Chapter 2
Principles of Disease Management

In this chapter you will find:

An introduction to disease management in wetlands – important concepts.

Why disease management needs to appreciate the relationship between wildlife, livestock and humans, and take an ecosystem approach.

Why disease management should be integral to wetland management.

A summary of proactive and reactive strategies for managing animal diseases in wetlands.

The dual benefits of controlling emerging infectious diseases and invasive alien species.

A brief introduction to the role of communication, education, participation and awareness in disease management.

Chapter contents

2.1 Important concepts of disease management in wetlands

Disease is a natural part of ecosystems and absence of disease should be seen as neither natural nor desirable. However, with wetland habitats subject to substantial and widespread modification and with such a broad variety of anthropogenic uses, diseases have emerged or re-emerged in the last few decades at a far greater frequency than previously recorded. **►Section 1.3 Wetlands and the threat of disease.** The dependence of all three sectors *i.e.* humans, domestic livestock and wildlife, on healthy wetlands has meant that disease management is now of significant importance in terms of public health, livelihoods, lifestyles, domestic animal production and healthy wildlife.

A million dead waterbirds in an outbreak of avian botulism is a clear indication of a major health problem. However, the wetland manager must understand that disease is usually a much more subtle process affecting body systems and functions, and creating energetic costs to the host. Morbidity or mortality may be the outcome but often there will be less obvious consequences on behaviour, reproductive success, the ability to compete for resources and evade predation, and so on. Disease, therefore, acts to shape and limit populations, affecting age structures and distribution of wild species. It is strange then, that wildlife disease has been rather sidelined as an issue by many ecologists for many years. Anthropogenic activities have now affected the environment to such an extent that wildlife disease has, in effect, 'shown itself' to the ecologists, land managers and policy makers and has now become established as a cross cutting conservation issue.

►Section 1.4. Effects of disease on biodiversity.

FURTHER INFORMATION 2-1. WETLAND MANAGERS AND THEIR KEY ROLE IN DISEASE MANAGEMENT

Anthropogenic activities are the drivers for 'problem' diseases. The real power for disease control and prevention is in the hands of the land managers and users. For wetland diseases, these key stakeholders are the wetland managers, local wetland users including farmers, hunters, fishers and people living in and around wetlands, and those making policies affecting wetland use. Therefore, this Manual focuses on the wetland managers and policy makers with the aim of influencing the activities and practices of all those using wetlands for their vital resources and services.

Disease management in wetlands aims to both prevent emergence of disease and, should disease become a problem, control or eradicate it. Effective disease management practiced at a landscape or catchment scale can ensure that disease does not spread and/or become endemic and cause long term problems.

The adage of 'prevention is better than cure' is fundamental to disease management. Costs of disease management must be weighed against the benefits of preventing problems, in particular long term issues negatively impacting livelihoods, public health, domestic animal production and biodiversity.

The spectrum of disease management practices is broad and may entail nothing more than routine wetland management practices through to major interventions for large scale disease control operations, depending on the issue, its scale and potential impact. Disease management practices may be focused on the environment, the hosts present in the wetland and its catchment, or, in the case of infectious disease, the parasite or pathogen, or any combination thereof.

►**Figure 2-1** illustrates some of the factors influencing disease outcomes for a host and thus provides insight into which factors can be targeted when managing disease.

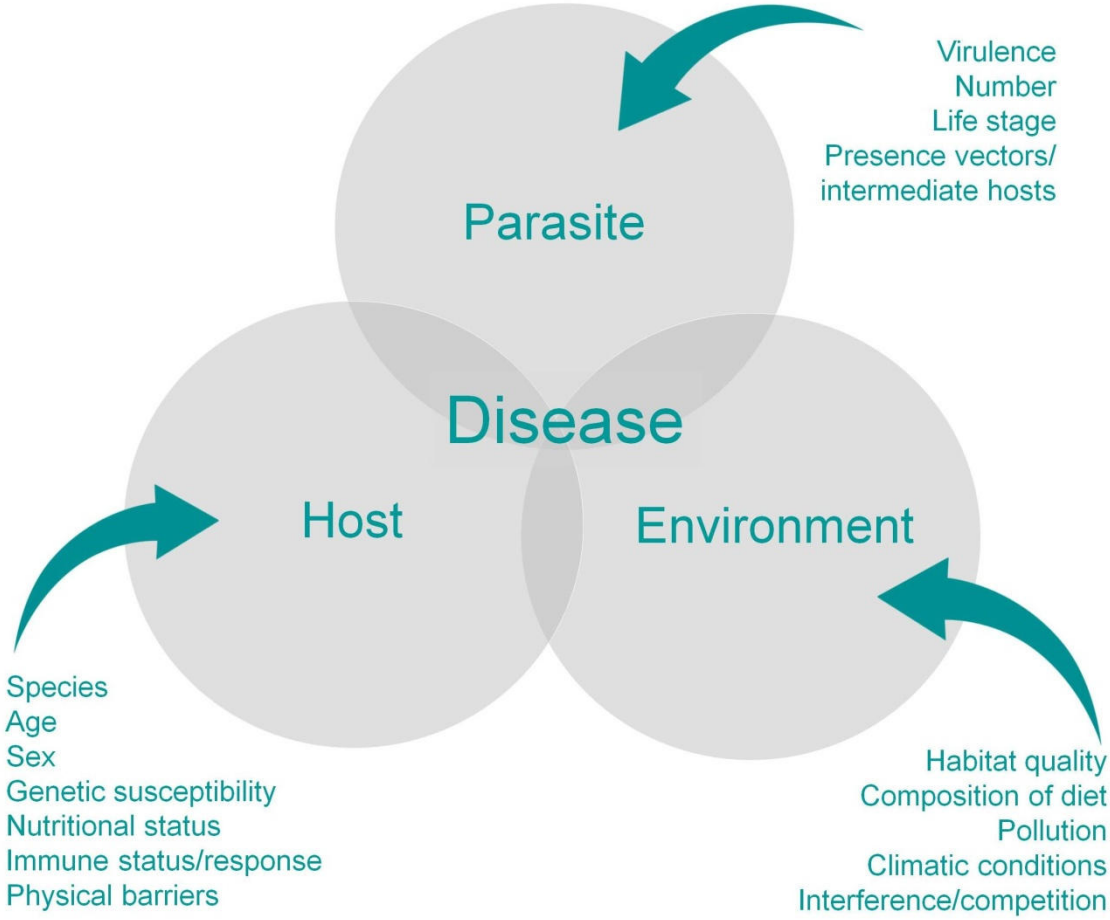

Figure 2-1. The outcome of disease is dependent on the relationship between a host and its environment, and in the case of infectious disease, the pathogen also. The figure shows some of the factors (outside the circles) which influence this relationship and thus some of the factors that can be targeted for disease control.

CASE STUDY 2-1. Rinderpest – eradication of a disease affecting all sectors

Rinderpest, once described as "the most dreaded bovine plague known", became the first disease of animals to be eradicated by human intervention. This acute viral disease has been responsible for the death of domestic cattle for millennia, adversely affecting livestock, wildlife and agricultural livelihoods, bringing starvation and famine. In its classical, virulent form, rinderpest infection can result in 80-95% mortality in domestic cattle, yaks, buffalo and many other wild ungulate species. The disease has had far reaching conservation impacts affecting the abundance, distribution and community structure of many species as well as becoming a source of conflict between agricultural and wildlife interests. The disease is caused by a morbillivirus known as the rinderpest virus (RPV), which is usually spread by direct or close contact between infected and susceptible animals. Clinical signs include: fever, depression, loss of appetite, discharges from the eyes and nose, erosions throughout the digestive tract, diarrhoea and death. Weight loss and dehydration, caused by enteric lesions, can cause death within 10-12 days.

Figure 2-2. Statue of a buffalo being unveiled by Kenya's president, Mwai Kibaki, to mark eradication of rinderpest (in Roeder 2011).

Key Actions Taken to eradicate rinderpest included the development of vaccines, disease surveillance, diagnostic tools and community-based health delivery.

- **Vaccine development:** Plowright developed a tissue culture rinderpest vaccine (TCRV) in the 1950s, a heat-stable variant of which was developed in the 1980s, which was successfully used in community-based vaccination campaigns in remote areas of Africa and Afghanistan.
- **International collaboration and coordination of eradication efforts**
  - **PARC:** The **Pan-African Rinderpest Campaign,** launched in 1986, incorporating 34 African countries, coordinated efforts to eradicate RPV from the Africa continent. Initially, mass livestock vaccination programmes were implemented followed by improved disease surveillance and focussed vaccination campaigns (containing any remaining reservoirs of disease).
  - **GREP**: FAO launched the Global Rinderpest Eradication Programme in 1994, with the aim of eradicating RPV by 2010. Initially, the GREP focussed on the extensive vaccination of susceptible livestock, later moving to disease surveillance. Research yielded sensitive tests for RPV detection, enabling rapid diagnosis and decreasing the likelihood of disease spread. The GREP coordinated rinderpest eradication efforts globally: assisting existing veterinary services through clinical disease research, disease surveillance, technical and laboratory support, awareness raising and contingency planning. The Programme worked in partnership with PARC.
- **Disease Monitoring**
  - The **Programme for the Pan African Control of Epizootics** (PACE) improved surveillance capacity in Africa.
  - The **Community-based Animal Health and Participatory Epidemiology** (CAPE) Project supported the development of veterinary service delivery and disease surveillance, particularly in remote areas. Community-based animal health workers were fundamental to disease control**.**
- **Accreditation of rinderpest freedom:** Finally, the FAO/OIE Joint Committee for Rinderpest Global Declaration was formed (1993) to guide and monitor accreditation of rinderpest freedom on a country-by-country basis. Disease surveillance and accreditation continued until **2011**, when on **June 28th** the world was declared free from rinderpest.

Outcomes: The benefits derived from the eradication of rinderpest are numerous and include: protected rural livelihoods, increased confidence in livestock-based agriculture, an opening of trade in livestock and their products and increased food security. Veterinary services worldwide have become more proficient as a consequence of the fight against rinderpest and the conservation of numerous African ungulates has also benefited. The socio-economic benefits of rinderpest eradication are said to surpass those of virtually every other agricultural development programme and will continue to do so. The direct economic benefits will become clearer over time but one preliminary study conservatively estimated a benefit of at least US$16 from each dollar spent on rinderpest eradication. Rinderpest was successfully eradicated due to ongoing, concerted, international efforts that built on existing disease control programmes in affected countries. Only through international coordination can other such transboundary diseases be controlled and eliminated, as isolated national efforts often prove unsustainable.

The point at which substantial interventions may be required will be related to the extent to which the problem affects or threatens livelihoods and public, domestic animal and wildlife health and welfare. It is important to note that different stakeholders will likely have different ideas about when interventions are required and ideally these can be addressed within management and contingency plans in 'peacetime' *i.e*. before a disease problem, to ensure engagement and 'buy in' of stakeholders and thus rapid responses in times of emergency.

It is important to understand that disease management may be thwarted by poor understanding of disease ecology and dynamics, and thus the appropriate management practices to mitigate. Inappropriate disease management practices can even result in counter-productive consequences and novel disease problems. Hence, a good evidence base is important, appreciating that this may be difficult to attain due to complexities or limitations of diagnosis, surveillance, and other knowledge gaps.

2.2 The disease relationship between wildlife, livestock and humans

The globalised planet currently supports some seven billion people and myriad associated livestock living across the planet in a broad range of modified habitats. As human development and livestock have encroached into wild habitats, not surprisingly infectious diseases have spread between these populations, negatively affecting all three sectors. Movements of people and extensive trade in wild and domestic animals have resulted in the global spread of a number of pathogens, causing particular problems where infectious agents are novel and new hosts are immunologically naïve.

The complexities of disease dynamics in wildlife have resulted in unpredicted disease emergence. Diseases of wildlife that affect humans or their livestock have sometimes led to eradication programmes targeted at wildlife which have not necessarily resulted in reduced disease prevalence but, instead, serious long term consequences for biodiversity, public health and well-being, and food security, whilst failing to address causal problems.

It has become common understanding that the world can no longer deal with diseases of people, domestic livestock and wildlife in isolation and, instead, an integrated 'One World One Health' approach to health has developed. Delivering integrated approaches and responses across the medical, veterinary, agricultural and wildlife sectors can be problematic given existing organisational roles and structures but demonstrating the benefits this can bring should help promote this progressive way of working. The recent global eradication of rinderpest provides an example of how one disease with impacts across all sectors requires global coordinated efforts to bring about success and benefits for all.
► **Case study 2-1. Rinderpest – eradiation of a disease affecting all sectors**.

For wetlands, which provide the 'meeting place' for people, livestock and wildlife, a mapping of a number of important wetland diseases, according to their hosts (Figure 2-3), illustrates clearly that more diseases are shared between these sectors than are specific to any one sector. Tackling disease in one sector is unlikely to be successful in the long term without consideration of the others. Moreover, not working at an ecosystem scale, and without integrated approaches, misses opportunities for broader positive health outcomes.

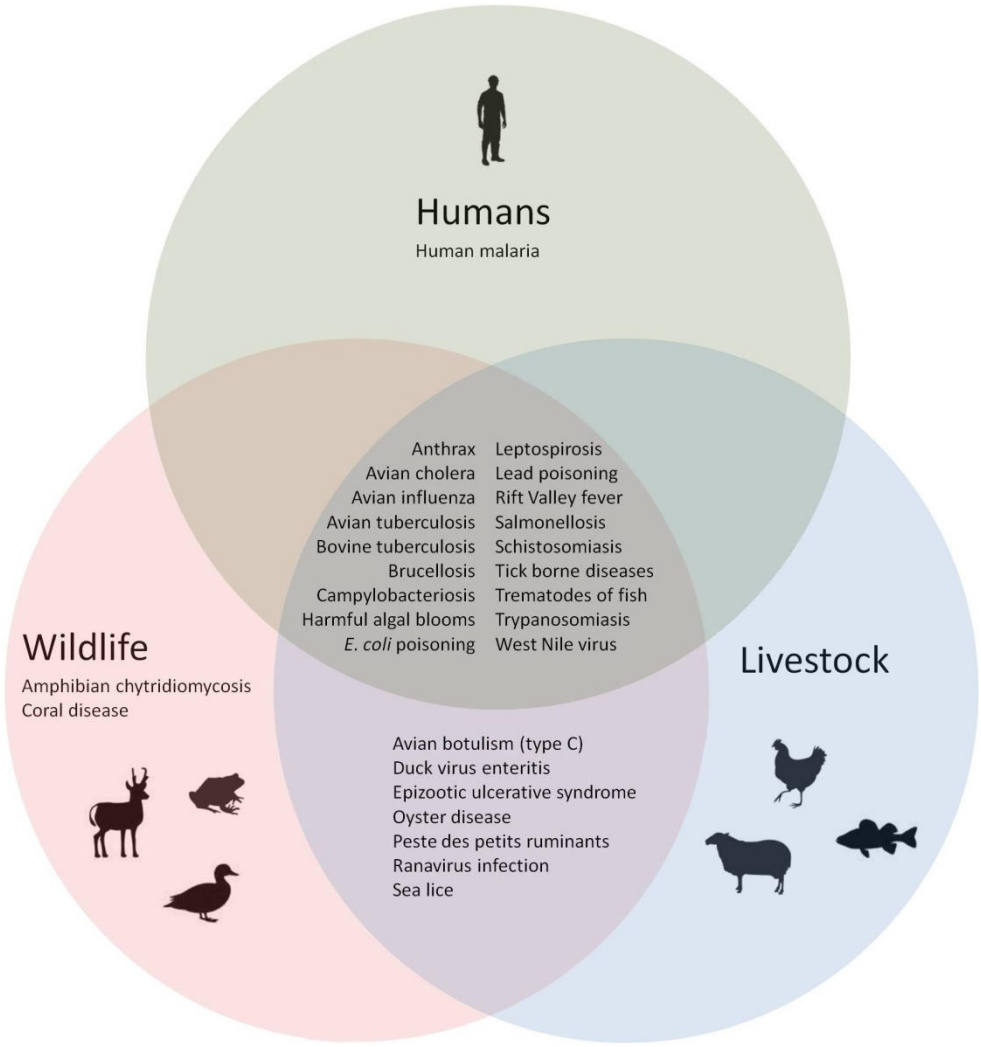

Figure 2-3. A number of important wetland diseases mapped according to the hosts they affect: the majority of both infectious and non-infectious diseases are common to all three sectors.

2.3 The ecosystem approach to health in wetlands

A perception of health with an operational context of only medical and veterinary hospitals and pharmaceutical companies comes from a societal focus on ill-health and emergency care; these dominate the thought processes, funding and expenditure in health. Whilst this focus is no doubt important, it distorts the health equation, and does not address what 'determines' health (or ill-health). That failure can result in unnecessary burdens of disease for humans, domestic and wild animals.

An ecosystem approach to health, instead, works further 'upstream' – closer to the driver of the problem. The approach is **preventative** recognising that 'prevention is better than cure' and, for wetlands, focussing at a landscape or catchment scale ensures maintenance of social and ecosystem services. This approach then seeks to establish the societal and environmental conditions for good health, bringing long-term savings for medical and veterinary costs and overall maximising benefits and minimising costs for wetland stakeholders, particularly those most likely to be affected by specific health issues.

Embracing an ecosystem approach to health in wetlands **recognises a fundamental connectivity:** the health and well-being of humans, domestic stock and wildlife is played out where wetlands are the **setting**, or the context; achieving a 'healthy wetland' through wise use, most often at a broader landscape and/or catchment scale. Managing disease within one sector without consideration of the others not only misses opportunities for improved health outcomes for more sectors, but importantly may result in negative health outcomes in other sectors, and feedback unintended consequences for the original sector in the long term. Seeing 'health' as a property of a(n eco)system, allows for more effective and widespread outcomes.

The 'One World One Health' and 'Ecohealth' movements arose due to the appreciation of this interdependence on, and connectivity between, health of humans, domestic livestock and wildlife and their social and ecological environment, **understanding disease dynamics in broader contexts** of sustainable agriculture, socio-economic development, environment protection and sustainability, and complex patterns of global change.

A fundamental aspect of taking an ecosystem approach to health is that it is **participatory** with stakeholders understanding that they can create or solve problems relating to their health and that of their livestock and wider environment. Given the complex relationships between humans and other biodiversity, the complexities of resource use, including barriers to sustainable resource use, improved health outcomes are maximised when more stakeholders are on-board and engaged. This is not an easy accomplishment and processes that allow for genuine co-operation and mutual understanding of quite different organisational sectors is required.

It is worth appreciating the consequences of not taking an ecosystem approach to health in wetlands. Wetlands as settings for lifestyles and livelihoods can deteriorate, and negatively affect health in this way. Activities which negatively affect wetland functions and services can create wetlands which actively pose health risks such as exposures to toxic materials and/or water-borne, or vector-borne diseases. Whilst steps can be taken to ameliorate these risks, the risks can increase (sometimes dramatically) if disruption to ecosystems, and the services they provide, continues.

2.4 Why disease management should be integral to wetland management

Control of disease in wetlands brings broad scale benefits even if these benefits may be somewhat intangible as 'absence' of a problem is often not fully appreciated nor costed appropriately. Current wetland management practices focussed at maintaining wetland function and wetland benefits usually also address disease prevention and control. However, there will be strategies for disease management that are additional to traditional management practices that once integrated, provide additional gains.

To view disease management as separate to other forms of land and wildlife management ensures that opportunities for good disease prevention will be missed. Wetland managers are the key stakeholders in delivering healthy wetlands and, as such, all efforts should be made to integrate disease management thoroughly within wetland site management plans and other stakeholder activities at wetlands.

►Section 3.1.3. Integrating disease management into wetland management plans.

2.5 Control of infectious disease and invasive alien species

It has been estimated that damage caused by invasive alien species worldwide amounts to almost five percent of the world economy. Invasive alien species of flora and fauna are considered the second biggest threat after habitat loss and destruction to biodiversity worldwide, the greatest threat to fragile ecosystems such as islands, and are a major cause of species extinction in freshwater systems. Climate change may also exacerbate the spread of non-native species as warmer temperatures may allow currently 'benign' non-native species to potentially extend their ranges and become invasive.

Invasive species impact native species in a wide range of ways, including competition, predation, hybridisation, poisoning, habitat alteration and disease. With respect to the latter, invasive alien species can carry novel pathogens non-symptomatically, to which native species may have no natural immunity. This can lead to population reduction and extinction in native species *e.g.* crayfish plague carried non-symptomatically by introduced North American signal crayfish *Pacifastacus leniusculus*, causes disease and mortality in European freshwater crayfish *Austropotamobius pallipes* [►**Section 4.1.12. Crayfish plague**], and amphibian chytridiomycosis carried non-symptomatically by introduced species such as American Bullfrogs *Lithobates catesbeianus* causes population declines and plays a role in amphibian extinctions [►**Section 4.1.2. Amphibian chytridiomycosis**].

There are many parallels between prevention and control of invasive alien species, and of infectious diseases, such as the proactive measures of:

- Risk analysis and assessment ►**Section 3.1.1. Risk assessment**
- Contingency planning ►**Section 3.1.4. Contingency planning**
- Surveillance (in particular horizon scanning) ►**Section 3.3.1. Surveillance and monitoring**
- High standards of biosecurity ►**Section 3.2.4. Biosecurity**
- Information and public awareness campaigns e.g. public education on measures to reduce the risk of introducing invasive species and how to recognise those species if they are present in an area ►**Section 3.5. Communication, education, participation and awareness**
- Training regarding management of those species ►**Section 3.5.2 Building capacity by education and training**
- Communication between governments and national organisations as invasive species often spread from one country to the next and advance warning allows time to increase biosecurity and surveillance strategies ►**Section 3.5.1 Communication and public awareness**

Given the dual benefits of reducing risk of invasive alien species and the pathogens they carry, these are worthwhile measures to take.

2.6 Strategies for managing animal disease

Proactive strategies

Proactive strategies aim to prevent disease introduction or an outbreak of existing disease and will always be more cost effective than dealing with the consequences of disease emergence. In general, to apply the concept of wise use and maintain biodiversity and ecological function *i.e*. maintain healthy wetlands, will provide the greatest contribution to health.

Figure 2-4. Maintaining healthy wetlands by applying the concept of wise use is the single greatest contributor to health in wetlands (*WWT*).

Although a good understanding of disease dynamics is needed for the most effective proactive disease control strategies, there are some basic generic principles which, if implemented, are likely to reduce risks of disease emergence. For example, strategies for biosecurity (including prevention of introduction of invasive alien species), reduction of stresses on hosts and environment, and prevention of pollution, will bring obvious health benefits. Table 2-1 provides a list of proactive practices for disease prevention and control and the locations of further information in Chapter 3.

Table 2-1. Proactive practices for prevention and control of disease in wetlands.

Practice	Section of Manual for further information
Healthy wetland management	*Wise use of wetlands*
Site-specific risk assessments	►Section 3.1.1
Formation and utilisation of multidisciplinary advisory groups	►Section 3.1.2
Integrating disease management into site management plans	►Section 3.1.3
Contingency plans which are tested regularly	►Section 3.1.4
Reducing stressors at a site	►Section 3.2.1
Disease zoning and use of buffer zones	►Section 3.2.2
Standards for movements of domestic livestock and restrictions where appropriate	►Section 3.2.3
Biosecurity measures	►Section 3.2.4
Surveillance and disease monitoring programmes	►Section 3.3.1
Identifying a disease problem	►Section 3.3.2
Control of vectors where appropriate	►Section 3.4.3
Vaccination programmes	►Section 3.4.4
Communication, education, participation and awareness raising programmes for wetland stakeholders in disease prevention and control to help develop a 'culture' of disease management	►Section 3.5

Reactive strategies

Reactive strategies, once a disease has emerged and/or been identified, aim to: reduce spread; impact; and potential for disease to become established and create a longer term problem.

Reactive strategies may include determining an evidence base, conducting surveillance, animal movement restrictions and instigating various other control measures. Reactive strategies for complete disease eradication may involve substantial intervention.

With such a wide variety of wetland stakeholders, it is important to appreciate that there is the potential for differences in opinions over reactive disease control strategies and thus cross-cutting education, awareness raising and communication about these activities is advisable, particularly where rapid responses to disease emergence are required. Table 2-2 provides a list of reactive practices for disease control.

Table 2-2. Reactive practices for control of disease in wetlands.

Practice	Section of Manual for further information
Utilisation of multidisciplinary advisory groups in response to outbreaks	►Section 3.1.2
Further integrating disease management into site management plans	►Section 3.1.3
Implementation of contingency plans which are tested regularly and refined as necessary	►Section 3.1.4
Reducing stressors at a site	►Section 3.2.1
Disease zoning and use of buffer zones	►Section 3.2.2
Standards for movements of domestic livestock and restrictions	►Section 3.2.3
Biosecurity measures	►Section 3.2.4
Surveillance and disease monitoring programmes	►Section 3.3.1
Investigation of outbreaks	►Section 3.3.5
Disinfection and sanitation	►Section 3.4.1
Control of vectors	►Section 3.4.3
Vaccination programmes	►Section 3.4.4
Habitat modification	►Section 3.4.6
Movement restrictions	►Section 3.4.7
Eradication, elimination, stamping out and lethal intervention	►Section 3.4.8
Communication, education, participation and awareness raising programmes for wetland stakeholders in disease prevention and control to help develop a 'culture' of disease management	►Section 3.5
Risk communication and dealing with the media	►Section 3.5.1

All these practices are detailed in Chapter 3. Their application is illustrated in the case studies throughout the Manual and in the 'Prevention and Control in Wetlands' sections of the disease factsheets in Chapter 4.

2.7 Communication, education, participation and awareness (CEPA)

The vision for the Ramsar Convention's CEPA programme is "people taking action for the wise use of wetlands". All wetland stakeholders (such as wetland managers, local wetland users including farmers, hunters and fishers, and local government agencies, community leaders and NGOs) should understand the basic principles of healthy habitat management and the action they can take for disease prevention and control. Wetland users do not need to become disease experts but communication and awareness raising programmes should aim to increase motivation to become engaged and 'do the right thing', with respect to disease management. This will likely only come from becoming informed about the problem, understanding the issues and implications, and participating in the solutions.

Developing capacity to undertake disease management may involve formal education and training of key personnel *e.g.* land managers or appropriate authorities. Ideally disease training should be part of other wetland management or wetland-related training to convey its integral nature and to

avoid it becoming detached from day to day practices. Frequency of training will depend on the disease issue *e.g.* there may be merit in provision of brief annual refresher training for a seasonal disease, or to coincide with changes in wetland management practices. Education and training for those involved in high risk activities *e.g.* a large-scale disease control operation, are essential to protect public health (if the disease is zoonotic) and potential for further spread of disease.

Communication networks of key wetland stakeholders, including disease control authorities, should be established in 'peacetime' to facilitate rapid disease control responses should the need arise.

This Manual aims to provide some of the information as a foundation for communication and public awareness programmes.

►Section 3.5. Communication, education, participation and awareness (CEPA)

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- The **greatest power to prevent disease** emergence in wetlands **lies in the hands of wetland managers** and other wetland users.
- The concept of **'One World One Health'** has arisen due to the appreciation of the **fundamental connectivity in health of humans, domestic livestock and wildlife**.
- Embracing an **ecosystem approach to health in wetlands** involves **recognising the dependence of health and well-being on 'healthy wetlands'** which can only be achieved through wise use, most often at a landscape and/or catchment scale.
- **'Prevention is better than cure'** and an ecosystem approach to health, maximises benefits and minimises costs for wetland stakeholders.
- **If wetland stakeholders understand** both the impacts of diseases and how to prevent and control them, **they will feel motivated and empowered** to take action. Stakeholder understanding must be built through effective communications or training but action will also be influenced by capacity to respond.
- **Understanding disease** in its broadest terms (*i.e.* not just in terms of life and death) and its overt and subtle effects on individuals and populations, and the factors that affect this, **allows a better appreciation of how to manage them** effectively.
- **To view disease management as separate** to other forms of land and wildlife management **ensures that opportunities for good disease prevention will be missed**. Therefore**, integrating disease management into wetland management** means putting disease consideration at the heart of the wetland management planning process.
- **Effective management of any disease** is dependent on **a good understanding of its epidemiology and the ecology of host populations**. The dynamics of disease in wildlife populations can be highly complex, and disease management interventions can have unpredictable outcomes.
- **Invasive alien species and novel pathogens and parasites have many parallels** in their biology, the risks they pose, and **in the measures required to prevent their establishment** and control. Prevention of their introduction is preferable to subsequent control, and wetland management practices aimed at prevention of any of these can provide additional benefits and protection from all.

- **A broad range of proactive and reactive strategies and practices are available** to the wetland manager and other wetland stakeholders to achieve or maintain the health of the ecosystem including:
  1. **Targeting the environment and land use** *e.g*. healthy habitat management including wise use; maintaining appropriate water quality and quantity; reducing risk from pollutants and toxicants; and manipulation of habitat to reduce disease agents or their invertebrate vectors.
  2. **Targeting host populations** *e.g*. maintaining good nutritional status; reducing stressors; managing density of domestic animals and wildlife; reducing contact between domestic animals and wildlife (including zoning); and vaccination or veterinary treatment.
  3. **Targeting pathogens and parasites** *e.g*. managing biosecurity; hygiene, disinfection and sanitation; and interrupting transmission by exploiting weaknesses in a parasite's life cycle, such as targeting intermediate hosts and/or their preferred habitat.

2.8 References

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