' is complex and **requires** thorough disease investigation and existing **good long term surveillance** information.
- In the event of a suspected outbreak of disease, **wetland managers are not expected to be the final disease diagnostician**. However, they should **play a key role in an outbreak investigation** team being ideally placed to provide the crucial contextual epidemiological information about timing of events, the populations at risk, the effects on these, land use and environmental conditions at the time and leading up to the outbreak, and other relevant local information.

3.3.1 Surveillance and monitoring

The detection of emerging disease, robust risk assessments and effective disease control in and around a wetland area rely on effective disease surveillance and monitoring. Surveillance and monitoring are terms often used interchangeably but surveillance generally refers to observing a population for signs of a disease over time. Monitoring, on the other hand, can be used to refer to measuring disease prevention or control programmes and providing the information to evaluate whether or not interventions have worked or how improvements can be made. Above all, surveillance programmes should aim to evaluate the health status of a group or population and help to prevent or limit the spread of diseases by informing disease control activities.

Surveillance is a continuous and systematic process which involves the collection of relevant data for a specified population, time period and/or geographical area, meaningful analysis of the data and dissemination of the results to appropriate stakeholders. Collected data should include observed clinical signs, diagnostic test results and any associated risk factors identified.

Surveillance and monitoring are vital for:

- establishing base-line data on the health of a population or group
- determining temporal and spatial variation in disease prevalence
- identifying the point at which there is a departure from 'normality' and hence the point at which action should be triggered
- detecting disease problems before they have adverse consequences
- predicting future disease outbreaks
- determining the potential role of wildlife in the ecology of the disease
- helping to plan and monitor control programmes if needed.

Information obtained from disease surveillance may need to be communicated to stakeholders representing public and animal health, wildlife conservation and management and environmental management interests. Disease surveillance and monitoring should form an integral part of any disease management strategy.

Importance of wildlife surveillance

Surveillance for wildlife diseases is an important tool for conservation management necessary for assessing risks to wild populations. Wildlife can also be important reservoirs or sources of zoonotic infections (*e.g.* leptospirosis) and diseases affecting domesticated stock (*e.g.* bovine tuberculosis). As humans and their livestock increasingly move into wildlife areas and as wildlife moves into urban areas to exploit novel resource opportunities, the likelihood of contact and spillover of infections from wildlife to humans and domestic animals has increased so enhancing the need and value of wildlife disease surveillance.

Designing a disease surveillance strategy

A disease surveillance strategy should have clearly defined objectives, sound epidemiological justification and should involve appropriately trained personnel with sufficient technical skills to perform both field and laboratory exercises [►**Section 3.5.2 Building capacity by education and training**]. Appropriate human health and biosafety precautions should be followed during surveillance and monitoring activities. Activities should focus on collecting only the information that is needed to achieve the objectives, noting that this information may differ between diseases.

Surveillance may involve collecting various samples from the environment, the health screening of living and dead specimens, remote screening and/or the introduction of sentinels [►**Checklist 3-1**].

CHECKLIST 3-1. Information commonly collected during surveillance activities

Timing

☐ Dates of findings, sampling, results *etc.*

☐ Estimation of timing of any change in health status

Host information

☐ Species involved

☐ Numbers affected

☐ Numbers sampled

☐ Population(s) at risk *i.e.* contextual information about species present at the site

☐ Ages (*e.g.* juvenile/adult)

☐ Sex

☐ Condition (*e.g.* from fat score or biometric measurements)

☐ Clinical signs

☐ Signs of trauma or injury

☐ Additional observations (*e.g.* whether animals seen prior to outbreak appear under-nourished or healthy)

☐ Other contextual information (*e.g.* population movements)

Samples

☐ Sample types taken (*e.g.* whole carcase, whole blood, serum, plasma, faeces, buccal swab)

☐ Storage and transport methods

Environmental information

☐ Location/s

☐ Type of habitat/area

☐ Environmental factors (*e.g.* weather conditions)

☐ Land use and human activities

☐ Specific features of an areas

Additional information

☐ All other relevant case related notes and comments

Laboratory findings

☐ Laboratory results and diagnosis

☐ Laboratory or diagnosticians conducting the work

Personnel

☐ Name and contact information of individuals involved in collecting information

Wherever possible, assessments should be made to ensure that an appropriate portion of a population is examined and that the correct types of data are collected, in order to fulfil the surveillance objectives as defined in the strategy. An accurate assessment is reliant on a thorough understanding of the disease and its lifecycle, notably, transmission [►**Case study 3-5. Surveillance strategies for highly pathogenic avian influenza (HPAI) H5N1**].Therefore, a multi-disciplinary approach to surveillance involving a variety of professionals (*e.g.* wetland stakeholders, human and animal health professionals, epidemiologists, wildlife ecologists, mathematical modellers, geographic information specialists and statisticians) is often most effective. In some cases, reports about sick wildlife from the general public can be the first indication that a larger incident of morbidity and/or mortality is about to occur.

To a large extent, the robustness of a surveillance strategy relies on sampling an appropriately sized sample of the appropriate portion of the population. Skilled animal health personnel will be needed to determine sample sizes although for wildlife the wetland manager is likely to have a *relatively* good understanding of structures of wild populations and thus can help in the design and practicalities of achieving this target sample size.

The problem of bias in surveillance strategies is less of an issue for domestic animals where it can be *relatively* straightforward to sample individuals randomly and in a stratified manner *e.g.* individuals of different ages, sexes, at different times of year *etc.* Surveillance in wildlife, however, can be fraught with problems of bias. All wildlife trapping techniques have their own biases, surveillance from carcases may introduce a range of biases, *e.g.* such strategies are often biased towards larger bodied animals (smaller ones being over-looked or scavenged before retrieval), or there may be other non-random reasons why carcases are found (*e.g.* road-killed animals may not be representative of the population at large but instead a sub-set of perhaps younger, less experienced or diseased individuals less able to remove themselves from danger).

CASE STUDY 3-5. Surveillance strategies for highly pathogenic avian influenza (HPAI) H5N1.

Active surveillance programmes for free-ranging healthy wild birds should be targeted at species with the following characteristics:

- Species known to have been infected in the past with the HPAI H5N1 virus
- Species known to be epidemiological reservoirs for low pathogenic AI viruses
- Social species that are known to aggregate seasonally at breeding, roosting, migration stopover and non-breeding (wintering) sites
- Species that potentially share habitats with poultry farms, integrated livestock-aquaculture systems, backyard poultry flocks and croplands such as rice fields (sometimes called 'bridge' species)
- Species whose seasonal movements or migratory patterns may explain disease dispersal and/or emergence. Selection of sampling sites will primarily be dictated by the habitat preferences of the species to be sampled and occurrence of outbreaks in poultry although other factors such as bird and researcher safety, and project logistics should also be considered.

Source: Food and Agriculture Organisation, 2007.

Between disease cases, there may be differences in:

1. **Surveillance approaches**
   - *Passive or 'scanning' disease surveillance*: this involves examination of only clinically affected individuals, with no special effort being made to 'seek out' infected or diseased cases. This may involve the routine gathering of information on disease incidents from the general public, medical or veterinary professionals and laboratories dealing with routine cases. Passive surveillance may lead to significant under-reporting of diseases and should, therefore, be supplemented by active disease surveillance particularly for important animal diseases.
   - *Active disease surveillance*: this involves proactive examination of individuals to actively seek out infection or disease, and targeted searching for evidence of disease in populations. Programmes may be broad-scale to capture any significant disease occurrences, targeted against specific high-threat diseases (*e.g.* diseases of particular public and animal health or agricultural significance), or designed to monitor the progress of individual disease control or eradication strategies. International trade may also guide surveillance schemes to establish national and regional disease status, especially where it relates to public health and economic initiatives. For livestock diseases which are spread by the movement of infected animals, areas where animals are moving should be targeted for surveillance (*e.g.* livestock markets, trading routes and border areas). Such areas or routes should also be carefully controlled during an outbreak.

2. **The speed of information flow** between different components of the disease surveillance system (immediate or routine).

3. **The rapidity of response required:** immediate investigation of disease incidence or routine and regular analysis of data with subsequent adjustments to control activities when required.

For a disease surveillance strategy to act as an early warning system, reporting, decision-making and response must be rapid. However, for endemic diseases, it may be more appropriate to evaluate the routine data collected to adjust or target control activities. National surveillance systems should include an integral approach and accommodate all needs.

Surveillance systems

All surveillance systems involve similar components (Figure 3-12). It may be possible to link and integrate several different surveillance systems.

The following functions may support surveillance systems:

- setting of standards (*e.g.* disease case definitions)
- training and supervision
- laboratory support
- communications
- resource management.

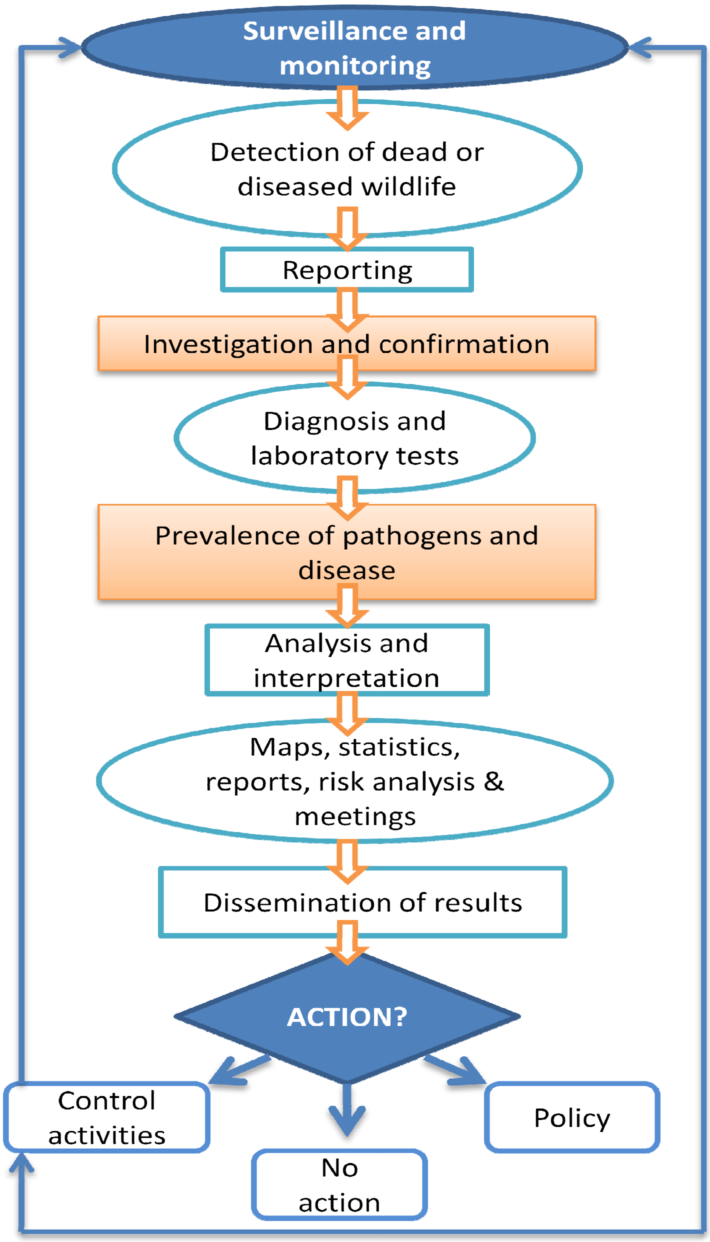

Figure 3-12. The key components of a surveillance and monitoring system.

The following tasks are recommended for improving animal disease surveillance:

1. Identify key stakeholders and organisations relevant to the site

- state or local veterinarian or animal health officer (will most likely be lead person in regional surveillance effort)
- public health contact
- veterinary diagnostic laboratories.

2. Identify relevant animal diseases for the site

- notifiable animal diseases
- wildlife animal diseases
- zoonoses.

3. **Familiarisation with country responses with reference to potential disease outbreaks at the site.**

4. **Establish standardised report forms for disease surveillance including definitions such as "confirmed" and "suspected".**

5. **Identify and collaborate with ongoing animal disease surveillance efforts at other wetland sites and government Ministries or Departments *e.g.* in the Departments of Agriculture or Health.**

6. **Identify efficient and effective communication channels with the relevant health authorities and laboratories and other wetland stakeholders and include opportunities for feedback.**

Prioritising diseases for surveillance

The following factors should be considered when determining which diseases to prioritise for surveillance:

- Whether the disease is of public health or agricultural importance.
- Whether the disease has a potentially severe impact (*e.g.* using indicators such as morbidity, disability, mortality).
- Whether the disease has significant epidemic potential.
- Whether the disease is a specific target of a local, regional, national or international control programme.
- Whether the information to be collected will lead to significant successful human/animal health action.

Figure 3-13. Conducting disease surveillance in an attempt to understand why water voles *Arvicola amphibius* in UK have suffered population declines (*WWT*).

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3.3.2 Identifying a disease problem

Disease is a natural part of any ecosystem. Identifying a departure from 'usual', 'natural' or 'expected' levels of mortality or morbidity can be complex and measures need to be put in place to help this process. Many of the other sections of this Manual will help in identifying a disease problem [*e.g.* **►3.1.4 Contingency planning, ►3.1.1 Risk assessment, ►3.2 Reducing risk of disease emergence,** and **►3.3.1 Surveillance and monitoring**].

Figure 3-14. Apparently healthy wildlife: identifying when a problem is emerging relies on a good understanding of what constitutes 'normal' mortality and morbidity and good early warning systems (*Sally MacKenzie*).

Early warning systems

Identifying a problem early before it becomes fully established or widespread can bring a wide range of potential benefits such as preventing loss of productivity from livestock, loss of biodiversity, loss of livelihoods, loss of disease-free status for trade, and reducing disease control costs. Thus, early warning systems are vital for swift responses.

CHECKLIST 3-2. Capacity requirements for identifying disease problems and informing early warning systems
☐ A good understanding of the use of the site by wild and domestic animals throughout the year and an understanding of their biology, abundance, behaviour and movements.
☐ A reasonable understanding of the epidemiology of particular diseases and of the stressors and other factors associated with disease outbreaks.
☐ An appreciation of possible routes of disease introduction (*e.g.* new livestock, migration, people movements).
☐ An understanding of times of greatest risk of disease outbreak at a site (*e.g.* a particular season or agricultural activity).
☐ Robust disease surveillance (both active and passive) in wildlife and livestock at a site. Ideally this should include regular visual checks of animal groups to screen for unusual behaviour, reduced body condition or productivity of domestic stock, signs of disease and/or mortality.
☐ Clear systems for reporting concern to a site manager and from the site manager to the local disease control authority.
☐ Use of these systems for immediate reporting of an unusual animal health problem to the local disease control authority.
☐ An understanding and capability to provide information and samples from a site to aid disease diagnosis [**►Sections 3.3.3 Sample collection and preservation, ►3.3.4 Sample transport and shipment, ►3.3.5 What data to collect at a suspected outbreak**].
☐ A communication network established between surveillance diagnosticians, site managers and disease control authorities both for two-way information flow about surveillance at the site but also from authorities about disease in surrounding areas including neighbouring countries.
☐ A communication network between site users in particular farmers and those working and living within wetlands.
☐ Awareness amongst wetland stakeholders of disease issues and an understanding of how to respond if there is an apparent problem.
☐ Training of site personnel to deliver the above [**►Section 3.5.2 Building capacity by education and training**].

Communication networks

Communication networks, developed ahead of an emergency situation, are vital not only between local and national authorities but also with other stakeholders, including local communities and landowners to ensure awareness raising and risk communication.

Early identification of a disease problem and the ability to respond are dependent on clear and well established channels of communication and formal or informal networks. A problem disease may manifest itself in various subtle ways and a site manager should have available a communication network that allows rapid synthesis of seemingly disparate information. For example, a flow of information should allow a site manager to become aware that there has been a recent incursion of wildlife due to disturbance in surrounding areas, that there has been some loss of productivity in the livestock using the site, or that a higher than expected number of dead or sick wild animals has been observed. Although these may all be entirely unrelated it should prompt the site manager to investigate further. This sort of approach to disease intelligence is key as it supplements disease surveillance data by making full use of additional qualitative information, enhancing awareness of disease related issues that may otherwise remain undetected.

Once a disease problem has been identified the response plan can then be put into action.
►**Section 3.3 Detecting, assessing and responding to new disease**
►**Section 3.4 Managing disease**

Further information and sources

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3.3.3 Sample collection and preservation

The wetland manager is not expected to be the final disease diagnostician, however they may play a key role in maintaining the quality of data and samples collected for surveillance and disease investigation purposes. All samples should be collected as fresh as possible and undamaged. Samples may include carcases, tissues, parasites, whole blood, serum, swabs, environmental material, faeces or ingested food *etc.*

Choosing a specimen

The most useful sample to collect is an entire carcase, which is fresh and undamaged by decomposition or scavengers. Such a sample allows a pathologist to carry out gross examination, take a variety of samples and perform a range of tests.

It is important to note that carcases of certain species such as fish and aquatic invertebrates, decompose more rapidly than those of birds or mammals and, therefore, examination or chemical-fixation (*e.g.* in alcohol) must occur as soon after death as possible. Collection of both healthy and diseased tissue from the same chemically-fixed specimen for comparison can prove invaluable in certain circumstances (*e.g.* for investigation of diseases of coral).

To help to reduce bias, samples should be representative of the range of species/individuals affected and several specimens of each species or class (*e.g.* age or sex) should be collected.

Personal protective equipment

The primary concern when collecting carcases or other diagnostic samples must be personal safety. Many animal diseases are zoonotic and every carcase or other diagnostic sample must be treated as a potential hazard to human health. Gloves (either plastic or disposable), coveralls, rubber boots and potentially masks, should be worn where possible and/or appropriate. If gloves are not available, inverted plastic bags can be used to protect the hands of the person collecting the carcase.

Each carcase should be double-bagged whilst using gloves and coveralls and the outside of bags and footwear should be disinfected before leaving the area. Any other specimens should also be double-bagged in plastic before leaving the area. Disposable protective equipment should also be double-bagged and incinerated at high temperature where possible.

Tissue collection

If submitting an entire carcase for analysis is impractical, it may be necessary to remove appropriate samples from specimens. It is advisable to first consult disease specialists about the method they require for sample preservation. The collection of parasites and their preservation should also be discussed (most parasites can be preserved in 70% ethanol). It is valuable to become familiar with these specialists, their fields of expertise and potentially the sample preservation methods they prefer, before an emergency situation occurs.

It is important to collect separate tissue samples where possible for microscopic examination, microbiology, toxicology and other types of analysis. For most tissue samples the following is appropriate: with a sharp knife or scalpel cut a thin (3-6 mm) section of tissue. If lesions are present include all or part of this affected tissue and adjacent apparently healthy tissue. Take care not to crush the tissue and place in a volume of preservative at least ten times the volume of the tissue to ensure adequate preservation.

Supplies

Basic supplies and equipment required will vary depending on the species and samples in question. It is advisable to keep a small kit packed for ease of ready sampling. Samples can be stored in appropriately sized plastic bags with a sterile interior as they are easily transported and labelled. Wide mouth plastic bottles with threaded caps are useful for sample storage. Indelible markers and pencils are necessary for sample labelling. Tape to prevent leakages is also advisable.

Photography

Photographing the site and carcases *in situ* can be extremely helpful to a diagnostician. Photographing any lesions (both external and internal) can provide useful information on their position and appearance. Include a ruler or other readily recognised objects in the photograph to provide scale, and keep a written record of contextual information on each photograph.

Labelling

For maintaining sample identity, proper labelling of samples is vital, together with preventing loss of readability of labels or their separation from samples. Where appropriate, affix a label directly to the sample (*e.g.* tie directly to a leg of the carcase). Write directly onto sample tubes or keep labels as close to the specimen as possible.

Double labelling is advisable, for example, directly label the sample or sample tube and also the bag in which the sample is placed. This helps prevent confusion and possible errors when multiple samples are received at the same laboratory. Use of pencil or waterproof ink on tags is advisable. The most durable tags are those made of soft metal that can be inscribed with a pencil. Waterproof paper can also be used when dealing with specimens from marine environments.

Information marked on carcase tags should include:

- name, address and telephone number of the person submitting the carcase
- collection site
- date
- reference number
- whether the animal was found dead or euthanised (plus method of euthanasia)
- brief summary of clinical signs.

Each carcase should then be place in a separate bag which should also be labelled.

Tissue samples taken into plastic bottles should be labelled on the outside of the bottle or a piece of masking tape placed around the tube. The label should include:

- date
- type of animal from which the sample came
- the type of tissue
- reference number.

If the sample is in a plastic bag the bag should be labelled in this way. Do not insert tags into bottles or bags with samples as they may contaminate the sample.

Preservation of specimens

Chill or freeze all specimens depending on the length of time it will take for them to reach a diagnostic laboratory (understanding that chilled is preferable), unless they are chemically fixed, in which case samples can be kept at ambient temperature. Freezing can damage tissue or kill pathogens and hence reduce options for diagnosis. However, if samples must be held for more than a few days they should be frozen on the day of collection to minimise decomposition.

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3.3.4 Sample transport and shipment

If diagnostic samples are spoiled during shipment then all the effort involved in their collection will have been wasted. Where samples need to be chilled or frozen an understanding of the concept of the 'cold-chain' is required. This refers to the need for samples to remain at the desired temperature and not to experience cycles of change (*e.g.* freezing and thawing) which can damage some samples irreparably.

The requirements for sample packaging and shipment vary between countries and diagnostic laboratories. It is, therefore, essential to contact the laboratory that will analyse samples to find out any specific shipping requirements as early as possible in the procedure. This will help with processing samples upon their arrival at the laboratory and reduce the risk of sample quality being compromised.

Transporting and/or shipping samples must not pose a biosecurity or human health risk. Seek advice from veterinary authorities about safety and regulations for transporting and shipping samples.

The most important considerations for successful sample transport and shipment are:

- prevent cross-contamination between specimens
- prevent decomposition of the specimen
- prevent leakage of fluids
- preserve individual identity of specimens
- properly label each specimen and the package in which they are sent.

Prevent breakage and leakage

Isolate individual specimens in their own containers and plastic bags. Wrap these samples with protective material where possible (*e.g.* bubble wrap or newspaper). Protect samples from direct contact with coolants such as dry ice or freezer blocks. Ensure that if any sample breaks or leaks the liquid does not leak to the outside of the package by containing all materials inside plastic bags, or other leak-proof containers, where possible.

Containing specimens

The plastic bags for containing specimens need to be strong enough to resist being punctured by the materials they hold and those adjacent to them. Polystyrene boxes within cardboard boxes are useful for their insulating and shock absorbing properties. The polystyrene should be at least two centimetres thick when possible. These boxes are strongest and least prone to break when their sides are straight. If polystyrene boxes are not available, sheets of this material can be cut to fit inside cardboard boxes with a similar effect (though the package is less leak-proof). The strength of the cardboard box needs to be sufficient for the weight of the package. If hard plastic or metal insulated boxes are used for transport, cardboard boxes around them can be used for protection and to attach labels.

Cooling and refrigeration

Keeping samples chilled

When it is necessary to keep samples cool during shipment (*i.e.* at refrigerator temperature of approximately 4°C), chemical ice packs are preferable to wet ice due to less leakage when they thaw. It is possible to make ice packs by freezing water inside a plastic bottle that is sealed (not filled completely and taped closed to prevent the top coming off in transit) and then placed in a sealed plastic bag to further prevent leakage. If frozen carcases are being transported they can act as a cool pack for other samples sent in the same container. When using ice packs they should be interspersed between samples to achieve a uniform temperature throughout.

When submitting dead fish for *post mortem* examination they should be wrapped in moist paper to prevent them drying out and then refrigerated but not frozen. Fish decay very quickly but a fish refrigerated soon after death may be held for up to twelve hours before examination and sample fixation.

Keeping samples frozen

Dry ice (solid carbon dioxide) or in some circumstances liquid nitrogen can be used to ship frozen specimens. The gaseous carbon dioxide given off by dry ice can also damage some disease agents and this must be considered before using it for tissue transport. As the volume of both dry ice and liquid nitrogen expand as they change to gas, specialist containers that allow for this expansion are needed for their transportation.

Note: Shipment of formalin, dry ice, liquid nitrogen and alcohol is regulated in many countries and must be cleared with a carrier before shipping.

Samples preserved in formalin, other chemical fixative or alcohol can be transported without chilling.

Shipping

It is important to pack any space within packages with a substance such as newspaper which will prevent movement of containers, act as a shock absorber and may also soak up any potential leakages. It also has insulating properties.

Packaging and labelling

Packaging and labelling of specimens must conform to the regulations of the country from which the package is sent and also those of the country in which it will be received (if it is being sent to a laboratory in another country). It is important to mark the outside of the package with the required labelling regarding the type of specimen being transferred and where necessary the method of cooling (*e.g.* packages containing dry ice should be marked with specific symbols).

Permits

Permits or licences may be required for collection and transportation of some samples such as CITES-listed species, and invasive collection of samples from living animals, and these permits and licensing regulations may vary between locations. Animal health permits will likely be required for crossing national boundaries. Advice from national authorities about permit requirements must be sought prior to collection and transportation of samples.

Carriers

Samples should be shipped where possible by carriers that can guarantee 24-hour delivery to the diagnostic laboratory. Where possible arrange for collection of sample packages from the point of origin to avoid delays. When shipping arrangements have been made, contact the diagnostic laboratory to provide them with further details including estimated time of arrival and any shipping reference numbers.

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3.3.5 What data to collect at a suspected outbreak

The wetland manager will not be responsible for leading an epidemiological investigation but can play a key role in this. Detailed field observations during the course of an outbreak and information about events preceding it, may provide valuable data on which to base a diagnosis and corrective actions. It is important for the information gatherer to keep an open mind about the potential cause of the problem. Some information which may seem irrelevant in the field may become very important when piecing together the events leading up to an outbreak. A thorough chronology of events is key to diagnosis and disease control operations, and is almost impossible to obtain some time after the outbreak has occurred.

A key concept is that of explaining to the diagnostician how the affected individuals relate to the whole *population at risk*. As an example, 100% of the dead animals may be adult males but the population present (*i.e.* at risk) may have only contained adult males and hence the disease is not *necessarily* related to age or sex.

How to record data

It is important to record as much relevant information as possible as soon as events unfold.

Photographs and video footage can quickly convey specific information such as land use, landscape, environmental conditions, gross lesions and the appearance of clinical signs in sick animals. Sources of information may include local people, landowners and agencies working in the area preceding or during an outbreak. Information should be passed to the diagnosticians as soon as possible, updating them as appropriate.

Which data to collect

Checklist 3-3 provides a summary of the information to collect at a suspected outbreak.

CHECKLIST 3-3. Which data to collect at a suspected outbreak.

A broad range of data should be collected at a suspected outbreak, including:

- ☐ Population(s) at risk *i.e.* contextual information
- ☐ Species affected (including species unaffected *i.e.* population(s) at risk)
- ☐ Age
- ☐ Sex
- ☐ Number sick/dead
- ☐ Clinical signs
- ☐ Estimation of time of disease onset
- ☐ Location(s)
- ☐ Type of habitat/area and land use
- ☐ Environmental factors (*e.g.* weather conditions)
- ☐ Other contextual information
- ☐ Specific features of problem areas (*e.g.* population movements)

Population(s) at risk

Perhaps the most important contextual information is the species and numbers of individuals present and affected in the vicinity of a mortality event. A broad range of affected host species may suggest a storm, other sudden environmental event or toxic/poisoning incident, whereas a narrow host range, with other species present and at risk yet *unaffected*, may indicate a specific infectious agent.

The proportion of animals affected in the population provides information about the nature and seriousness of the problem. Statements such as '100 dead birds were found' are meaningless without an indication of what proportion of the population this constitutes.

Ensure that demographic data collected from affected animals are related to that of the wider population present. For example, if all the animals were juveniles yet this was the population present and at risk at the time, then this needs to be explicit to the diagnostician.

Species affected

It is important to note as much detail as possible regarding the species affected. See above point regarding species *not affected*.

An understanding of the ecology of the affected species will help to determine why some species might have been affected and others not. As an example, some species may have avoided exposure to an infectious source or poisoning event through differences in feeding behaviour.

Age

Where possible assess the age of the population at risk and the age of those individuals affected. Some diseases may only affect juveniles due to age-related immunity in adults. Other diseases affect all ages although those that are older or younger may be more susceptible due to other stresses. Diseases may also affect age groups differentially due to behavioural differences in feeding habits, for example.

Sex

Where possible assess the sex ratio of the population at risk and the sex of those animals affected. There may be inherent physiological or behavioural reasons for sex-related differences in susceptibility to disease.

Number sick/dead

The number of sick individuals compared with the number of deaths can help to determine the nature of the disease and the length of time it takes to become fatal. The longer it takes, the greater the proportion of sick compared with dead individuals and the less acute the disease process. This can also apply to the proportion of an area affected in marine environments. Again, relate numbers of affected animals to the population that was at risk.

Make an assessment of the number of sick or dead animals which may have been lost to predators and scavengers or that may have decomposed.

Clinical signs

As much detail as possible should be recorded about clinical signs observed in sick individuals, including changes in behaviour, physical features or temperament. Photographs and video footage can be extremely helpful in recording this information.

Estimation of time of disease onset

Establishing a timeline of events in an outbreak is crucial. When estimating the time of onset of a disease incident, aspects to be considered include:

- The earliest date when people would have been on site to observe individual animals showing signs of illness or mortalities.
- The date mortalities were first reported.
- The proportion of fresh carcases compared with those decomposed or scavenged.
- The number and type of scavengers should be assessed to determine how long carcases are likely to remain in view.
- Air, water and soil temperatures will affect rates of decomposition and should be taken into account when estimating how long individuals have been dead.
- Any change in coat or plumage (including stage of moult) between live and dead individuals as this can help pinpoint how long ago an individual died.
- Size of any dead young compared with known growth rates (and size of living young) to help assess how long ago the individual died.

Location

Record precisely (ideally GPS coordinates), in as much detail as possible, the location and spatial extent of the event and of carcases or sick individuals, so these data can be accurately mapped.

Type of habitat/area and land use

Identify the habitat type, including soil and vegetation present. Describe land use (by humans and animals) including any recent changes. This information together with topography can often be illustrated well using photography or video footage. Particular attention should be paid to areas where groups of dead individuals were found. Any differences in habitat in these areas should be noted.

Environmental factors

It is important to describe the habitat and land use *etc.* and also determine if any unusual event preceded or precipitated the suspected outbreak, *e.g.*:

- Stress can be caused by abrupt changes in environmental conditions (*e.g.* storms, temperature fluctuations or precipitation) and can precipitate outbreaks of disease.
- Food shortage or imbalance can also lead to loss of condition and disease outbreaks.
- Changes in water level may disperse or concentrate populations and change the availability of food and water and access to potential toxins (*e.g.* invertebrate die offs leading to outbreaks of avian botulism).
- Estimation of whether biting insect populations have increased can be important, as they may serve as disease vectors.
- Water quality may be important as poor water quality may contribute to disease and mortality (*e.g.* avian botulism). Primary contamination by toxic substances can also lead to morbidity and mortality (*e.g.* oil).
- Recent management practices (*e.g.* pesticide spraying) should be recorded, as should any previous disease issues in the area.

Other contextual information *e.g.* population movements

Other contextual information should be recorded, particularly if there have been changes in conditions or populations. Information on the condition and behaviour of animals prior to the outbreak should be recorded if possible, as should any changes in their abundance and distribution. Local people may be the best source for much of this information.

Specific features of problem areas

Other specific features not mentioned above should be noted and provided to the diagnostician.

Supplementary investigations

If further investigations are carried out these reports should be summarised and kept as a supplement to the original findings. These reports should be copied to the diagnostic laboratory where the specimens were sent. The date of investigations, type of searches carried out (*e.g.* air or ground), number of investigators, time spent on searches, weather conditions and time of day the search was carried out should all be reported.

Further information and sources

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3.4 Managing disease

Diseases are natural components of ecosystems and do not necessarily require any management intervention. Deciding whether a disease should be managed or not, rests largely on the extent to which it endangers human and animal health and welfare, economic systems, conservation aspirations, and the likelihood that intervention will achieve disease management objectives.

The appropriate approach will depend on the characteristics of the problem and, when dealing with an infectious disease, on the correct identification of reservoirs, hosts and vectors of infection. Prevention and control of a disease is usually more easily achieved than complete eradication [►**Section 3.4.8 Eradication, elimination, stamping out and lethal intervention**].

Appropriate disease management options will depend on whether one is dealing with endemic or epidemic disease, and whether the intention is to prevent or control disease spread. See ►**Section 2.6** for the principles of proactively and reactively managing animal disease and ►**Section 3.2** for techniques to both reduce risk of disease emergence and help limit potential spread.

Disease management options

Management measures may target the:

☐ **PATHOGEN**

1. Biosecurity ►**Section 3.2.4**
2. Disinfection and sanitation ►**Section 3.4.1**
3. Collection and disposal of carcases ►**Section 3.4.2**

☐ **VECTOR**

1. Control of vectors ►**Section 3.4.3**
2. Genetic manipulation ►**Section 3.4.5**

☐ **HOST**

1. Reducing stressors ►**Section 3.2.1**
2. Disease zoning, barriers and buffer zones ►**Section 3.2.2**
3. Standards for releasing and moving animals ►**Section 3.2.3**
4. Vaccination ►**Section 3.4.4**
5. Genetic manipulation ►**Section 3.4.5**
6. Movement restrictions ►**Section 3.4.7**
7. Eradication, elimination, stamping out and lethal intervention ►**Section 3.4.8**

☐ **ENVIRONMENT**

1. Habitat modification ►**Section 3.4.6**

☐ **HUMAN BEHAVIOUR AND ACTIVITIES**

1. Communication, education, participation and awareness ►**Section 3.5**

Ultimately, an integrated approach involving several methods is likely to be the most successful in managing diseases in a wetland.

Above all, management measures should be sustainable, based on accurate epidemiological and ecological information, and must balance the requirements for preserving biodiversity and protecting human health and economic well-being. This chapter describes several options for managing diseases in wetlands.

- *Disinfection and sanitation*
- *Collection and disposal of carcases*
- *Control of vectors*
- *Vaccination*
- *Genetic manipulation*
- *Habitat modification*
- *Movement restrictions*
- *Eradication, elimination, stamping out and lethal intervention*

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- **The appropriate approach to disease management will depend on the characteristics of the problem** and, when dealing with an infectious disease, on the correct identification of reservoirs, hosts and vectors of infection. **Management measures may target** the **pathogen**, **host, vector, environmental factors or human activities**. Ultimately, an **integrated approach** involving several complimentary measures is likely to be most **successful** in managing diseases in wetlands.
- **Disinfection and sanitation** procedures target pathogens and can be **very effective at controlling spread of infection** but must be **used with caution in wetland situations** to avoid negative impacts on biodiversity.
- **Animal carcases** represent a significant **potential source of infection** and **require rapid and appropriate collection and disposal**. Disposal options are varied and again need to be used with caution in wetland situations to reduce risks of pollution of water courses or further spread of infection.
- **Targeting vectors in integrated disease control strategies can be effective** and usually take the form of environmental management, biological controls and/or chemical controls, or actions to reduce the contact between susceptible hosts and vectors. To reduce negative impacts on biodiversity **caution must be used when using these measures within wetlands**.
- **Vaccination programmes**, often supplemented by other disease control measures, **can help control** and even eliminate diseases affecting livestock. Vaccination of wildlife is feasible but it is often complex - other management strategies may be of greater value.
- **Habitat modification in wetlands can eliminate or reduce the risk** of disease, by reducing the prevalence of disease-causing agents, vectors and/or hosts and their contact with one another, through the manipulation of wetland hydrology, vegetation and topography and alterations in host distribution and density.
- **Movement restrictions of animals and people**, usually imposed by government authorities, can be an **effective tool** in preventing and controlling disease transmission through avoiding contact between infected and susceptible animals.
- **Complete eradication of a disease requires a thorough understanding of its epidemiology, sufficient political and stakeholder support** and thorough resourcing and is thus rarely achieved! Elimination of disease from an area is a more likely outcome although this depends on measures to prevent re-emergence being taken. 'Stamping out' (involving designation of infected zones, quarantine, slaughter of susceptible species, safe disposal of carcases and cleaning and disinfection) is a management practice used for rapidly reducing the prevalence of a disease during an outbreak situation.

3.4.1 Disinfection and sanitation

Disinfection and sanitation

The spread of, and exposure to, *infectious* diseases can be significantly reduced through using effective sanitation and disinfection processes. Sanitation measures involve preventing animal contact with physical, microbiological, biological or chemical agents of disease, which are often found in wastes, and maintaining clean, hygienic conditions. Inadequate sanitation is a major cause of disease worldwide and simple measures for improving sanitation are known to have significant beneficial impacts on public and animal health.

Disinfection prevents the mechanical transmission of disease agents from one location to another by animals and inanimate objects, by eliminating many or all pathogenic microorganisms (except bacterial spores) on inanimate objects so that they will no longer serve as a source of infection. Disinfection measures can be used to help maintain good sanitation and hygiene.

Figure 3-15. Disinfection following fieldwork prevents transfer of infection on fomites such as boots and clothing.

Measures taken to prevent a disease outbreak

For public health and biosecurity reasons, people working in wetlands should maintain high standards of sanitation and hygiene, and avoid direct contact with human and animal faeces, solid wastes, domestic, industrial and agricultural wastes [►**Section 3.2.4 Biosecurity**]. Effective sanitation and hygiene can be achieved through engineering solutions (*e.g.* sewerage and wastewater treatment including treatment wetlands [►**Section 3.2.4 Biosecurity**]), safe storage structures (*e.g.* water and septic tanks), and by hygiene practices (*e.g.* disinfecting equipment and washing hands with soap). Any items that have been in contact with waste materials (*e.g.* clothes, equipment and hands) should be thoroughly cleaned and disinfected after use. Livestock housing should be regularly cleaned and disinfected and waste and clean water should be separated and safely stored. Waste materials from captive animals should be properly processed and disposed of.

Cleaning is a necessary first step that allows the subsequent disinfecting agent to come into direct contact with pathogens on the surfaces of an object. Cleaning is important as many disinfectants are inactivated by organic debris.

Some viruses, bacteria and other infectious agents can persist in the environment for protracted periods. Disinfection is only practical for circumstances in which the pathogen or disease transmission occurs in a very limited area. The appropriateness of disinfectants will be informed by information on the presence of non-target species and other potential environmental impacts, particularly any adverse effects on wetland ecosystem function. Disinfection for wildlife disease situations is often difficult and likely to be most effective where wild animals are concentrated, such as at artificial feeding or watering sites.

Measures taken during a disease outbreak

During a disease outbreak, it may be necessary (if practical) to disinfect the local environment to prevent recurrence. Procedures are generally similar, however, the nature and infectivity of the pathogen will affect the protocols employed. For example, chytrid fungus and foot and mouth disease virus will require very different procedures for decontamination. As a consequence, disinfection of a disease outbreak site should always be conducted under the guidance of disease control specialists.

From the above, the following should be done, as appropriate: during disinfection activities, easily cleaned protective clothes such as waterproof coveralls and rubber boots and gloves should be worn, and all clothes should be thoroughly washed after use and before leaving the outbreak area. If possible, personnel should wash their hair before leaving the area, and always before going to other wetland areas. Personnel handling potentially infectious agents should not work with similar species or those susceptible to disease for at least seven days after participating in disease control activities.

Disinfection processes require a suitable disinfectant, containers for the solution once it has been diluted to the appropriate strength and a suitable method for its application. Vehicles and boats with pumps and tanks can be used to store and dispense disinfectant. All vehicles should be cleaned and disinfected on entering and leaving an outbreak area. Brushes, buckets, and containers that can be used to clean and disinfect boots and pressure sprayers that can be used to dispense the disinfectant are also required.

Disease control specialists should advise on the most appropriate type of disinfectant and its application in wetland settings.

The effectiveness of a disinfectant in eliminating or reducing pathogenic microorganisms depends on the:

- **Number and location of microorganisms:** generally the larger the number of microbes, the more time required to destroy all of them.
- **Resistance of microorganisms to certain chemicals.**
- **Concentration and potency of disinfectants.**
- **Physical and chemical factors:** temperature, pH, relative humidity, and water hardness (*e.g.* the activity of most disinfectants increases as the temperature increases).
- **Organic and inorganic matter:** serum, blood, pus, faeces or other organic materials can interfere with the effectiveness of disinfectants.
- **Duration of exposure:** items must be exposed to the chemical for the appropriate contact time.

Commercial disinfectants are available from appropriate stores and sources. Disease control contingency plans should identify readily available sources of supplies and equipment needed for disinfection activities in case of an outbreak. Wetland managers, particularly those caring for housed livestock, should consider keeping a supply of disinfectant for general use. [►**Section 3.2.4 Biosecurity** for further information on biosecurity measures used in disease control].

Health and safety risks of using chemicals

Disinfectants may be toxic to humans as well as animals and plants, and therefore all chemicals should be used in accordance with the relevant safety precautions. Key factors that help to assess the human health risk of chemical exposure include the duration, intensity (*i.e.* how much chemical is involved) and the route (*e.g.* inhalation, skin) of exposure. Acute toxicity could be caused by an accidental chemical spill. Wetland managers may be responsible for informing workers about the chemical hazards involved and implementing disinfection control measures. Where required, wetland managers should be able to readily provide workers with appropriate personal protective equipment and Material Safety Data Sheets (usually available on the internet) for each chemical or mixture of chemicals that may be in use.

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Wetlands International, (2010). **Wetlands & Water, Sanitation and Hygiene (WASH) - understanding the linkages.** Wetlands International, Ede, The Netherlands. http://www.wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/downloadinfo/articleId/2467/Default.aspx [Accessed March 2012].

3.4.2 Collection and disposal of carcases

When considering collection and disposal of carcases it is important to remember that approved methods vary according to animal species, disease, scale of mortality and country. Animal health authorities should be contacted to advise on appropriate measures remembering that the health and safety of the personnel involved in any disposal operation are paramount.

Rapid and effectively planned carcase collection and disposal is essential to prevent spread of infectious disease and to reduce potential secondary poisoning in the case of toxic diseases. Presented below is a broad overview of the most commonly used methods for animal carcase collection and disposal, each has strengths and weaknesses which should be considered in the context of each specific situation.

Collection of carcases

Ideally carcases can be dealt with *in situ* to reduce chances of spread of infectious agents. However, in most circumstances where an outbreak has occurred and there are a number of carcases, they will need to be gathered to a central location for disposal. To help prevent potentially contaminated body fluids leaking during collection and transport to the central location, wherever possible (depending on size of dead animal), the carcases should be *double* bagged in plastic leak-proof bags (noting that claws, beaks *etc.* may accidentally pierce bags). Wooden containers are difficult to decontaminate as fluids soak into wood so, wherever possible, plastic or metal bins/barrows *etc.* should be used for transporting bagged carcases.

If carcases are being transported off-site to disposal facilities this must be done in leak-proof vehicles. Advice should be sought from animal health authorities regarding transportation of potentially infectious carcasses.

Burial of carcases

This is the often a preferred method of disposal as it is relatively easy to organise, quick, inexpensive, has potentially fewer immediate environmental hazards and it is a convenient means of disposing of large numbers of carcases. However, the suitability of this method needs to be considered carefully in or around wetlands as pits must not contaminate ground water nor be susceptible to inundation. Also care must be taken to avoid later exposure of carcases to people or other animals. Open pits were historically used for this purpose but potential problems include exposure to scavengers and the threat to groundwater quality. If carcases do not decompose sufficiently then contaminants may leach from the pit.

Closed pits are now generally favoured with at least a metre of topsoil laid over carcases. This restricts the carcases rising in the pit due to gas entrapment, helps prevents access to scavengers, absorbs decomposition fluids and facilitates odour filtration. Potential scavengers can be further dissuaded by the addition of lime or fuel oil to the carcases, or use of thorny plants such as acacia spread across the pit.

Specialist animal health advice should be sought on pit site selection as a poor choice can have serious adverse effects on the environment and public and animal health in the vicinity. Factors to consider include:

- height of water table
- distance from watercourses or wells
- access to site
- facilities available
- equipment required
- safety to personnel
- acceptability to landowner
- protection from public view
- distance from residences/roads
- surface slope
- cultural/historical considerations
- biosecurity considerations.

Incineration (burning) of carcases

Incineration of carcases is advantageous due to the generally pathogen-free solid waste by-product. However, factors to consider prior to burning carcases include:

- location of site
- prevailing wind direction
- access to site
- type of animal carcase involved
- fuel availability
- number of carcases to burn
- environmental considerations.

Common methods of incineration include open air burning, fixed facility incineration and air curtain incineration.

To achieve the high temperatures required to completely consume carcases in open air burning additional combustible materials (*e.g.* timber or fuel oil) must be used. Carcases can be either put on a platform above a fire at ground level or within a pit. Soaking or sprinkling carcases with fuel oil and allowing approximately 15 minutes for absorption results in a high burn temperature to be achieved which aids complete incineration. However, structures such as burning platforms must be capable of withstanding this heat without collapsing. It is worth noting that animals with higher fat content will burn faster than those with a lower body fat.

When burning either above ground or in a pit, it is important to burn carcases one layer at a time as piling them up may result in incomplete incineration of those in the middle. It is important to note that if the burn is incomplete then foul odours, particulates and pathogens can be released into the wider environment after the fire has been extinguished.

Important factors for the location of open air burning include direction of prevailing winds, surrounding habitat or land use and visibility/access by the public. Surrounding vegetation should be cleared to reduce the risk of fire spreading and, in dry situations, pit burning is advised to reduce this risk further.

Fixed facility incinerators are available in different sizes from small on-farm units to large specialist municipal incinerators. All produce controlled high temperature burning and many are fitted with afterburners to ensure complete reduction of carcases to ash. Portable controlled burning units may be available and can be brought on site in some situations.

Air curtain incinerators involve a powered fan blasting air over a burning pit with the resultant high air pressure and temperature obliterating carcases and restricting the escape of particulates. Such devices can incinerate other contaminated organic materials alongside carcases and, as such, are useful in large scale infectious disease outbreak situations.

Composting of carcases

Composting of carcases involves controlled decomposition during which heat and microorganisms consume the organic materials. The process is relatively lengthy involving an initial phase of up to several months of high temperature, a similar period of lower-temperature ‘curing’ or stabilisation, resulting in the production of carbon dioxide, water vapour, heat and compost.

Within a contained unit (a bin or even a building) with an impermeable base and lid/roof for controlling water vapour, alternate layers of carcases and litter (or straw) are built up on top of a base layer of litter. It is important to ensure the right carbon to nitrogen ratio to achieve good composting conditions.

For some situations in hot countries it may be possible to rapidly compost carcases by placing them in sealed heavy duty black plastic and exposing to the sun for an appropriate period of time until decomposition has occurred.

Advantages of composting include relatively low cost, low levels of pollution and a fertiliser as an end product. However, this approach may be inappropriate for use in many infectious disease situations, as the causative organism may not be destroyed. Additionally the length of time the composting process takes (which requires monitoring) may limit its usefulness.

Rendering

Rendering involves cooking carcases as a means to separate animal fats and proteins with the resultant products sometimes used as animal foodstuffs and for other industrial processes. Rendering is often not appropriate for infectious disease situations, due to the risks of spread of infection (including risk of transmissable spongiform encephalopathies as was seen with the outbreak of bovine spongiform encephalopathy in the UK in the 1980s). This is a specialist disposal technique and animal health advise should be sought regarding its suitability.

Further information and sources

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3.4.3 Control of vectors

Certain biological vectors of disease are closely associated with wetlands and play a role in transmitting disease pathogens amongst hosts. Arthropods are particularly important disease vectors of wetlands. Biting flies such as mosquitoes, midges, horse flies, tsetse flies and sand flies, can transmit viruses, bacteria, protozoa and nematodes. Non-biting house flies, blow flies, and flesh flies mechanically transfer disease pathogens on their legs and other body parts, or by dropping infected faeces or even vomit. These organisms may fly, or be carried, large distances from wetland habitats by wind or vehicles. Other important disease-carrying vectors associated with wetlands include snails, crustacea and ticks.

Vector control strategies aim to reduce transmission by reducing or eliminating the vectors and by reducing contact between them and potential hosts. Measures vary depending on the disease and vector species, but may be broadly categorised as environmental management, biological control and chemical control.

Environmental management

Environmental management measures may involve altering hydrology, topography or vegetation to reduce the capacity of the local habitat to maintain populations of disease vectors and to provide suitable habitat for vector predators. This can be conducted through environmental modification where there is a temporary, long-lasting or permanent physical transformation of vector habitats (*e.g.* through irrigation schemes that increase water flows and reduce mosquito oviposition sites), and environmental manipulation where there are temporary changes to a vector habitat (*e.g.* by removing specific types of vegetation that provide breeding sites for vectors, or altering water levels at key vector breeding times to reduce their productivity).

Modification or manipulation of human habitation or behaviour can reduce contact between disease carrying vectors and animals and humans. This may involve improved water storage (*e.g.* with covers) and solid waste management and personal protective measures such as mosquito nets and effective hand hygiene.

Biological control

Biological control measures use living organisms such as larvivorous fish or bacteria, to manipulate pathogens, parasites, predators, competitors, alternate hosts and other symbionts of target organisms. Introduction of sterile vectors can also help reduce the vector population and hence disease transmission. Advantages of such measures include specificity against target organisms and no chemical contamination of the environment. However, there are a number of potential disadvantages: the efficacy of reducing disease transmission through biological control measures is unknown for many vector species; there are various (often significant) ecological considerations; rearing organisms may be expensive; there may be difficulty in their application and production; and their use will be limited to aquatic sites where temperature, pH and organic pollution meet the requirements of the agent.

Chemical control

Chemicals can be quickly applied and may rapidly kill vectors at a relatively low financial cost. However, chemicals may cause damage to wetland environments and their wildlife and prolonged use may lead to the development of resistance in some vector populations. Using pesticides for the control of vectors may not be considered 'wise use' of a wetland site particularly if they affect non-target species. The efficacy of chemicals in reducing vector populations depends on the appropriateness of formulations, local conditions and the vector species itself.

Appropriateness of vector control measures should be based on the vector species, life stages involved, type and extent of habitats to be treated, the presence of non-target species of special concern, in addition to other environmental impacts, such as any likely adverse effects on wetland ecosystem function.

Vector control programmes

Integrated vector management strategies (to also be integrated into the wetland management plan ►**Section 3.1.3**) use a combination of vector control measures and are often most effective in reducing disease transmission. When designing a vector control programme, an assessment should be made of vector ecology (species, habitat, population, distribution and breeding cycle), the immune status of the host populations at risk, and the nature and prevalence of the parasite. This assessment will inform what may be achievable from a strategy.

Common objectives for a strategy include the prevention and control of outbreaks, stopping preventable deaths and minimising illness. Advice on the most appropriate vector control measures and the availability of control resources should be sought from the appropriate national and international authorities.

FURTHER INFORMATION: Tick control

Environmental (habitat) management:

Success in reducing the density of ticks is largely dependent on regular removal of ground cover, especially the mulch that shelters all tick stages, by mechanical means, herbicides or by fire.

- Remove low-growing vegetation and brush to reduce the structural support required by ticks to contact hosts.
- Remove leaf litter and underbrush to eliminate habitats for ticks and their small mammal hosts.
- Controlled burning of habitats favoured by ticks can reduce tick abundance from six months to one year.
- Larger host mammals such as deer, may be contained within certain areas separating them from areas inhabited by people (*e.g.* public walk ways) by physical barriers.
- The environmental impact of suggested control measures should be evaluated and appropriate approvals should be granted before they are undertaken.

Environmental management – adapting behaviour of people and animals

People – personal protection:

- Wear light coloured clothing to enable ticks to be observed easily.
- Apply insect/tick repellent containing DEET.
- Wear clothing to cover arms, legs, and feet whenever outdoors, tucking trousers into socks or wearing gaiters helps prevent tick access to legs.
- Walk in the centre of trails to avoid contact with overgrown grass and brush.
- Check yourself, others and companion animals thoroughly for ticks and manually remove any ticks found (►Tick removal).

People – tick removal:

- Use blunt curved tweezers or a thread.
- Grasp the tick as close to the skin surface as possible and pull upwards with a steady, even pressure.
- Pull firmly enough to lift up the skin, holding this tension for 3-4 minutes and the tick should back out.
- Do not twist the tick as this may cause the mouth to detach and remain in the skin.
- Do not squeeze or crush the tick as its fluids may contain bacteria.
- Dispose of the tick immediately. If you have any additional disease concerns, put the tick in a plastic bag and freeze it for taking to a medical professional.
- Immediately wash your hands and the affected area with soap and water.

Animals:

- Manually remove ticks from animals if practical to do so (►Tick removal).
- If tick infestation occurs, livestock can be dipped in recommended acaricides or pesticides.
- Consider use of resistant breeds of cattle.
- Rotational grazing regimes can also control infestations.
- There are vaccines available for some tick-borne diseases and even against some species of ticks themselves.
- Strict quarantine measures are important for domestic animal movements, particularly when importing into tick-borne disease-free areas.
- Companion animals should be closely monitored for ticks on a daily basis. Commercial products are available for controlling fleas and ticks on pets.

Integrated tick control

An integrated approach which uses personal protection methods, tick monitoring, habitat modification and acaricide application may be most effective in controlling ticks. Tick control measures should be tailored to the biology and seasonality of particular species. When choosing control measures, the type of habitat, density and activity of the human population, incidence of infection in the vector species, extent to which tick control is necessary, and degree of environmental modification that is acceptable should be carefully considered.

►Chapter 4: Tick-borne diseases factsheet

FURTHER INFORMATION: Mosquito control

Environmental (habitat) management

Encourage mosquito predators and their access to mosquito breeding habitats:

- Connect shallow water habitat (mosquito breeding areas) with deep-water habitat > 0.6 m (favoured by larvivorous fish) and steep sides, through meandering channel connections, deep ditches and tidal creeks.
- Include at least some permanent or semi-permanent open water.
- Construct artificial homes or manage for mosquito predators such as bird, bat and fish species.
- Do **not** introduce non-native species of fish or other predators into the wetland for mosquito control.

Reduce mosquito breeding habitat:

- Reduce the number of isolated, stagnant, shallow (5-7 cm deep) areas.
- Cover or empty artificial containers which collect water.
- Manage stormwater retention facilities.
- Strategically manipulate of vegetation.
- Vary water levels temporally.
- Construct a vegetation buffer between the adjacent land and the wetland to filter nutrients and sediments.
- Install fences to keep livestock from entering the wetland to reduce nutrient-loading and sedimentation problems.

In ornamental/managed ponds:

- Add a waterfall, or install an aerating pump, to keep water moving and reduce mosquito larvae. Natural ponds usually have sufficient surface water movement.
- Keep the surface of the water clear of free-floating vegetation and debris during times of peak mosquito activity.

Chemical control

It may be necessary to use alternative mosquito control measures if the above are not possible or ineffective. The environmental impact of vector control measures should be evaluated and appropriate approvals should be granted before undertaken.

- Use larvicides in standing water to target mosquitoes during their aquatic stage. This method is deemed least damaging to non-target wildlife and should be used before adulticides.
- Use adulticides to spray adult mosquitoes.
- During periods of flooding, the number and extent of breeding sites is usually too high for larvicidal measures to be feasible.

Open marsh water management

Control mosquitoes by introducing their natural predators to areas of tidal marsh using a system of pools connected by radial ditches. Fish feed on mosquitoes during high tide, then retreat to sumps or reservoirs at low tide.

Environmental management – adapting behaviour of people and animals

People:

- Wear light coloured clothing which covers arms and legs.
- Use impregnated mosquito netting when sleeping outdoors or in an open unscreened structure.
- Avoid mosquito-infested areas or stay indoors when mosquitoes are most active.
- Avoid physical exertion, and use colognes and perfumes sparingly as these may attract mosquitoes.
- Use mosquito repellent when outdoors. Note that some repellents cause harm to wildlife species, particularly amphibians. Wash hands before handling amphibians.
- Use citronella candles and mosquito coils in well ventilated indoor areas.
- Use mesh screens on all doors and windows.

Animals:

- Use insect repellent. Note that this method should not be solely relied upon.
- Use screened housing with measures to eliminate mosquitoes from inside structures.
- Use fans to reduce the ability of mosquitoes to feed on animals.

FURTHER INFORMATION: Snail control

Environmental (habitat) management

Reduce snail populations

Strategies should be implemented with specific knowledge of the ecology of the causative snail. Water impoundments of all shapes and sizes (*e.g.* irrigation systems, lakes and dams) provide fertile breeding grounds and good habitat for freshwater snails and encourage close and frequent contact between people and infected water. The following habitat alterations may help reduce snail populations.

Alter flow rate and water levels to disturb snail habitats and their food sources:

- Include 'v' shaped banks in irrigation channels.
- Remove vegetation/silt in channels to avoid a drop in velocity which may lead to further vegetation growth and good habitat for snails. Note that personnel involved in the manual removal of vegetation are increasing their exposure to snails. Frequent removal may be needed.
- Flow rate should only be addressed with knowledge of the ecology of the snail in question *e.g.* for *Biomphalaria* and *Bulinus* flows greater than 0.3 m/s would suffice but most snails can withstand flows up to 0.5 m/s.
- Borrow-pits, small pools and ponds serving no special purpose (for humans, wildlife or livestock) may be drained to eliminate breeding sites.

Expose snail habitat:

- Remove littoral vegetation from the sides of canals feeding irrigation projects to expose snail habitat. Heavy rain can also cause removal.
- Thought should be given to downstream conditions and the potential for the liberated snails to recolonise new habitat.
- Where possible dry out littoral zones to strand snail populations, however take into account the specific ecology and the resilience of the target species.

Chemical control

- Use of molluscicides may cause environmental damage and should be avoided. Use should be targeted rather than wide-spread. Applications are usually restricted to places frequently used by people for swimming, bathing *etc.*

Environmental management – adapting behaviour of people and animals

People:

- *Where possible*, avoid new human settlements near infested wetlands.
- Avoid contact with snail-infested waters. Use water supplied from covered pipes or pit-wells.
- Avoid swimming, wading, washing or bathing in water suspected of infestation. It is safest to consider all freshwater bodies in endemic areas as potential transmission sites if sites otherwise not identified.
- For agricultural workers at constant risk of infection, periodic examination and treatment may be the most feasible approach to disease control.
- Ensure good sanitary practices. A clean water supply and improved sanitation (including on board boats) must be provided to stop human excrement entering wetlands.

Animals:

- Prevent contaminated faeces from livestock entering wetland habitats. This is especially important for species that parasitise animal, livestock and human hosts.

CASE STUDY 3-6. Snail fever integrated control and prevention project in Tongxing Village of Wucheng Township, Yongxiu County of Jiangxi Province, P.R. China, 2007.

Summary

Disease issue or problem:	Snail fever / Schistosomiasis
Action taken:	▪ interruption of cattle-parasite-cycle by means of permanent stabling of cattle (long-term); ▪ awareness raising campaign by carrying out publicity and education activities; ▪ assessment of snail host spatial distribution; ▪ cattle examination and medical treatment.
Outcomes:	Newly reconstructed stables hosting approximately 100 head of cattle. The spread of snail fever in the Tongxing Village controlled and prevented effectively, which saves about 30.000 Yuan each year for human and cattle medical treatment.
What went well:	Participatory approach – stable reconstruction according to local farmers' needs.
Organisations involved:	Promotion Association for Mountain-River-Lake Regional Sustainable Development of Jiangxi Province (MRLSD) and the International Development Research Centre, Canada. Project funded by German Embassy Small Grant and additional contributions from local government on different levels.

Background

The project area is situated in the Tongxing Village of Wucheng Township, located in the Yongxiu County of Jiangxi Province, China. The Wucheng Township lies at the lakeshore of Poyang Lake, covering a total area of 368 km^2, with 47 km^2 consisting of grasslands infested with snail fever. The highest rates of infection with snail fever in the Wucheng population occurred in 1998 with more than 15% of the total population being infected; 10% of these suffered from terminal-stage snail fever. The infection rate among cattle was also elevated, with 71.8% being infected. The highly endemic situation for snail fever is explained by the extensive cattle raising on infested wetlands, maintaining a permanent snail-fever cycle among livestock. As snail fever can equally infect cattle and human beings, the ecological conditions for human infection with snail fever are, therefore, particularly hazardous throughout the entire township.

Tongxing Village is the largest administration village of Wucheng Township. The village-area consists of seasonally flooded wetlands and permanent water. Based on the abundant, grass-covered wetlands, cattle-breeding has become a major activity for local livelihoods. Therefore, the level of infection with snail fever remained alarmingly elevated, seriously hampering local economic development. Indeed, snail-fever was conceived as being a major cause for persisting poverty in the village.

The recent governmental programme of integrated control of snail fever, carried out in the Yongxiu County, prioritises preventative and sanitary measures combined with the development of secure livelihoods and the provisioning of preventive medical and veterinary services. It is well understood by villagers that the cattle-parasite cycle has to be interrupted in order to sustainably reduce the environmental risks of infection with snail fever. One principal intervention strategy is modifying the ongoing practice of extensive livestock breeding aiming at maintaining cattle outside snail fever infected areas (*i.e.* stabling or fencing).

Before the project started, 40 stables for the seasonal stabling of water-buffalos *Bubalus bubalis* already existed in the Paitou sub-village of Tongxing, but most of the stables had collapsed or were damaged. Therefore, they were not suitable for permanently keeping cattle outside the wetlands. The villagers wanted to reconstruct the stables and adapt them for permanent stabling.

In February 2007, the Promotion Association for Mountain-River-Lake Regional Sustainable Development of Jiangxi Province (MRLSD) submitted the Snail Fever Integrated Control and Prevention project in the Tongxing Village to the German Embassy in Beijing. The application was approved in April. The project started in April and was completed by beginning of October.

Activities

Reconstructing existing stables:

- the court, the access-ways, and the interior of the stables cleaned up and stabilised;
- 12 collapsed stables and 28 damaged stables repaired, including their roofs and cracked walls. All stables received painting to protect the outer facade;
- a wall was constructed around the main court covering an area of 1,200 m^2;
- the entrance was stabilised with cement covering an area of 160 m^2;
- sewage disposal ditches were constructed over a total distance of 300 m;
- two concrete ponds for dung disposal constructed with a total volume of 10 m × 5 m × 2 m;
- one sentinel house was newly constructed.

Carrying out publicity and education activities:

The Yongxiu County Snail Fever Control and Prevention Station, the Yongxiu County Agricultural Bureau and the Wucheng Township Government carried out a series of publicity and education activities on snail fever integrated control and prevention in Tongxing Village, by means of training, dissemination of educational materials and posting of pictures. A total of 2,000 people received the education/information.

Conducting investigations of snail hosts:

The Yongxiu County Snail Fever Control and Prevention Station conducted an investigation of snail hosts around the areas of Dahu Lake, Zhushihu Lake, Changhu Lake and Yanzihu Lake, which are frequently visited by the cattle. As result of the investigations, the spatial distribution of densities of the snail hosts was surveyed. The average density of snail hosts in Dahu Lake and Zhushihu Lake is 0.004/m^2, and 0.0097/m^2 in Changhu Lake and Yanzihu Lake.

Conducting cattle examination and medical treatment:

The Yongxiu County Agricultural Bureau provided examination of the cattle in Tongxing Village and free veterinary treatment. A total of 1,060 head of cattle were examined in the village, from which 9.8% were found to be infected. Of the infected cattle, 80% received treatment.

Use of funds

The total budget of the project was RMB 199,680 Yuan, among which 80,000 Yuan was contributed by the German Embassy in Beijing. Additional costs were met by local government.

Conclusions

After the implementation of the project, the newly reconstructed stables were able to house approximately 100 head of cattle. The spread of snail fever in the Tongxing village has been effectively controlled, saving approximately 30,000 Yuan each year in human and cattle medical treatment.

Case study from Mechthild H. Adameit & Martin Wiese,
Promotion Association for Mountain River Lake Regional Sustainable Development (MRLSD)

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3.4.4 Vaccination

Vaccination is used to protect against disease by inducing a level of protection from infection or the progression of disease in otherwise susceptible hosts. Vaccination programmes, supplemented by other disease control measures, can help control and even eliminate epidemic diseases affecting animals and humans.

The role and efficacy of vaccination as a means of control varies amongst diseases. Most commercially available vaccines are targeted against microparasites such as viruses and bacteria. Vaccination against macroparasites such as helminths (where immune responses are often more varied and less effective, and extent of disease is related to parasite burden), are generally less effective. Some vaccines may be highly effective in preventing clinical signs of the disease, preventing infection and reducing growth and shedding of the disease-causing agent.

Other vaccines may prevent clinical disease but not prevent infection or transmission. In some cases, vaccination may not be effective, may only reduce the severity of the disease or may offer different levels of protection depending on host age. Therefore, when deciding whether or not to include vaccination as part of a disease control strategy, a thorough knowledge of the characteristics of the disease agent and its epidemiology, and the suitability of available vaccines, is required. It is worth considering that outcomes of vaccination programmes are not always certain and success in one target population may not necessarily translate to elsewhere under different ecological, genetic or environmental conditions.

Humans at risk of exposure to zoonotic diseases, should seek advice about vaccination options from the appropriate health authorities.

The following issues should be evaluated before selecting an animal vaccination strategy:

Vaccine type

There are different types of vaccines and the advantages and disadvantages of each should be evaluated. Live attenuated vaccines often provide a longer lasting immunity. Some live vaccines can be administered using methods that involve little or no handling of animals, *e.g.* by using oral-baited vaccines, although more than one dose is often required. Inactivated (killed) vaccines should be safe in all circumstances.

To achieve adequate levels of immunity for epidemic livestock diseases where the disease-causing agent exhibits antigenic variation (*i.e.* exists as different types or is prone to change and/or mutation), it is important to select the correct antigenic type and subtype vaccine. Isolates of the agent should be regularly collected from a wide geographical spread, and submitted for reference laboratory analysis so that the appropriate vaccine strain can be selected.

All vaccines must be thoroughly tested on the target animal species to establish safety. Appropriate licences for target animal species may be required which can be particularly challenging and time-consuming to achieve for wildlife species.

Vaccine quality

Vaccines should be sourced from manufacturers who follow internationally accepted quality assurance procedures and codes of good manufacturing practice. The manufacturers should be subject to approval and quality control verification by independent national or international biological control authorities. Appropriate storage is essential for maintaining vaccine quality.

Vaccine protection

Not all vaccines protect animals from infection, although the prevention of disease progression may be sufficient to reduce transmission and hence aid in controlling disease spread. The pathogen will continue to circulate amongst unvaccinated individuals, but the purpose of a vaccination programme is to deliver the vaccine to a sufficient proportion of the population to enable an overall reduction in levels of transmission. Consequently an effective vaccination campaign will confer benefits even to the unvaccinated proportion of the population (often referred to as 'herd immunity').

The effectiveness of a vaccine in a given population is a function of the efficacy of the vaccine (*i.e.* the likelihood that it benefits an individual) and the proportion of the population to which it can be delivered. The level of vaccination coverage required to achieve disease control benefits will vary between host and pathogen populations. Sustained effort will be required in order to maintain the benefits of vaccination in the face of sources of re-infection (*e.g.* unvaccinated parts of the same population, other host species or environmental contamination).

Ongoing surveillance is, therefore, an important tool for monitoring the progress of vaccination programmes. Not all vaccines deliver life-long immunity and in some cases periodic re-administration may be required to deliver disease control benefits.

Vaccination and disease surveillance

Vaccination programmes may interfere with disease surveillance. For example, clinical surveillance may be more difficult in populations with a mixture of vaccinated and unvaccinated animals, as the disease may be unevenly distributed. Many serological tests cannot distinguish between antibodies that have been derived from vaccination or from natural infection, although some differential diagnostic tests do exist or may be developed. Interpretation of serology results can be greatly assisted by marking vaccinated animals, so that it is at least known whether samples have been taken from vaccinated or non-vaccinated animals. This may also be important to avoid the adverse welfare and financial implications of over-dosing individuals.

Vaccination storage and application

Vaccines should be stored at the correct refrigeration temperatures at all times and must be used before expiry dates. Vaccination teams must include personnel trained in administering vaccines.

Checklist 3-4 provides a summary of the principal considerations when selecting a vaccination programme.

CHECKLIST 3-4. Selecting a vaccination programme
When selecting a vaccination programme, the following should be considered:
☐ The programme should have a clear purpose and objective
☐ Once the target animal population and area have been defined, vaccination should be carried out as comprehensively as possible
☐ Separate vaccination personnel should be used for herds and flocks thought to have infection to minimise the spread of the disease between them
☐ Individual herds and flocks should be gathered separately to minimise the spread of disease
☐ Vaccinated animals should be permanently marked for future identification
☐ Vaccination programmes should be accompanied by other measures such as disease surveillance, livestock movement controls and quarantine (where possible and appropriate)
☐ Vaccination programmes should be accompanied by public awareness campaigns

Examples of vaccination programmes:

1. **Blanket vaccination** is the comprehensive vaccination of 'all' susceptible animals over a large area. This may be favoured when the disease has become well established, when there are many sources of infection, or when other disease control measures are impractical and/or ineffective. Areas with known and suspected infection and areas thought to be at high risk of disease should be covered. Several rounds of vaccination over several years may be required.
2. **Ring vaccination** is the rapid creation of a belt of vaccinated animals around an infected area. This can be implemented to contain a fast spreading disease outbreak, in situations where the effectiveness of other methods is unlikely to succeed, or in areas which are too inaccessible for blanket vaccination or other disease control measures. Epidemiological factors and resource availability should be assessed to determine the width of the vaccination zone. Vaccination should be completed within a short period of time, *e.g*. a week, and start at the outer edges of the ring, moving inwards towards infected animals. A second outer ring can be created if necessary [►**3.2.2 Disease zoning, barriers and buffer zones**].

Specific considerations for vaccination of wildlife

Vaccination of domestic livestock has been widely used and may often present a practical disease control option where an effective vaccine exists. Vaccination of wildlife is more challenging owing to many technological and logistical barriers including difficulties in delivering it to a sufficiently large proportion of the target population. Also, only few vaccines have been tested sufficiently to demonstrate their safety and efficacy and achieve a licence for their use in wild hosts. Even domestic animal vaccines against the same pathogen, may need to undergo significant testing to determine their safety and efficacy in wild hosts. These factors may rule vaccination out in many circumstances, although the approach has met with some success in controlling rabies and classical swine fever in wildlife populations in recent decades.

The aim of any wildlife vaccination programme needs to be clear from the outset, for example, does the vaccination programme aim to reduce mortality, reduce suffering, reduce the risk of spread to livestock or humans, or to ensure the viability of the population?

There may be risks associated with the vaccine itself, either in target or non-target populations. Live vaccines have the greatest potential for problems following release into the environment. Also, the ecological consequences of vaccination should be considered, including the possibility of altering demographic processes (*e.g.* survival rates, population growth rates).

Delivery of the vaccine to the target population may be logistically difficult or prohibitively expensive. Methods of vaccine delivery include the injection of captured animals and the deployment of palatable baits containing vaccine. Capture and injection options are likely to be relatively expensive and could have adverse welfare implications. Deployment of edible baits is often a more attractive option, but the development of a suitable bait which is compatible with the vaccine and sufficiently stable in the environment can be technically challenging.

Some well-resourced wildlife vaccination programmes such as rabies vaccination for red foxes *Vulpes vulpes* in Europe have proved successful. Other successful projects have involved vaccination of endangered wild populations against domestic animal diseases for which vaccines already exist, where populations were relatively restricted in range and well studied, and the aims of the project have been clear.

Vaccination of wildlife can be successful and may seem like an appealing option, however, other management techniques, particularly where naturally acquired immunity is developed, may be just as effective and in many ways preferable.

CASE STUDY 3-7. Buffalo treatment campaign in Iraq

Breeding marsh buffalo *Bubalus bubalis* is important in different parts of Iraq, particularly in its southern regions and wetlands such as the Central marsh due to the abundance of appropriate food, water and pasture land. Unfortunately, many by-products of modern technology and poor water management policies have damaged the natural environment of these areas.

This in turn necessitates the existence of veterinary centres to provide the proper treatment and vaccines needed for healthy buffalo populations. Due to an apparent lack of training and proper supplies, there is the potential for these centres to spread and worsen some diseases that afflict buffalo and cattle, such as septic blood haemorrhages and other diseases. These diseases lead to substantial losses in livestock, so consequently the authorities have instituted serious measures with the close support of Nature Iraq, an Iraqi environmental organisation, to contain these diseases through a campaign for fast and effective treatment of haemorrhagic blood septicaemia and other diseases.

Main diseases that afflict buffalo:

- Haemorrhagic septicaemia
- Symptomatic anthrax

The focus of this report is the prevention of haemorrhagic septicaemia. The following are the vaccines used in the prevention of this disease:

- Haemorrhagic Septicaemia Vaccine (H.S.V.)
- Blackleg Disease Vaccine (B.L.V.)

To make the combined vaccine, the two vaccines (H.S.V. with B.L.V.) must be mixed together and then it is ready for injection into the buffalo.

Haemorrhagic septicaemia

This is among the most common diseases infecting buffaloes throughout Iraq as well as in other African and Asian countries. After 13 years of two epidemiological studies in India, this disease was determined to be the more deadly than diseases such as cow plague, foot and mouth disease and symptomatic anthrax.

This disease appears along with seasonal increases in wind and heat. It is caused by the bacterium *Pasteurella multocida* and it is pathogenic in cows and deadly for buffaloes.

Infection

Cows and buffaloes which carry the disease are considered the main source of the disease, which can exist inside the mouth of other nearby animals that can infect them directly or indirectly.

The infection can be transmitted by breath or swallowing the germ. The high rate of infection is closely tied to the animals' wetland habitat and the close quarters the herds experience at night inside their enclosures.

Clinical signs

The infected buffaloes can be recognised by sluggishness, lack of movement, salivation, increased temperature, difficulty breathing, breathing through their mouth, nose excretions, and throat or neck lesions sometimes extending to the chest, as well as fluid in the throat and lungs.


Vaccination

Allergy testing is necessary, as are vaccine-resistant strains of the disease. The vaccination should also vary according to local conditions in various countries but it is essential that the vaccination must begin early, as soon as the disease is detected.

There are methods to help buffaloes survive the disease by making a slot in the trachea of the animals to give more time for the vaccine to work. It is possible to inject the animals intravenously whilst executing this minor surgical procedure at the same time by using anaesthetic.

In this project, work continued for a period of forty-eight days during which time 18,331 buffalo and 1,229 cows were treated in several regions of Thi Qar province, as shown in the following table.

District & sub-district	Number of vaccinated buffaloes	Number of breeders	Number of vaccinated cows
Suk Ash-Shuyook	6448	412	-
Al-Taar	1488	62	-
Al-Aslah	1479	51	846
Al-Cidaynoweya	617	28	-
Al-Fuhood	2232	81	-
Al-Chibayish	3783	252	60
Al-Hammar	1290	44	85
Karamatt Bani Saeyid	994	81	238

Results

The following results were obtained from the vaccination campaign:

- Improved conditions and help in controlling haemorrhagic septicaemia in the visited villages;
- Increased health awareness of Iraqi buffalo breeders;
- Creation of a trusting relationship between the citizens and Nature Iraq;
- Motivated the veterinary centres in Thi-Qar to contribute to increasing veterinary awareness for the people;
- Stopped the disease's migration from an infected area, and entrusted stewardship of the environment to the local people.

Case study from Al-Asadi A & Talib M. 2010. Buffalo Treatment Campaign. Nature Iraq Report, Pub. No: NI-0610-01. Thi-Qar Veterinary Hospital & Nature Iraq Chibayish, Iraq.

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3.4.5 Genetic manipulation

Altering the genetics of a host, by whatever means, can provide a way to reduce susceptibility to disease. For both wildlife and indigenous breeds of livestock, natural selection for genetic resistance to pathogens occurs over time, and, generally where the relationship between host and pathogen is well established, a balance is acquired.

Selective breeding has traditionally been achieved by cross-breeding two individuals, each possessing a favourable trait, to obtain one offspring with both. This is normally a lengthy process requiring many breeding cycles to eliminate undesirable traits that may also be inherited. Creating genetic resistance in hosts or using genetic techniques for other forms of disease control can be achieved more quickly using genetic manipulation/modification (GM) techniques.

GM is a biotechnology that involves the modification of the genes of an organism to produce a desirable trait, the altered organism is termed a genetically modified organism (GMO). Genetic manipulation allows the desired genes (and therefore traits) to be spliced directly into organisms and removes the randomness of sexual genetic recombination making the breeding process more targeted and efficient.

In the majority of cases, both old and new, methods of genetic manipulation are an impractical option for wetland diseases, nonetheless, both selective breeding and genetic modification (GM) are having an impact on some important diseases. These techniques have the potential to provide powerful and sustainable solutions to global health problems because they are effective, specific and can reduce pesticide use, which in turn reduces resistance and environmental damage. GM is, however, controversial as it raises concerns about risks of unintended and widespread impacts on the environment, *e.g.* transgenes moving between species or new insects or diseases filling niches once occupied by the eradicated/suppressed insect, potentially causing greater problems. Nonetheless, the huge potential for increased productivity and improved health benefits has resulted in continued development in the use of GM for disease management.

Genetic manipulation of hosts and habitats

Where disease resistance is known to have a genetic basis, traditional selective breeding can be used to generate resistant individuals and much research to date has focussed on breeding host individuals with immunity to a disease.

For domestic animals, in general, indigenous breeds of livestock will have greater resistance to endemic diseases and may, thus, provide a sound way to control diseases and maintain productivity. As an example, indigenous, trypanotolerant ruminant livestock (*e.g.* N’Dama and West African Shorthorns, as well as Djallonke sheep and goats) are useful in the control of African animal trypanosomiasis. Naturally resistant breeds are able to maintain productivity even in the face of disease risks and do not require expensive veterinary treatments, nor the costs (financial and environmental) of using chemicals for control of vectors.

For wildlife, genetic manipulation or selective breeding, is a subject for debates in environmental ethics, however, in the face of a particular threat from a pathogen causing serious impacts it provides a potentially practical solution. Selected individuals may then be used to repopulate a habitat that has already been adversely affected by a pathogen. For threatened species a successful *selective* captive breeding programme would offer a 'safety net' immune population that could be used for re-introductions should the species succumb to the pathogen (*e.g.* amphibians under threat from chytridiomycosis).

Genetic modification of plants can both increase their own disease resistance and bring broader health benefits. Wetland grasses and other monocotyledons are important natural remediators of pollutants, and through genetic modification researchers have demonstrated an ability to enhance performance in the metabolism of trichloroethylene and the removal of a range of other toxic volatile organic pollutants, including vinyl chloride, carbon tetrachloride, chloroform and benzene.

CASE STUDY 3-8. Dieback in Western Australia

Phytophthora cinnamomi (responsible for the disease dieback) is a destructive and widespread soil-borne pathogen that infects the roots of woody plant hosts. In Western Australia (WA) the disease has had devastating effects on native ecosystems: 40% of the 5710 known native species of WA are considered susceptible. Naturally occurring, genetic-based resistance to *Phytophthora cinnamomi* has been demonstrated and researchers are selectively breeding for resistant individuals. Resistant jarrah plants have been micro-propagated by tissue culture and clonal lines are being used for field trials and to repopulate dieback-decimated forests.

Genetic manipulation of vectors

For vector-borne disease management it is often favourable to target vector populations to break the life cycle between host and pathogen. The sterile insect technique (SIT) is a method which introduces sterile males into a vector population to compete with wild males reducing the population of the next generation. Historically, radiation had been used to sterilise males, which led, for example, to the successful eradication of the screwworm fly *Cochliomyia hominivorax* on the island of Curacao in the 1950s. A disadvantage of irradiation is that females often will not mate with the irradiated males. Modern GM techniques have offered improved options for SIT because GM insects have been shown to compete effectively with wild counterparts.

As vectors for globally important human diseases such as dengue fever and malaria, mosquitoes have been the target of a substantial body of research [►**Case study 3-9. The genetic manipulation of mosquitoes**]. There has also been development on GM-based control of the tsetse fly, the vectors of African human and animal trypanosomiasis. Research is demonstrating the potential to produce tsetse fly populations resistant to the trypanosome parasite by genetically modifying the symbiotic bacteria, which are passed down by the mothers and reside in the gut of the fly, to inhibit the trypanosome parasites.

CASE STUDY 3-9. The genetic manipulation of mosquitoes

The genetic modification of mosquitoes to produce sterile males was trialled in the Cayman Islands in 2009 where the *Aedes aegypti* mosquito is a vector for the human viral disease dengue fever. The modification allows GM males to mate with normal female mosquitoes, however, any offspring of GM males will only live up to the pupae stage. Following the release of batches of GM male mosquitoes, the GM insects made up 16% of the study population and went on to father 10% of the wild larvae and hence cause a 10% reduction in the progeny. The work demonstrated the potential for this technique to bring about vector population reductions even if GM insects are not equally as competitive as wild mosquitoes.

Other research projects are tackling the problem in different ways: one group has engineered *Anopheles* mosquitoes to be immune to the malaria parasite they normally carry; another has manipulated male *Anopheles* to produce no sperm; whilst others have modified the insect to produce flightless female progeny.

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3.4.6 Habitat modification

The Ramsar Convention Secretariat provides clear guidance on wetland management and what constitutes 'wise use'. Whilst operating within this framework, habitat modification in wetlands can eliminate or reduce the risk of disease, by reducing the prevalence of disease-causing agents, vectors and/or hosts and their contact with one another, through the manipulation of wetland hydrology, vegetation and topography.

Modifications to habitat features can help reduce the capacity of the local habitat to maintain populations of disease-carrying vectors through reducing vector breeding sites and encouraging vector predators [►**Section 3.4.3 Control of vectors**]. Such measures are often preferable to more environmentally damaging biological and chemical control methods. Habitat modification can also reduce the likelihood of exposure of disease-causing agents such as species of bacteria and toxic algae and other contaminants although this technique is more often directed at hosts and disease vectors than at the causative agents. Measures can alter or reduce host distribution and density and may be used to disperse and encourage hosts away from outbreak areas.

Maintaining 'healthy' naturally functioning wetlands is generally important for reducing the risk of disease. Damaged or degraded wetlands can result in poor water quality, reduced water flows and vegetation growth, features which provide ideal habitat for some disease-carrying vectors and may act as stressors for hosts. However, some characteristics associated with naturally functioning wetlands, such as good water quality and flow, may also directly encourage vector and host populations. It is therefore important to assess both the potential risks and benefits of wetland modification in reducing the risk of disease in light of the specific habitat requirements of the pathogen, vector and host. For invertebrate disease vectors and hosts, for example, measures will often depend on the specific environmental requirements of the aquatic life stage of the species.

Effective management of wetland habitats requires a thorough understanding of wetland ecosystem functions of the inter-connected hydrological, geomorphological, biochemical and ecological components, as changing one parameter can have implications for another. Important processes include flow regimes, water level changes and flood inundation, and their effects on vegetation and sediment and the requirements of wetland fauna. The effects of habitat changes on predator populations should always be considered when determining habitat modification measures. As long as undertaken in the context of the wetland management plan, the following alterations to wetland hydrology and vegetation (often through changes to topography) can be used to reduce the risk of disease spread in wetlands.

Altering wetland hydrology

Altering the extent of inundated and saturated areas

Wetland systems can be modified to alter the extent of an inundated and saturated area and hence available habitat for disease agents, vectors and hosts. A reduction in the extent of an inundated and saturated area will lead to a decrease in the abundance of some vectors and hosts (*e.g.* certain mosquito and snail species), particularly if other environmental parameters such as water flow and quality are favourable. However, this is accompanied by an inevitable loss of valuable wetland services and therefore any adverse impacts on wetland ecosystem function should be carefully examined before such actions are taken. Measures used for decreasing an inundated and saturated area include draining and infilling, and water control structures such as pumps, which must be carefully sited to minimise disturbance to wildlife.

Changes in habitat characteristics may benefit one host population, whilst disadvantaging another. For example, certain obligate freshwater snail hosts may decrease in number after the reduction of an inundated and saturated area, whilst some mosquito species favour smaller isolated pools, created after infilling or draining.

Altering water flow patterns
Altering the water flow may change the retention time of water within the wetland and affect several key characteristics such as water quality, retention of flood-flows and vegetation, in turn affecting the habitat's suitability for hosts and vectors. Alteration of water depth, for example, may change the extent of emergent macrophyte beds, manipulation of which can be used to minimise certain vector and host species. Reduced water depth and flow rates may cause decreased turbidity, and increased water temperatures in warmer weather, but can decrease temperatures in colder weather, influencing the distribution of some aquatic vector and host species, such as snails. Measures to alter water flow include changing the dimensions, gradient and features of water channels.

Altering water quality
Water quality may affect disease agents, hosts and vectors, primarily through changes to vegetation and water flows [►sections above and below]. Land-use in and around a wetland substantially influences water quality. Activities that generate high inputs of organic matter and pollutants to a wetland, such as intensive farming and industry, can be reduced to improve water quality, and piped inflows from potentially polluted sources can be routed away from the wetland system.

Altering wetland vegetation

The type and biomass of vegetation can be modified to reduce suitability for vectors and pathogens and availability of contaminants either through direct action, such as planting, or through the secondary effects of altering other wetland features such as hydrology. Emergent vegetation is known to have a deleterious effect on important disease vectors such as the tsetse fly *Glossina spp.*, and some mosquito populations by obstructing oviposition and supporting a greater diversity of aquatic predators. Vegetation can also provide protection for the larvae of other vectors from predators, causing an increase in their populations and enhancing disease risks. Vegetation may be used to improve water quality and reduce sediment load through filtering organic outflows. Ecological buffer zones can be created for these purposes [**►Section 3.2.2 Disease zoning, barriers and buffer zones** and **►Section 3.2.4 Biosecurity**].

Fire may be used to burn areas where certain disease agents occur, such as the burning of anthrax outbreak areas to destroy the bacterium and burning selected trees to reduce certain species of tick.

Altering topography

The shape, height, depth and profile of the land surface can be physically modified to reduce attractiveness to vectors and exposure to disease agents. This can be achieved through modifications to vegetation and hydrology [►sections above] and by using other mechanical methods such as removing the top layer of contaminated soil to reduce exposure of a disease agent or reducing the number of isolated, stagnant, shallow water areas to deter disease vectors such as mosquitoes from laying eggs.

Figure 3-16. Replacing topsoil on an island used by high densities of birds in the winter helps to reduce environmental contamination and can be useful for small areas of land.

Altering host distribution and density

Habitat modification by the methods outlined above, may also be employed to disperse host animals away from known disease sites and encourage them to use areas of lower risk. For example, waterbirds can be redistributed to lower risk areas by lowering the water level of contaminated areas whilst creating or enhancing other habitats. Outbreak/contaminated areas may be fenced and other measures such as fire and scare devices may be used to deter animals from those areas and separate livestock from wildlife disease reservoirs and *vice versa*.

The provision of more favourable habitat at a distance from an outbreak/contaminated area may encourage animals away from those areas and thus reduce risks of further disease spread. Habitats can be modified to prevent large host die-offs, whose carcases could become substrates for the growth of disease-causing agents. For example, raising water levels in warm, dry weather may prevent the death of bacteria-harbouring fish and aquatic invertebrates.

Compensatory habitat restoration

Although measures taken to modify habitats should not, in so far as possible, impact adversely on the wetland ecosystem as a whole, this may be unavoidable in certain circumstances where options are limited and the potential impact of disease is severe. Under these circumstances compensatory habitat restoration should, wherever possible, be undertaken. This may involve habitat restoration, creation or enhancement with the aim of compensating for lost habitat.

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3.4.7 Movement restrictions

The movements of wildlife and domestic animals may facilitate the spread of disease through the introduction of pathogens to formerly disease-free areas. Restrictions on the movements of domestic animals and people, usually imposed by government authorities, can therefore be an effective tool for preventing and controlling disease transmission by reducing contact between infected and susceptible animals.

Such measures are particularly useful in wetland sites with substantial human activity, such as human residencies, intensive livestock production, large numbers of visitors or hunters, captive breeding and/or translocation programmes.

Movement restrictions to prevent an outbreak

Preventative measures may be taken as a response to periods of elevated risk of an outbreak affecting a wetland. In the event of a disease outbreak near to a wetland or at a national level, implementation of animal movement restrictions may be considered a prudent measure. Where a disease outbreak is considered serious, national stock 'standstills' may be imposed which restrict all animal movement. It is also important to note that movements of people may also be restricted to and from a wetland. Trade in animals and derived products may also be prohibited locally, nationally or internationally.

Movement restrictions to control an outbreak

Rapid notification of the presence of disease by wetland managers is vital for the timely mobilisation of control activities. The overall cost of a disease management strategy may be reduced if disease is prevented or controlled at an early stage during the outbreak, and economic impacts related to restricted animal trade will be minimised. If a notifiable disease is confirmed in domestic animals and/or wildlife at a wetland site, there are likely to be automatic movement restrictions placed on people and animals by government authorities to reduce the risk of further spread. During such an outbreak stock must not be moved within or external to the site until restrictions are lifted: contravention of statutory movement restrictions can result in criminal prosecution. The site contingency plan should be implemented and personnel guided through the process in the event of a disease outbreak [►**Section 3.1.4 Contingency planning**].

Controls may be implemented whereby movements of susceptible species are only permitted under strict, designated conditions, when it is deemed safe. There may be restrictions on gatherings of susceptible animals (*e.g.* at livestock markets) or the transport of animals directly to abattoirs for immediate slaughter for animals with diseases that are transmitted by meat or other animal products. When such activities are allowed to resume, they should be subject to surveillance and rigidly enforced codes of practice. If area restrictions have been imposed on a site, visits to other wetland sites or areas with livestock should only take place if they are essential and should be subject to strict biosecurity measures [►**Section 3.2.4 Biosecurity**].

Until a disease outbreak is brought under control, rights of way through the infected area should be closed and non-essential visits to infected sites should be suspended. To remove the source of infection and to help eradicate the pathogen, destroyed animal carcases and related products including contaminated fomites, should be disposed of in the appropriate manner [**►Section 3.4.2 Collection and disposal of carcases**] and generally should not be moved off, or within, the site.

Infected or potentially infected sites, animals and their products, personnel, potentially contaminated animal products and other materials may be placed under **quarantine**. Appropriate health restrictions can be placed on the movement of susceptible animals into, or out of, the quarantine area until the infection is considered to have been removed. This may be supported by disinfection and decontamination of personnel, vehicles, equipment and other materials leaving and entering the quarantine area [**►Section 3.4.1 Disinfection and sanitation**, and **►Section 3.2.4 Biosecurity**]. Quarantine guidelines vary depending on the case and factors involved (disease, terrain, local human and animal populations) but will generally cover at least a 3-5 km radius from the initial case.

Movement restrictions are often imposed over a wider area around the quarantined or infected site as part of a **zoning** strategy which seeks to identify disease infected, disease-free and buffer zone areas [**►Section 3.2.2 Disease zoning, barriers and buffer zones**]. The coverage of the outbreak area and surrounding areas of risk can be determined from surveillance activities and relies on an understanding of the epidemiology of the disease and host ecology [**►Section 3.3.1 Surveillance and monitoring**]. Animal movement tracking may help identify the source of disease [**►Section 3.2.3 Standards for releasing and moving domestic animals or translocating wildlife**].

A number of control zones may be set up around infected premises. Animal movement within identified zones is not permitted unless appropriate permits have been issued by the local authorities. Trade in certain animals and their products may be permitted under particular circumstances from disease-free zones but only where this has been authorised. Controlled area restrictions may apply whereby the movement of animals outside the protection and surveillance zones is controlled. This is advisable when there is a risk of the disease spreading more widely (*e.g.* if an infected animal has passed through a market).

Imposed movement restrictions and other disease control activities should be communicated promptly and clearly to relevant stakeholders and local communities by local authorities [**►Section 3.5 Communication, education, participation and awareness**]. An integrated disease management strategy, which includes a range of disease control activities such as movement restrictions, zoning, surveillance and vaccination, is often most effective. A disease management strategy for the site should incorporate how best to respond to and cope with movement restrictions. Consideration should be given to voluntary implementation at times of increased risk (*e.g.* suspension of hunting activities or site visits) if a disease has emerged within a region. It should be noted that long term restrictions will affect commercial enterprises and so consideration should be given to incorporation of a business continuity plan into the site contingency plan.

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3.4.8 Eradication, elimination, stamping out and lethal intervention

Global disease eradication

Global eradication is used to refer to the permanent reduction of the worldwide incidence of a disease to zero as a result of deliberate efforts, eliminating the need for further disease control measures. This has been achieved for smallpox in 1979, and, more recently, rinderpest in 2011 [**▶Case study 2-1. Rinderpest – eradication of a disease affecting all sectors**]. Successful eradication programmes produce sustainable improvements in health and many other benefits but depend on significant levels of global co-operation in the sustained and co-ordinated control of infection, usually requiring a combination of approaches.

An eradication programme will not succeed in the absence of a sound scientific basis, availability of sufficient resources and public and political will. International coordination and collaboration with regional and national governmental, and non-governmental organisations is essential for the control and eradication of transboundary animal diseases.

Disease elimination

Elimination of a disease usually refers to the reduction to zero of incidence in a defined geographical area as a result of deliberate efforts. Examples include the successful elimination of polio in the Americas and of neonatal tetanus in 19 countries between 1999 and 2010. Importantly, unless the disease can be globally eradicated, continued disease control intervention measures are needed to prevent re-emergence.

Disease elimination in wetlands poses a number of problems particularly in relation to wildlife diseases and water-borne infectious agents. The following measures can aid disease elimination and their merits should be considered within any disease control strategy:

- Identification of infected zones through intensive disease surveillance [**▶Section 3.3.1 Surveillance and monitoring**].
- Designation of infected zones [**▶Section 3.2.2 Disease zoning, barriers and buffer Zones**].
- Imposition of quarantine and livestock movement restrictions [**▶Section 3.4.7 Movement restrictions**].
- Possible slaughter of infected or susceptible animals using a range of methods [**▶Stamping out and lethal intervention**].
- Vaccination of susceptible animals [**▶Section 3.4.4 Vaccination**].
- Safe disposal of carcases and other potentially infectious materials [**▶Section 3.4.2 Collection and disposal of carcases**].
- Disinfection and cleaning of infected premises [**▶Section 3.4.1 Disinfection and sanitation**].
- Ensuring that the infected area is free of susceptible animals for an appropriate period of time.

Stamping out and lethal intervention

'Stamping out' is a term often used to describe the localised destruction of susceptible or infected animals. The most appropriate use of this approach at a wetland site would be for the rapid elimination of a disease in livestock. Lethal methods include dispatch by firearm or captive-bolt, the use of gaseous, biological or injectable agents.

Stamping out may often be a cost-effective approach to disease control in livestock in an emergency situation, as in appropriate circumstances (*e.g.* in the absence of an external source of infection) it can have rapid results. This allows restrictions on trade and other animal movements, *e.g*. restocking, to resume more quickly.

As with all disease strategies, the scientific feasibility, and health, ethical, social and economic costs and benefits of stamping out and lethal intervention should be carefully evaluated before it is selected as a disease control strategy. The likely success of alternative strategies should also be considered. Lethal intervention has been used for disease control in wildlife, but in wetland sites this may not be consistent with conservation objectives. Hence, the potential costs and benefits of lethal interventions need to be considered carefully. This requires some knowledge of the likely behavioural and demographic responses of host populations to lethal control as these can result in complex outcomes in terms of disease control. Selective culling may be an appropriate approach in some circumstances. However, implementation at the level of individual hosts requires the availability of adequate diagnostic tools, and at the population level it is important to be able to accurately identify the target population.

Lethal interventions of invasive alien species or pests is likely to be consistent with conservation objectives but, nevertheless, a sound understanding of the response of the target population is required prior to intervention to help predict impacts.

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3.5 Communication, education, participation and awareness (CEPA)

Well planned, targeted and resourced CEPA programmes for wetland stakeholders are essential for raising awareness of wetland diseases and the measures that can be taken to successfully prevent, detect, control and mitigate disease outbreaks, in particular the basic principles of 'healthy habitat' management. These programmes form some of the most fundamental aspects of managing diseases in wetlands and should be included in all wetland disease management strategies.

Successful communication relies upon establishing a regular dialogue between wetland stakeholders and disease control authorities. A 'culture' of disease management can only be developed if: a broad range of wetland stakeholders (*e.g.* local wetland users, local government agencies, community leaders, hunters and NGOs) participate in these programmes; information between and within stakeholder groups flows regularly; and communication, awareness raising and educational activities are on-going or at least 'refreshed' periodically.

This section contains further information on the following topics:

- *Communication and public awareness*
- *Building capacity by education and training*

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- **Well planned, targeted and resourced CEPA programmes** for wetland stakeholders are **essential for raising awareness and appreciation of wetland diseases** and the measures that can be taken to successfully prevent, detect, control and mitigate disease outbreaks. Such programmes should be integrated into all wetland disease management strategies.
- **Programmes should aim to inform** wetland stakeholders of **the basic principles of healthy habitat management,** thus reducing the risk of a disease outbreak.
- **A 'culture' of proactive disease management** can only be developed if a broad range of **wetland stakeholders participate in CEPA programmes**.
- **Communication strategies should aim to make stakeholders aware of the nature and potential consequence** of animal disease and of the benefits gained from prevention and control measures. They should **ultimately encourage people to take the recommended courses of action** in preventing and controlling a disease outbreak. Awareness raising campaigns should emphasise the importance of early warning systems and of notifying and seeking help from the nearest government animal and/or human health official as soon as an unusual disease outbreak is suspected.
- **Selection of the appropriate message, the messenger and the method of delivery is critical for successful communication.**
- **A strategy**, written in 'peacetime' f**or dealing with the media can increase likelihood of successful outcomes** from this relationship maximising potential benefits and minimising potential negative impacts.
- **Simulation exercises and testing of contingency plans are a valuable method for training**.

3.5.1 Communication and public awareness

Communication programmes and activities can raise awareness of diseases, the risks they pose, and the measures that can be taken to prevent, detect, control and mitigate outbreaks [**►Case study 3-8. Snail fever integrated control and prevention project in Tongxing Village of Wucheng Township, Yongxiu County of Jiangxi Province, P.R. China**]. Such programmes are one of the most critical aspects of managing disease in wetlands, and engender a 'bottom-up' approach. A 'culture' of disease management can only be developed if a broad range of wetland stakeholders participate in these programmes.

Target audience

Communications and awareness raising materials should be targeted at those likely to affect potential for disease emergence, those likely to be affected by disease or come into contact with it, and to those whose activities may influence its prevalence and spread, such as local authorities, people living in 'high risk' areas, farmers and livestock owners and traders. Each different group is a specific audience and communications need to be tailored appropriately.

The message

It is important to consider the intended audience for your message when writing/determining its content. Be mindful of the key purpose of the message whilst considering your target audience's education, socio-economic status, current knowledge and experience of the issue/disease, age, language, culture and geographic location. The audience will determine the length, content and style of the message. Given the multiple benefits of disease control, there can be an element of rallying the community to a common cause, ideally involving local community groups, key land users and farming organisations where appropriate.

Messages need to be communicated clearly and simply and with credibility, accuracy, consistency and speed.

An effective message should be:

- repeated
- come from a trusted, credible and legitimate source
- be specific to the event being experienced, and
- offer a positive course of action.

Materials and services

Messages can be communicated using various materials and services. These include signs, printed materials, the internet, media coverage, public service announcements, national campaigns, audio conferences, seminars and workshops. Ways should be considered for the audience to submit information or ask questions too, for instance by giving a phone number or email address: they may be your eyes and ears on the ground.

Partnerships with agencies and organisations that have relationships with the target audience, or are otherwise recognised as community leaders (*e.g*. religious leaders, service groups), should be fostered.

It is valuable to find out how a target audience likes to receive information, such as, online, on the radio, on a notice board, in the newspaper. Communicating through sources trusted by the target audience can heighten the credibility of, and attention to, messages.

Figure 3-17. Engaging the public in disease control: the public information sign on a trail in Victoria, Australia, outlines the problem, provides a positive course of action and provides contact information for further communication.

The media

The media, such as television, radio, newspapers and online news sources, can help get a message to a large number of people quickly and easily. When working with the media, be aware that control of the message can be lost. There is a greater chance that it may be edited or misinterpreted. Developing partnerships or good relationships with local or national media can reduce potential for misunderstanding.

Ideally, selected personnel should receive media training and be designated spokespersons on behalf of an organisation involved with managing disease, to effectively convey information before, during and after an outbreak or other problem. ►**Disease outbreaks and the media**

Community outreach and mobilisation

Community outreach involves presenting messages in person, in addition to media and educational materials, and cultivates community ownership for disease prevention activities. A community task force that includes health, environmental, civic and business concerns can be valuable in reaching various segments of society and in developing a common message. Community outreach activities should encourage community mobilisation whereby groups take part in actions to prevent and control an outbreak, *e.g.* community efforts to improve water sanitation and reduce pollution risks.

Target audience research

Knowing different audiences is critical to putting communication plans into practice. Attitudes to disease management measures may vary considerably by region or section of society. Previous experience with disease prevention and control measures will affect the acceptability of future efforts. Target audience research can identify local attitudes, motivations, barriers to 'change', and opportunities to promote desired behaviours. Surveys assessing knowledge, understanding, attitude and practice levels can be of particular value - ideally combining qualitative and quantitative methods. Evaluations, including lessons learned, should be conducted, whenever possible, to measure the efficacy of communications in achieving their aims, and adjustments made accordingly.

Emergency communications for a disease outbreak

Emergency communications are inevitably focused on managing for the worst case scenario. This is where planning will be invaluable. Above all, a communication plan is a resource of information for those that need it and should be integrated into the overall wetland disease management strategy. All relevant wetland stakeholders, disease control authorities, spokespersons and communications professionals should be involved (*e.g*. wetland users, animal and human health agencies and governmental authorities), key messages should be clear and understood by all, and resources should be shared.

Overall a communication plan can be broken down into:

1. **Crisis Communication:** this is used when there is an unexpected disease outbreak and there is a need to quickly communicate about that crisis to wetland stakeholders and the wider public.
2. **Issues Management Communication:** this is used with the knowledge of an impending crisis and, therefore, the opportunity to choose the timing of the communication to the wetland stakeholders and the wider public.
3. **Risk Communication:** this is used to prepare people for the possibility of a disease outbreak and to provide appropriate steps to prevent an outbreak and mitigate for its impacts.

It is important to understand the stages of an unfolding disease outbreak in order to help communicators anticipate problems, anticipate the information needs of disease control authorities, wetland stakeholders, the media and the general public, and therefore respond effectively. There will be stages to every outbreak and communication must also evolve with each stage. The following cycle demonstrates the likely stages of an outbreak:

Precrisis	Initial	Maintenance	Resolution	Evaluation
▪ Be prepared. ▪ Foster alliances. ▪ Develop consensus recommendations. ▪ Test messages.	▪ Acknowledge the event with empathy. ▪ Explain and inform the public, in simplest forms, about the risk ▪ Establish agency/spokes-person credibility. ▪ Provide emergency courses of action (including how/where to get more information). ▪ Commit to stakeholders and public to continued communication.	▪ Help public more accurately understand its own risks. ▪ Provide background and encompassing information to those who need it. ▪ Gain understanding and support for response and recovery plans. ▪ Listen to stakeholder and audience feedback, and correct misinformation. ▪ Explain emergency recommendations. ▪ Empower risk/benefit decision-making.	▪ Improve appropriate public response in future similar emergencies through education. ▪ Honestly examine problems and mishaps, and then reinforce what worked in the recovery and response efforts. ▪ Persuade the public to support public policy and resource allocation to the problem. ▪ Promote the activities and capabilities of the agency (corporate identity reinforced-internally, too).	▪ Evaluate communication plan performance ▪ Document lessons learned. ▪ Determine specific actions to improve crisis systems or the crisis plan.

Figure 3-18. Crisis communication lifecycle (*from CDC, 2002*).

Disease outbreaks and the media

In the case of a significant disease outbreak, it is likely that the media will want information. Tactics for dealing with the media should be covered within a communications plan. Strategies for dealing with the media will vary depending on desired outcomes, for example, the media may be an effective way to communicate with wetland stakeholders.

There are, however, risks. Control of the messages is ceded by adding an additional level between you and your target audience. Sometimes the media can negatively affect a situation either by inaccurate reporting or taking up too much time and resources during a crisis.

By being prepared and planning for this scenario, it can be ensured that the attention of the media works to help the situation. The communications plan should cover, for example, whether:
a) nominated people within an organisation are a spokesperson and/or field enquiries, or
b) enquiries are passed on to other organisations with greater relevant communications resources and experience.

When dealing with the media over disease risks, there are a number of guidelines which may be helpful and should be borne in mind. ►**Checklist 3-5** summarises these.

CHECKLIST 3-5: Guidelines for dealing with the media over disease risks

- ☐ Create a very detailed communications plan with specific actions for dealing with the media (not just a top line strategy) that covers all media aspects and has clearly assigned roles and responsibilities for individuals.
- ☐ Write the plan in ‘peacetime’, before a disease problem, when it is easy to take time and plan calmly.
- ☐ Work out clear simple messages.
- ☐ Agree an organisational line but be adaptable as the situation changes.
- ☐ Clearly assign roles and responsibilities, including a single organisational contact point for media inquiries and spokespeople.
- ☐ In peacetime, train a small number of key spokespeople (exercises can be very useful).
- ☐ Foster good relationships with the media in ‘peacetime’ by briefing them on wetland issues. This will help them see you as an authority to be trusted during a crisis.
- ☐ Do not let allow the media to control you or the situation. If dealing with the media does not bring benefits, then do not be afraid to say no to journalists - you will not offend them or ruin your relationship, they are used to hearing no, they respect it and often expect it. It will help to determine scenarios when you will proactively use the media and when you will only react to enquiries.
- ☐ If you are responding to an inquiry, ask beforehand what is the nature and angle of the media story so you have opportunity to prepare and do some background research.
- ☐ Ensure that what you say is evidence-based (qualify the certainty of your statements if necessary), avoid speculation and stick to your area of expertise.
- ☐ When deciding whether to answer media enquiries, keep asking yourself 'what are the potential risks to the situation of doing this and what are the potential benefits?' This may sounds simple but it helps to ensure you are maximising your resources during a time of crisis.
- ☐ Try to harmonise your communications with other stakeholders. Working together provides a stronger voice. As an example, joint statements can be powerful.
- ☐ Interviews tend to be very short so messages must be clear and brief. In general, for crisis situations ‘CARE’ offers a simple three line framework:

  C – concern. Share the concern about the situation

  A – action. Say what action is being taken

  RE – reassure. Where appropriate, provide reassurance.
- ☐ It is key is to get people to stick to the plan and not panic – this is sometimes hard!

CASE STUDY 3-10. The media and highly pathogenic avian influenza H5N1

The autumn of 2005 and spring of 2006 saw a significant westward spread of Eurasian lineage HPAI H5N1. Long before a case had been diagnosed in western Europe the media had, by its own admission, 'gone to town' on the story and its potential threats to human health in particular. The stories invariably discussed the bird infection, wild bird migration and a human pandemic together as if all were closely linked, and the latter was inevitable and possibly imminent. In general, the coverage was misleading and led to public misunderstanding of the threat from birds and thus was detrimental to conservation as measured by various means such as significantly reduced visitation to nature reserves.

Figure 3-19. Sensationalist media coverage: photo montage of ducks over London in national newspaper.

This case study documents some lessons learned from dealing with this unusual and very challenging time:

When an outbreak occurs it is easy to get completely overwhelmed by journalists, media and the general public demanding information and/or organisational statements. Because of this, it is important and extremely useful to have a dedicated person and/or team to deal exclusively with AI to agree policy line and the method of response to an outbreak. The extent to which this is possible depends on organisational capacity.

It is helpful to have:

- One or two people to be spokespeople with all media queries directed to them.
- Someone to keep up-to-date with a rapidly changing situation, accumulating news and disseminating it to the organisation and interested parties.
- Making sure that all staff are well informed of any new developments (they may be approached by journalists too) using:
    - i. Emails
    - ii. Intra/internet updates
- Easy access to information for journalists and the general public.
    - i. Web based for quick and easy updating of information.

Proactive messages/strategies

- What is the message that you are trying to convey? Agree on the message but be ready to adapt it constantly as new facts emerge.
- Get across a balanced message with verified facts. Use trusted sources of information.
- With all the negative coverage of wild birds in the media, it is sometimes easy to overstate the lack of evidence for the spread of AI by wild birds. Stick to the facts.
- Use sympathetic journalists/media to get across your views to specific/targeted audiences. Actively seek out and develop relationships with journalists.

Reactive strategies

Forward planning. Much of the background information and accompanying text can be prepared in advance of a case of H5N1. Different scenarios can be envisaged and the appropriate information for each prepared. This can be crucial in saving time.

Checklist of things to remember

- Every situation/outbreak is different.
- Keep an open mind as to the source of infection.
- If feasible, have someone at or near the site to talk to media.
- Be easily available to the media, whether in person or by phone and email.
- Keep those commenting on developing situations to as few as possible.
- Approach the media yourself.
- Stick to your area of expertise. It is very easy to stray into and comment on other topics to reinforce your point. Try to avoid this.
- Taking the scientific approach of waiting for evidence before commenting on likely routes of infection may be seen as ‘sitting on the fence’, especially when media will want immediate answers. It is vital that one does not make comments based on ‘gut feelings’. Reiterate the importance of an evidence base before making comments.
- Check your facts regularly and make sure they are as up-to-date as possible.

Case study from RSPB/Birdlife International 2007

3.5.2 Building capacity by education and training

Systematic multidisciplinary education and training programmes should be established for all those who, in their professional capacity, are involved in any stage of managing and controlling disease. This includes personnel managing a site, assessing the risk of an outbreak, reducing the risk of disease emergence, involved in the diagnosis and surveillance of a disease, and controlling an outbreak.

Training is particularly important for front-line personnel, who are likely to come into contact with an incursion or outbreak of disease first, such as, wetland managers and members of disease diagnostic teams. All appropriate stakeholders should be thoroughly trained in their roles and responsibilities in a disease emergency. More intense and specialised training is needed for personnel/professionals holding key positions, such as members of specialist diagnostic and surveillance teams, forecasting experts and animal and human health professionals. Selected staff should also receive training in disease reporting procedures.

Given the complexity of multi-use wetlands (*i.e.* those supporting people, agriculture and wildlife), training programmes can be most useful for trainees when they are multidisciplinary. Moreover, training programmes should be comprehensive and regular, to accommodate the possibility that a disease may occur in any part of a country, and to allow for staff turnover. Training must extend to staff in remote areas, as well as to selected officials, such as local authorities. Back up staff for each position should also be trained, in the eventuality of absent front-line staff.

It will not always be possible, or practical, to train all personnel to a high level of expertise in the diseases themselves. Knowledge of basic clinical, pathological and epidemiological features of diseases known to be important, or potentially important, to a site, together with an understanding of actions to be taken when the presence of disease is suspected, may suffice in many circumstances. Importantly, the principles and practicalities of investigating a disease outbreak with an open mind should be the subject of training [►**Section 3.3.5 What data to collect at a suspected outbreak**].

The following training possibilities may be selected, as appropriate:

- **National emergency disease training workshops**: coordinated workshops should form the focus of training and should target those involved in each stage of managing an outbreak. These workshops should be organised by trained personnel and ideally include representatives from, for example, neighbouring counties or regions, or those countries or regions with experience of dealing with the specific disease in question.
- **Exchange of personnel**: key staff should be sent to other disease control centres which are proficient in dealing with the relevant disease, particularly those in the process of controlling an outbreak, to gain first-hand experience of steps taken to manage an outbreak. Other opportunities for staff to gain knowledge and understanding of managing outbreaks, such as attending workshops, should also be utilised.
- **Linkages with international disease control centres and reference laboratories** should be fostered to share knowledge about, and 'lessons learned' from, managing outbreaks.
- **Training and field manuals** may be useful for reference but ideally, should not be solely relied upon for training.

Simulation exercises

Simulation exercises are valuable for testing and refining contingency plans in advance of any disease emergency [►**Section 3.1.4 Contingency planning**] and are an effective way of building teams for emergency disease responses and training staff. Realistic disease outbreak scenarios should be created, using real data where possible. A scenario may cover several phases of an outbreak, with a range of possible outcomes, but should not be overly complicated or long. It is useful to test one system at a time (*e.g.* communication network or operation of a local animal disease control centre). Simulation exercises can be desk-based, involve mock activities or combine both approaches. There should be a review after completion of each simulation exercise to identify further training needs and any areas of the contingency plan in need of modification.

A full-scale disease outbreak simulation exercise should be attempted after individual components of the disease control response have been tested. Care must be taken to ensure that the simulation exercises are not confused with actual outbreaks in the minds of the media and the public (*e.g.* simply ensuring all electronic files and paperwork have the word 'Exercise' printed across it).

Figure 3-20. Desk top or practical simulation exercises to test contingency plans are highly valuable, particularly when bringing together a range of stakeholders including disease control agencies.

CASE STUDY 3-11. Training for live wild bird avian influenza surveillance in the Dagona Wetlands of Northern Nigeria

Prompted by the clear need for building capacity for national wild bird avian influenza surveillance programmes, particularly in an African context, the Food and Agriculture Organization of the United Nations (FAO) and the European Commission's New FluBird project funded a three week advanced waterbird capture and avian influenza surveillance training programme at the Dagona Base Camp in the Chad Basin National Park, Yobe State, northern Nigeria, in October/November 2009.

The aim of the course was to develop skills amongst ornithological practitioners and infrastructure to allow long term wild bird avian influenza surveillance to be established in this region of Nigeria and provide skilled personnel for surveillance in the countries of the other African participants. The course trained 31 participants from five mainly Chad Basin countries (Nigeria (23), Niger (2), Chad (2) and also Sudan (2) and Kenya (2)). The course proved to be very successful and was deemed by participants to have fully achieved its objectives and their personal objectives also.

The course was run by trainers from the Wildfowl & Wetlands Trust (WWT) and Wetlands International (WI). A variety of capture techniques were taught with the main focus on the advanced technique of cannon netting. Cannon netting has the potential to allow the capture of large numbers of ducks (the main target for avian influenza surveillance) and is of particular use in areas where other trapping methods cannot be used.

Figure 3-21. Course participants constructing a duck trap and a set trap in a wetland.

Duplicate sets of avian influenza cloacal and oropharyngeal swab samples were taken from trapped waterbirds, one set for in-country analysis[(1)] at the National Veterinary Research Institute, Vom, Nigeria, and one set for the New FluBird partner University of Kalmar, Sweden.

Cannon netting is a technical, complex and potentially hazardous trapping technique and successful cannon netters and cannon netting teams require certain key attributes. Many of the already experienced participants proved themselves to be very technically adept and capable bird trappers and with a little extra training within existing experienced cannon netting teams should be competent at being part of a regional cannon netting team capable of both national and international wild bird surveillance programmes.

Given the experience of the Nigerian authorities and institutions in dealing with outbreaks of highly pathogenic avian influenza (HPAI) H5N1, the existing ornithological skills in Nigeria (primarily at the A.P. Leventis Ornithological Research Institute, APLORI) and this, and previous, Nigerian capacity building and

FIGURE 3-22. Sampling a Northern Pintail *Anas acuta* as part of avian influenza surveillance.

surveillance work, it is proposed that Nigeria becomes a regional platform for future wild bird avian influenza activities.

[1]*When conducting surveillance for notifiable disease it is likely that the country of sample origin will wish to conduct their own analysis of samples in addition to any samples being analysed out of country.*

Case study from the Wildfowl & Wetlands Trust, November 2009.

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