

Appendices

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Appendix I

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Appendix II

Key Messages for Wetland Managers and Policy Makers

1. Introduction to diseases in wetlands

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- The term '**disease**' is used to define any impairment to health resulting in dysfunction. There are **many disease types**, including: infectious, toxic, nutritional, traumatic, immunological, developmental, congenital/genetic and cancers.
- **Disease is often viewed as a matter of survival or death when, in fact, effects are often far more subtle**, instead affecting productivity, development, behaviour, ability to compete for resources or evade predation, or susceptibility to other diseases factors which can consequentially influence population status.
- **Well functioning wetlands** with well managed livestock, with little interface, with well managed wildlife should provide human wetland dwellers with the **ideal healthy environment in which to thrive**.
- **Disease is an integral part of ecosystems** serving an important role in population dynamics. **However, there are anthropogenic threats affecting wetlands** including climate change, substantial habitat modification, pollution, invasive alien species, pathogen pollution, wildlife and domestic animal trade, agricultural intensification and expansion, increasing industrial and human population pressures including the interface between humans and domestic and wild animals within wetlands, all of which may act as drivers for emergence or re-emergence of diseases.
- **Wetlands are meeting places** for people, livestock and wildlife and **infectious diseases can be readily transmitted** at these interfaces.
- **Stress is often an integral aspect of disease** capable of exacerbating existing disease conditions and increasing susceptibility to infection. **There are a broad range of stressors** including toxins, nutritional stress, disturbance from humans and/or predators, competition, concurrent disease, weather and other environmental perturbations. Stressors can be additive, working together to alter the disease dynamics within an individual host or a population.
- **Impacts** of disease on public and livestock health, biodiversity, livelihoods and economies **can be significant**.
- **The emergence and re-emergence of diseases has become a wildlife conservation issue** both in terms of the impact of the diseases themselves and of the actions taken to control them. Some diseases may be significant sources of morbidity and mortality of wetland species and in some cases (*e.g.* amphibian chytridiomycosis) can play a role in multiple extinctions of wetland species.

2. Principles of managing diseases in wetlands

KEY MESSAGES FOR WETLAND MANAGERS AND POLICY MAKERS

- The term '**disease**' is used to define any impairment to health resulting in dysfunction. There are **many disease types**, including: infectious, toxic, nutritional, traumatic, immunological, developmental, congenital/genetic and cancers.
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- **Well functioning wetlands** with well managed livestock, with little interface, with well managed wildlife should provide human wetland dwellers with the **ideal healthy environment in which to thrive**.
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- **Wetlands are meeting places** for people, livestock and wildlife and **infectious diseases can be readily transmitted** at these interfaces.
- **Stress is often an integral aspect of disease** capable of exacerbating existing disease conditions and increasing susceptibility to infection. **There are a broad range of stressors** including toxins, nutritional stress, disturbance from humans and/or predators, competition, concurrent disease, weather and other environmental perturbations. Stressors can be additive, working together to alter the disease dynamics within an individual host or a population.
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3. Practices of managing diseases in wetlands

3.1 Assessing risk and planning for the future

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.

3.2 Reducing risk of disease emergence

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.

3.3 Detecting, assessing and responding to new disease

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.

3.4 Managing disease

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 carcasses** 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 carcasses and cleaning and disinfection) is a management practice used for rapidly reducing the prevalence of a disease during an outbreak situation.

3.5 Communication, education, participation and awareness (CEPA)

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' for 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.

Appendix III Glossary

Abiotic disease:	Non-infectious disease caused by non-living environmental agents, such as toxic chemicals, heavy metals, extreme temperatures, UV radiation, nutrient imbalance.
Acaricides:	A chemical used to kill mites or ticks.
Accidental host:	A host that harbours an organism that is not ordinarily pathogenic in that particular species. Accidental hosts are usually a 'dead end' for a pathogen.
Acute:	Meaning either a rapid onset of infection or short in nature.
Agar gel immunodiffusion:	Laboratory technique that uses the diffusion of antibodies and antigens across an agar gel to diagnose infections.
Aerosol:	Suspension of solid or liquid particles in a gas or droplets of liquid (<i>e.g.</i> disease agents in spray).
Aetiology:	The study of the causes of diseases.
Anorexia:	Poor appetite and/or inability to eat leading to loss of body weight.
Anthelmintic:	A substance capable of destroying or expelling parasitic worms.
Anthropogenic:	Caused or influenced by human activities.
Antibiotic:	Chemical substance produced with the ability to kill or inhibit growth of other microorganisms. Used in the treatment of some infectious diseases.
Antibodies:	Serum protein produced by lymphocytes in response to the presence of specific antigens. Detection of specific antibodies is useful for diagnosis.
Anticoagulated:	The prevention of coagulation (clotting), usually referring to blood taken into tubes containing an additive <i>e.g.</i> heparin.
Antigen:	Any substance that is recognised by the body as foreign <i>e.g.</i> invading organisms, toxins, non-self tissues. The recognition gives rise to an immune response and antibody production.
Aquaculture:	The cultivation of aquatic plants and animals for food.
Arthropod:	A member of the phylum Arthropoda. An invertebrate animal with an external skeleton, a segmented body and jointed appendages (<i>e.g.</i> insects, arachnids, crustaceans).
Ascitic:	An abnormal accumulation of serous fluid (or serum) in the abdominal cavity.
Asymptomatic:	Carrying an infection or diseased but showing no symptoms.
Ataxia:	Neurological disorders which cause the loss of ability to coordinate muscular movement.

Attenuated vaccine:	A vaccine containing a weakened form of the organism that causes the disease. Also called a live vaccine.
Avian influenza (AI):	A disease of birds caused by influenza A virus, can refer to either low pathogenic or highly pathogenic forms of the disease (LPAI or HPAI).
Bacteriophage:	A virus that parasitises a bacteria.
Biliary duct:	A duct that transports bile from the liver to the intestines.
Bioassay:	Bioassay (biological assay) is a procedure that determines the concentration of a particular biological constituent of a mixture.
Biochemical:	Chemical composition of a particular living system or biological substance.
Biosafety:	The precautions taken to prevent exposure to infectious agents.
Biosecurity:	The precautions taken to minimise the risk of introducing infection (or invasive alien species) to a previously uninfected site and therefore preventing further spread.
Biotic diseases:	Those caused by a living agent, such as a bacterium, virus, fungus or protist.
Bovid:	Member of the Bovidae family (including cattle, buffalo and bison).
Buffer zone:	An area of land separating two or more different land types (<i>e.g.</i> between a disease-infected area and a disease-free area). This zone may consist of physical barriers, an absence of hosts, an absence of disease vectors or only immune hosts <i>e.g.</i> following ring vaccination.
Bushmeat:	Hunting and/or consumption of meat from wild animals.
Caecal:	Of, or pertaining to, the caecum, or blind gut.
Carrier (disease):	A person or organism infected with an infectious disease agent but displaying no symptoms (asymptomatic).
Caudates:	Latin for 'tail', refers to amphibians with tails (<i>e.g.</i> salamanders and newts).
Causative:	Refers to the agent or cause of a disease.
Cercaria:	Parasitic larval stage of a trematode worm.
Cervid:	Member of the Cervidae family <i>i.e.</i> deer.
Challenge:	The physiological, and especially immunological, stress a host is subjected to by a pathogen.
Chemical fixation:	Using chemicals to preserve tissues and prevent decay.
Chemotaxis:	The characteristic movement or orientation of an organism or cell along a chemical concentration gradient either toward or away from a chemical stimulus.

Chronic:	Describing a long-standing disease or lesion which may follow an acute phase, or a disease marked by frequent reoccurrence.
Clinical signs:	Observed changes in the course of a disease process.
Cloacal:	The common cavity into which the intestinal, genital and urinary tract open in vertebrates such as birds, fish, reptiles and some primitive mammals.
Colostrum:	The first secretion from the mammary glands after giving birth, rich in antibodies.
Communicable:	Capable of being transmitted from one person/species to another, infectious or contagious in nature.
Convulsions:	Uncontrolled shaking of the body as a result of the body muscles rapidly and repeatedly contracting and relaxing.
Counter immune-electrophoresis:	A laboratory technique that uses an electrical current to migrate antibodies and antigens across a buffered agar gel. Used to diagnose bacterial infections.
Culling:	A reduction in population by selective slaughter. Usually implemented to restrict disease movement.
Culture: medium.	The growth and multiplication of biological cells in a controlled nutrient-rich medium.
Cutaneous:	Relating to or affecting the skin.
Decontamination:	The process of cleansing to remove contamination from substances.
Definitive host:	An animal in which a pathogen lives and reproduces.
Diagnosis:	Determining the nature and cause of a disease through examination of physical and chemical symptoms.
Diagnostician:	Person that performs diagnostics.
Diagnostics:	The science and practice of diagnosis.
Disease:	A departure from a state of health or any impairment to health resulting in physiological dysfunction.
Disease agent:	An organism capable of causing disease <i>i.e.</i> viruses, bacteria, fungi, protozoa, helminths or arthropods.
Disease ecology:	The interaction of the behaviour and ecology of hosts with the biology of pathogens in relation to the impacts of diseases on populations.
Ecohealth:	The concept of health at the level of ecosystem, appreciating the interconnectivity of humans and all living organisms and functions within this and how these linkages are reflected in a population's state of health.
Ecological:	The relationship between organisms and their environment.
Ecthyma:	A contagious viral disease of sheep and goats marked by lesions on the lips.

Ectoparasite:	An external parasite.
ELISA:	Enzyme-linked immunosorbant assay. A diagnostic test that uses disease specific proteins (antigens or antibodies) to detect antibodies (or antigens), and therefore disease.
Emerging disease:	A disease that has appeared in a population for the first time, or that may have existed previously but is rapidly increasing in incidence or geographic range, or has recently evolved from another disease.
Encyst:	Enclose or become enclosed in a cyst.
Endemic:	Native to a population, or a disease characteristic of a particular area.
Endogenous:	Originating from within an organism.
Endoparasite:	An internal parasite.
Enteric:	Relating to or being within the intestines.
Entomopathogens:	Pathogens that infect insects.
Epidemic:	A disease affecting many organisms at the same time, spreading rapidly within a population where the disease is not usually prevalent.
Epidemiology:	The study of the distribution and determinants of health-related states and its application to the control of diseases.
Equid:	Member of the Equidae family <i>i.e.</i> wild or domestic horses.
Eradicate:	To exterminate an infectious agent so no further cases of a specific disease arise.
Exotic:	Non-native species introduced to areas where they do not naturally occur.
Flukes:	Also known as trematodes, a class of parasitic flatworm.
Fomites:	Inanimate objects on which disease agents may be transported (<i>e.g.</i> bedding or faeces).
Gastroenteritis:	Inflammation, infection or irritation of the digestive tract, particularly the stomach and intestine.
Genetic resistance:	Genetically determined resistance to specified infectious agents.
Haemorrhage:	Profuse bleeding from ruptured blood vessels.
Health:	A positive state of physical and mental well-being.
Helminth:	Parasitic worm.
Herbivorous:	Plant eating animals.

Heterozygosity:	The state of being heterozygous <i>i.e.</i> having dissimilar alleles at corresponding chromosomal loci – having genetic diversity.
Histopathology:	Diagnosis and study of disease by expert interpretation of cells and tissue samples.
Horizontal transmission:	Transmission of an infectious agent between members of the same species.
Host:	An organism in which another, usually parasitic, organism is nourished and harboured.
Host range:	The range of host species which a particular pathogen is able to infect.
H5N1:	Highly pathogenic avian influenza. H5N1 refers to the combination of haemagglutinin (H) and neuraminidase (N) proteins on the surface of the virus coat protein.
Hydrology:	Pertains to the movement, distribution and quality of water.
Hyphae:	Long, branching filamentous structures of a fungus.
Iodophore:	A solution that contains iodine and a surface-active agent, it releases iodine gradually to act as a disinfectant.
Immunity:	The condition of being immune refers to a state in which a host is not susceptible to infection or disease from invasive pathogens.
Immunocompetence:	The ability of the body to resist disease and distinguish between alien and endogenous bodies.
Immunocompromise:	Having an impaired immune system and therefore a reduced ability to mount an immune response and fight infection.
Immunofluorescence:	A laboratory technique used to detect the presence of an antigen or antibody in a sample by coupling a specific interactive antigen or antibody with a fluorescent compound.
Immunohistochemistry:	The application of immunological techniques to the chemical analysis of cells and tissues.
Immunologically naïve:	Pertaining to an immune system not previously exposed to stimuli from pathogens.
Immunosuppression:	The inhibition of the normal immune response because of disease, administration of drugs or surgery.
Incidence:	The number of individual cases of disease in relation to the population at risk.
Infection:	Occurs when one living organism (the host) is invaded by another living organism. This may be clinically inapparent or result in only local cellular damage. The infection may remain localised, subclinical and temporary if the immune system is effective. A local infection may persist and spread to become an acute, subacute

or chronic clinical infection or disease state when micro-organisms gain access to lymphatic or vascular systems.

Infectious:	Capable of being transmitted between host organisms.
Intermediate host:	An animal in which a parasite lives in a non-sexual, larval stage.
Intervention:	The act of intervening in a disease or epidemiological sequence.
Intraspecific:	Arising or occurring within a species.
Invasive alien species:	Species that have been introduced outside their natural distribution area.
Keystone species:	A species with a disproportionate impact <i>i.e.</i> positive function, on its ecosystem relative to biomass and abundance.
Larvicide:	An insecticide specifically targeted against the larval life stage of an insect to halt the life cycle.
Lesion:	A region in an organ or tissue that has suffered damage through injury or disease.
Live vaccine:	A vaccine containing a weakened form of the organism that causes the disease. Also known as an attenuated vaccine.
Maintenance host:	An animal which is capable of acting as natural source of infection for other individuals of the same species (see reservoir host).
Meningeal:	Of or affecting the meninges (the membrane system that envelope the central nervous system).
Metacercaria:	The encysted larva of a trematode in an intermediate host.
Metamorphs:	Amphibian life-cycle stage between larvae and adult.
Microbial:	Pertaining to microorganisms.
Microorganisms:	Microscopic organism such as bacteria, virus, fungi or protozoa.
Micropropagated:	The production of a large number of individual plants from a piece of plant tissue cultured in a nutrient medium.
Miracidium:	Free-living, ciliated, first larva stage of the trematode lifecycle.
Mitigate:	To moderate or alleviate a condition.
Morbidity:	Incidence of clinical cases of a disease in a given population.
Mortality:	The incidence of death in a given population in a given period. The incidence of death among animals affected by a particular disease or condition.
Mustelids:	Member of the Mustelidae family (includes weasel, ferret, mink, otter and skunk).
Necrophagy:	Eating dead bodies or carrion.

Necropsy:	<i>Post mortem</i> examination.
Non-infectious:	Not capable of being transmitted between host organisms.
Non-zoonotic:	Disease or infection which cannot be naturally transmitted from vertebrate animals to humans (noun: non-zoonosis). See ' <i>zoonosis</i> '.
Notifiable:	A disease which must be reported to the relevant national and international authority (<i>i.e.</i> OIE).
Novel disease:	A novel disease is one that has not previously been exposed to a given species or population. This may be due to mutation of the organism that is responsible for the disease.
Obligate:	Used to describe an organism which is bound or restricted to a certain habitat, host or environment.
Oomycetes:	Marine, freshwater and soil living non-photosynthetic algae-like fungi, includes water moulds and downy mildews.
Oropharyngeal:	Of, or relating to, the oropharynx, which is the part of the pharynx, between the soft palate and the epiglottis.
Ovid:	Member of the Ovidae family <i>i.e.</i> wild or domestic sheep.
Oviposition:	Process of depositing or laying eggs.
Paralysis:	Temporary or permanent loss of muscle function in the body.
Parasite:	Used in this context to be synonymous with <i>pathogen</i> . However, the <i>microparasites</i> (viruses, bacteria, fungi and protozoa) tend to be referred to as <i>pathogens</i> . <i>Macroparasites</i> refer to helminths and arthropods and are often referred to simply as <i>parasites</i> .
Parasite load:	A measure of the degree of which a host is burdened by parasites.
Pathogen:	An organism capable of causing infection and disease <i>i.e.</i> viruses, bacteria, fungi, protozoa, helminths or arthropods.
Pathogenic:	Causing disease or capable of doing so.
Pathogenicity:	A pathogen's ability to cause disease. Similar to the term 'virulence' but broader because it is more of a qualitative term.
Pathology:	The study of the structural and functional changes in the fluids, cells, tissues and organs of the body.
PCR:	Polymerase chain reaction (PCR): a technique in molecular biology to amplify a single or a few copies of a piece of DNA or RNA across several orders of magnitude, generating thousands to millions of copies of a particular sequence allowing easier detection.
Peacetime:	Used in this context to mean before a problem.

Phytosanitary:	Relating to the health of plants and the prevention of spreading plant diseases.
Post mortem:	After death but often used to refer to medical/veterinary examination of a dead body (short for <i>post mortem</i> examination).
Poultry:	Term referring to domestic birds bred for meat, eggs and/or feathers. Includes chickens, turkeys, ducks, geese, quail <i>etc.</i>
Prevalence:	A general term describing the commonality of a disease or condition in a group of animals. Proportion of individuals within a given population with disease at a given time.
Protist:	Mostly single-celled, but some multicellular, organisms in the kingdom Protista. Includes protozoans, eukaryotic algae and slime moulds.
Pulmonary:	Pertaining to the lungs.
Quarantine:	A period of isolation to cover the incubation period of a certain disease which reduces disease transmission to the remaining population.
Redia:	The cylindrical larval stage of some trematodes.
Reservoir host:	Refers to host organisms that serve as a source of infection by sustaining a population of an infectious pathogen, often with immunity to the disease. Pathogens may 'spillover' from reservoir populations to cause disease in nearby susceptible hosts which may be a different species.
Resilient:	Ability to recover quickly or withstand adverse conditions.
Resistant:	Ability of an organism to remain uninfected and/or unaffected by agents.
Scrapie:	Degenerative brain disease of sheep.
Secretions:	Substances secreted from the blood or cells (<i>e.g.</i> saliva, mucus, tears, bile, and hormones).
Sentinel herd:	Small herd of susceptible hosts located in geographically representative areas used to detect prevalent diseases.
Septicaemia:	Blood poisoning, invasion of the bloodstream by virulent microorganisms from a focus of infection.
Serological:	Relates to serum and antigen-antibody reactions.
Serovar:	A group of closely related microorganisms distinguished by a characteristic set of antigens.
Slurries:	Thin, watery mixtures of fine, insoluble material such as clay, cement, soil, or faeces.
Spatial variation:	Differences in a landscape usually associated with populations. For example, this may be related to habitat or weather differences.

Spillback:	Reverse spillover of infectious agents from wildlife to sympatric populations of susceptible animals (often domesticated species).
Spillover:	The transmission of infectious agents from reservoir animal populations (often domesticated species) to sympatric wildlife.
Spore:	An infectious body produced within bacteria.
Sporocyst:	The larva of a trematode worm that produces redia larvae by asexual reproduction.
Sterile:	Free from microorganisms.
Stressors:	A chemical or biological agent, an environmental condition, an external stimulus or an event that causes stress to an organism (<i>e.g.</i> capture, overcrowding, harassment by humans or other animals).
Subclinical:	A mild infection or early stage infection with no detectable symptoms.
Substrate:	A surface on which an organism grows.
Suid:	Member of the Suidae family <i>i.e.</i> wild or domestic pigs (including warthog, babirusa and bush pigs).
Susceptibility:	The state of being susceptible <i>i.e.</i> readily affected by disease.
Symbiont:	An organism in a symbiotic relationship <i>i.e.</i> a relationship of mutual benefit or dependence.
Syndromes:	The result of the combination of clinical signs or symptoms that collectively indicate or characterise a disease.
Taxa:	Plural of taxon. A taxonomic category for the classification of organisms.
Toxin:	A type of poisonous substance.
Transmission:	Transfer of an infection from one source to another.
Trypanotolerant:	Trypanotolerant and trypanotolerance describe the condition of being able to resist trypanosomiasis <i>e.g.</i> some endemic breeds of cattle.
Vector:	A carrier which transfers an infectious agent from one host to another <i>e.g.</i> a tsetse fly carries trypanosomes from animals to humans and other animals.
Vertical transmission:	Transmission of an infectious agent between different generations within a population <i>i.e.</i> mother to offspring.
Viable:	Capable of function under favourable conditions.
Virion:	The infective form of a virus.
Virulence:	The severity to which a microorganism can cause disease, similar to pathogenicity.
Waterbird:	Species of birds ecologically dependent on wetlands for at least part of their annual cycle. Synonymous with 'waterfowl'.

- Water-borne disease:** A disease caused by pathogenic micro-organisms that are most commonly transmitted in contaminated fresh water.
- Zoonosis:** Disease or infection which can be naturally transmitted from vertebrate animals to humans (plural: zoonoses; adjective: zoonotic).
- Zoosanitary:** Relating to the health of animals and the prevention of spreading animal diseases through cleaning and containment practices.
- Zoospore:** A motile asexual spore that uses a flagellum for locomotion

Appendix IV

OIE Member Countries (as of March 2012)

Afghanistan	Gambia	Nigeria
Albania	Georgia	Norway
Algeria	Germany	Oman
Andorra	Ghana	Pakistan
Angola	Greece	Panama
Argentina	Guatemala	Papua New Guinea
Armenia	Guinea	Paraguay
Australia	Guinea Bissau	Peru
Austria	Guyana	Philippines
Azerbaijan	Haiti	Poland
Bahamas	Honduras	Portugal
Bahrain	Hungary	Qatar
Bangladesh	Iceland	Romania
Barbados	India	Russia
Belarus	Indonesia	Rwanda
Belgium	Iran	San Marino
Belize	Iraq	Sao Tome and Principe
Benin	Ireland	Saudi Arabia
Bhutan	Israel	Senegal
Bolivia	Italy	Serbia
Bosnia and Herzegovina	Jamaica	Seychelles
Botswana	Japan	Sierra Leone
Brazil	Jordan	Singapore
Brunei	Kazakhstan	Slovakia
Bulgaria	Kenya	Slovenia
Burkina Faso	Korea (Dem. People's Rep. of)	Somalia
Burundi	Korea (Rep. of)	South Africa
Cambodia	Kuwait	Spain
Cameroon	Kyrgyzstan	Sri Lanka
Canada	Laos	Sudan
Cape Verde	Latvia	Suriname
Central African Rep.	Lebanon	Swaziland
Chad	Lesotho	Sweden
Chile	Libya	Switzerland
China (People's Rep. of)	Liechtenstein	Syria
Colombia	Lithuania	Taipei Chinese
Comoros	Luxembourg	Tajikistan
Congo	Madagascar	Tanzania
Congo (Dem. Rep. of the)	Malawi	Thailand
Costa Rica	Malaysia	Timor-Leste
Cote d'Ivoire	Maldives	Togo
Croatia	Mali	Trinidad and Tobago
Cuba	Malta	Tunisia
Cyprus	Mauritania	Turkey
Czech Republic	Mauritius	Turkmenistan
Denmark	Mexico	Uganda
Djibouti	Micronesia Federated States of	Ukraine
Dominican (Rep.)	Moldova	United Arab Emirates
Ecuador	Mongolia	United Kingdom
Egypt	Montenegro	United States of America
El Salvador	Morocco	Uruguay
Equatorial Guinea	Mozambique	Uzbekistan
Eritrea	Myanmar	Vanuatu
Estonia	Namibia	Venezuela
Ethiopia	Nepal	Vietnam
Fiji	Netherlands	Yemen
Finland	New Caledonia	Zambia
Former Yug. Rep. of Macedonia	New Zealand	Zimbabwe
France	Nicaragua	
Gabon	Niger	

Appendix V

OIE Listed Diseases (2012)

Source: <http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2012/> (Accessed March 2012).

Multiple species diseases

- Anthrax
- Aujeszky's disease
- Bluetongue
- Brucellosis (*Brucella abortus*)
- Brucellosis (*Brucella melitensis*)
- Brucellosis (*Brucella suis*)
- Crimean Congo haemorrhagic fever
- Echinococcosis/hydatidosis
- Epizootic haemorrhagic disease
- Equine encephalomyelitis (Eastern)
- Foot and mouth disease
- Heartwater
- Japanese encephalitis
- Leptospirosis
- New world screwworm (*Cochliomyia hominivorax*)
- Old world screwworm (*Chrysomya bezziana*)
- Paratuberculosis
- Q fever
- Rabies
- Rift Valley fever
- Rinderpest
- Surra (*Trypanosoma evansi*)
- Trichinellosis
- Tularemia
- Vesicular stomatitis
- West Nile fever

Sheep and goat diseases

- Caprine arthritis/encephalitis
- Contagious agalactia
- Contagious caprine pleuropneumonia
- Enzootic abortion of ewes (ovine chlamydiosis)
- Maedi-visna
- Nairobi sheep disease
- Ovine epididymitis (*Brucella ovis*)
- Peste des petits ruminants
- Salmonellosis (*S. abortusovis*)
- Scrapie
- Sheep pox and goat pox

Cattle diseases

- Bovine anaplasmosis
- Bovine babesiosis
- Bovine genital campylobacteriosis
- Bovine spongiform encephalopathy
- Bovine tuberculosis
- Bovine viral diarrhoea
- Contagious bovine pleuropneumonia
- Enzootic bovine leukosis
- Haemorrhagic septicaemia
- Infectious bovine rhinotracheitis/infectious pustular vulvovaginitis
- Lumpy skin disease
- Theileriosis
- Trichomonosis
- Trypanosomosis (tsetse-transmitted)

Swine diseases

- African swine fever
- Classical swine fever
- Nipah virus encephalitis
- Porcine cysticercosis
- Porcine reproductive and respiratory syndrome
- Swine vesicular disease
- Transmissible gastroenteritis

Equine diseases

- African horse sickness
- Contagious equine metritis
- Dourine
- Equine encephalomyelitis (Western)
- Equine infectious anaemia
- Equine influenza
- Equine piroplasmosis
- Equine rhinopneumonitis
- Equine viral arteritis
- Glanders
- Venezuelan equine encephalomyelitis

Amphibian diseases

- Infection with *Batrachochytrium dendrobatidis*
- Infection with ranavirus

Mollusc diseases

- Infection with abalone herpes-like virus
- Infection with *Bonamia exitiosa*
- Infection with *Bonamia ostreae*
- Infection with *Marteilia refringens*
- Infection with *Perkinsus marinus*
- Infection with *Perkinsus olseni*
- Infection with *Xenohalotis californiensis*

Crustacean diseases

- Crayfish plague (*Aphanomyces astaci*)
- Infectious hypodermal and haematopoietic necrosis
- Infectious myonecrosis
- Necrotising hepatopancreatitis
- Taura syndrome
- White spot disease
- White tail disease
- Yellowhead disease

Fish diseases

- Epizootic haematopoietic necrosis
- Epizootic ulcerative syndrome
- Gyrodactylosis (Infection with *Gyrodactylus salaris*)
- Infectious haematopoietic necrosis
- Infectious salmon anaemia
- Koi herpesvirus disease
- Red sea bream iridoviral disease
- Spring viraemia of carp
- Viral haemorrhagic septicaemia

Avian diseases

- Avian chlamydiosis
- Avian infectious bronchitis
- Avian infectious laryngotracheitis
- Avian mycoplasmosis (*M. gallisepticum*)
- Avian mycoplasmosis (*M. synoviae*)
- Duck virus hepatitis
- Fowl typhoid
- Highly pathogenic avian influenza and low pathogenic avian influenza in poultry as per [Chapter 10.4. of the Terrestrial Animal Health Code](#)
- Infectious bursal disease (Gumboro disease)
- Newcastle disease
- Pullorum disease
- Turkey rhinotracheitis

Bee diseases

- Acarapisosis of honey bees
- American foulbrood of honey bees
- European foulbrood of honey bees
- Small hive beetle infestation (*Aethina tumida*)
- *Tropilaelaps* infestation of honey bees
- Varroosis of honey bees

Lagomorph diseases

- Myxomatosis
- Rabbit haemorrhagic disease

Other diseases

- Camel pox
- Leishmaniasis

Appendix VI






Outputs of disease prioritisation exercise









Disease <i>Factsheets produced for diseases in bold</i>	Importance to					Weighted sum
	Relevance to wetlands	Wildlife	Livestock	Human health	Livelihoods	
Oyster diseases	5	5	5	1	5	61
Tick borne diseases	4	5	5	5	5	60
Epizootic ulcerative syndrome	5	5	5	0	5	60
Crayfish plague	5	5	?	0	4	?
Avian influenza	5	4	5	4	5	59
Avian cholera	5	5	5	0	3	58
Coral diseases	5	5	2	0	5	57
Inclusion body disease (fish)	5	4	5	0	5	55
Bovine tuberculosis	3	5	5	5	5	55
Harmful algal blooms	5	4	0	4	5	54
Salmon and trout sea lice	5	4	4	0	4	53
Trematodes (fish)	5	3	4	4	4	52
Pesticides	4	5	1	4	2	52
Heavy metals (other than lead)	4	5	1	4	2	52
Lead poisoning	4	5	1	4	1	51
Amphibian chytridiomycosis	5	5	1	0	0	51
Rift Valley fever	4	3	5	5	5	50
African animal trypanosomiasis	3	4	5	5	5	50
Ranavirus infection	5	5	0	0	0	50
Avian tuberculosis	4	4	4	1	4	49
Avian botulism	5	4	2	0	2	49
Anthrax	2	5	5	4	4	48
Duck virus enteritis	5	3	3	0	3	46
West Nile virus disease	3	4	4	4	3	46
Peste des petits ruminants	3	4	5	0	5	45
Foot and mouth disease	2	5	5	0	5	45
African swine fever	2	5	5	0	5	45
Classical swine fever	2	5	5	0	4	44
Salmonellosis	4	2	5	5	3	43
Brucellosis	3	3	5	4	4	43
Rabies	2	5	2	5	1	43
Eastern equine encephalitis	3	3	3	4	3	40
Venezuelan equine encephalitis	3	3	3	4	3	40
Newcastle Disease	3	3	5	0	5	40
Rinderpest	1	5	5	0	5	40
Schistosomiasis	5	1	0	5	4	39
Western equine encephalitis	3	3	3	3	3	39
Escherichia coli poisoning	3	2	5	5	3	38
Campylobacteriosis	3	2	5	5	3	38
Trematodes (various)	4	2	4	0	4	38
Vibrio.	3	3	5	1	2	38











Disease <i>Factsheets produced for diseases in bold</i>	Importance to				Weighted sum	
	Relevance to wetlands	Wildlife	Livestock	Human health		Livelihoods
Pasteurellosis	3	3	3	1	4	38
Leptospirosis	3	2	4	4	4	37
Blue tongue	3	2	5	0	5	35
Japanese encephalitis	3	1	3	4	3	30
Tularaemia	3	1	3	4	3	30
Avian malaria	3	4	0	0	0	35
Leishmaniasis	3	1	0	4	3	27
Necrotic enteritis	3	3	0	0	0	30
African horse sickness	3	0	4	0	3	22
Yellow fever	3	0	0	3	2	20
Chikungunya	3	?	?	3	2	?
Inclusion body disease (birds)	3	3	?	0	0	?






Appendix VII

Summary of impacts of diseases on wildlife






Disease name	Causative agent						Region	Comments	OIE notifiable disease
African animal trypanosomosis	Protozoan trypanosomes						Endemic in most of Africa. Occurs where the tsetse fly vector exists.	Primarily affects domestic mammals. Most wild mammals are trypanotolerant. Mainly spread by the tsetse fly.	Ⓝ
Amphibian chytridiomycosis	The fungus <i>Batrachochytrium dendrobatidis</i>						All continents except Antarctica.	Affects most species of amphibian and is a major cause of amphibian mortality and morbidity.	Ⓝ
Anthrax	The bacterium <i>Bacillus anthracis</i>						Worldwide. Endemic in southern Europe, parts of Africa, Australia, Asia and North and South America.	Spores may remain dormant and viable for decades. An acute infectious disease, can affect almost all species of mammals, including humans.	Ⓝ
Avian botulism	The bacterium <i>Clostridium botulinum</i>						Worldwide.	Affects birds and some mammals. Caused by ingestion of a toxin produced by <i>C. botulinum</i> .	—
Avian cholera	The bacterium <i>Pasteurella multocida</i>						Mainly North America. Also occurs in South America, Africa, Asia, Europe and Oceania.	Most commonly affects ducks, geese, swans, shore birds, coots, gulls and crows.	—
Avian influenza	<i>Influenzavirus A</i> subtypes						Since 1997, highly pathogenic AI (subtype H5N1) has been reported in S.E. Asia, Europe, Africa and the Middle East.	H5N1 is the cause of unprecedented AI-related mortality. Has both direct and indirect conservation consequences.	Ⓝ
Avian tuberculosis	The bacterium <i>Mycobacterium avium</i>						Worldwide.	Most commonly reported in wild waterbirds, gregarious birds, raptors and scavengers. Clinical manifestation in mammals is rare.	—
Bovine tuberculosis	The bacterium <i>Mycobacterium bovis</i>						Worldwide. Widespread in Africa, parts of Asia and some Middle Eastern countries.	Cattle are considered the true hosts of <i>M. bovis</i> ; responsible for elevated mortality and morbidity in wild mammals in some protected areas.	Ⓝ

Disease name	Causative agent						Region	Comments	OIE notifiable disease
Brucellosis	Bacteria of the genus <i>Brucella</i>						Worldwide. High risk areas include: the Mediterranean Basin, South and Central America, Eastern Europe, Asia, Africa .	Particularly affects cattle, swine, goats, sheep but also wild bison, elk, deer, other ruminants. Infection can cause reproductive losses.	
Campylobacteriosis	Bacteria in the genus <i>Campylobacter</i>						Worldwide.	Infection in wild birds and mammals often inapparent.	—
Coral diseases	Various						Reported in marine ecosystems worldwide.	Responsible for considerable ecological damage, affecting numerous species of coral (primarily the soft corals or true stony corals).	—
Crayfish plague	Oomycete <i>Aphanomyces astaci</i>						Widespread in Europe and North America.	All species of freshwater crayfish are considered susceptible to infection, European species have declined due to novel infection.	
Duck virus enteritis	Herpesvirus						Reported in North America, Asia and several countries in Europe.	Can cause high seasonal mortality in ducks, geese and swans	—
Epizootic ulcerative syndrome (EUS)	Oomycetes <i>Aphanomyces Invadans/piscidida</i>						Worldwide distribution. Affects 25 countries in four continents: southern Africa, Asia, Australia and North America.	Affects wild and farmed, fresh- and brackish-water fish.	
<i>Escherichia coli</i> poisoning	Strains of the bacterium <i>Escherichia coli</i>						Worldwide.	Direct release of raw sewage is a frequent source. Often inapparent in wild animals. Certain strains (O157) can cause severe disease in humans.	—
Harmful algal blooms	Toxic species of algae						Worldwide.	Occur in both saltwater and freshwater environments, particularly where there are high nutrient levels, causing high levels of mortality.	—
Lead poisoning	Toxic lead						Occurs globally and in any wetland where lead is deposited.	Particularly affects waterbirds, birds of prey, and mammals.	—

Disease name	Causative agent						Region	Comments	OIE notifiable disease
Leptospirosis	Bacteria from the genus <i>Leptospira</i>						Worldwide. Most common in temperate or tropical climates with high rainfall.	Causes infections in many terrestrial and marine mammals. Commonly affects domestic animals and humans.	
Oyster diseases	Various						Worldwide.	Can affect wild populations of oysters and also commercial setups. Oysters grown in contaminated areas can cause human disease.	
Peste des petits ruminants (PPR)	Peste des petits ruminants virus						Considered endemic across North Africa, China and parts of the Far East.	Predominantly affects sheep and goats causing very high mortality, less severe in wildlife.	
Ranavirus infection	Ranaviruses						Reported in the Americas, Asia, Pacific and Europe.	Significant effects on amphibians (including salamanders, toads and frogs).	
Rift Valley fever	Rift Valley fever <i>Phlebovirus</i>						Endemic in tropical regions of Eastern and Southern Africa. Cases also reported in Saudi Arabia and Yemen.	A vector-borne disease, commonly transmitted by mosquitoes. Affects most terrestrial mammals; predominantly sheep, cattle and wild ruminants.	
Salmonellosis	Types of <i>Salmonella</i> bacteria						Worldwide.	Affects many domestic and wild animals including birds, reptiles, amphibians, fish and invertebrates.	<i>S. abortus ovis</i> only
Schistosomiasis	Schistosomes (trematode worms)						Most commonly found in Asia, Africa and South America in areas where the water contains freshwater snails.	Affects many species of wild animals and wildfowl, however, humans and livestock are the most at risk of clinical disease.	—
Tick-borne diseases	Variety of pathogens						As a collective TBDs occur worldwide. Usually in foci with suitable conditions for ticks and with susceptible animal hosts.	Ticks often found in grassy, wooded habitat. TBDs can affect most mammals and birds; primarily livestock, humans and companion animals.	Some TBDs are OIE listed
Trematode Infection of fish	Trematodes (flatworms / flukes)						Worldwide.	Trematodes can parasitise many vertebrate species. Commonly fish, frogs, livestock, domestic animals, humans and some invertebrates.	—

Disease name	Causative agent						Region	Comments	OIE notifiable disease
West Nile virus disease	West Nile <i>Flavivirus</i>						Reported in Africa, Europe, the Middle East, west and central Asia, Oceania and most recently, North America.	Spread by insect vectors (primarily mosquito). Affects numerous bird species and some terrestrial mammals (including humans).	

KEY

Taxa symbols	
	Invertebrates Animals without backbones – all animals except fish, amphibians, reptiles, birds and mammals. Includes corals, molluscs, insects, crustacea <i>etc.</i>
	Fish A group of taxa, including hagfish, lampreys, sharks and rays, ray-finned fish, bony fish, coelacanth and lungfish.
	Amphibians and reptiles (together known as herpetofauna) Animals from the classes Amphibia (such as frogs, salamanders and caecilians) and Reptilia (such as crocodiles, lizards and turtles).
	Birds Animals from the class Aves.
	Mammals Animals from the class Mammalia.

Impact colours			
	Severe impact		Mild impact
	Moderate impact		No impact

Appendix VIII

Technical editors of the disease fact sheets

Disease fact sheet	Technical editor	Affiliation
African animal trypanosomiasis	Richard Kock	The Royal Veterinary College, UK
Amphibian chytridiomycosis	Andrew Cunningham	Institute of Zoology, Zoological Society of London, UK
Anthrax	Richard Kock	Royal Veterinary College, UK
Avian botulism	Paul Duff	Animal Health and Veterinary Laboratories Agency, UK
Avian cholera	Richard Botzler	Humboldt State University, USA
Avian influenza	Richard Irvine	Animal Health and Veterinary Laboratories Agency, UK
Avian tuberculosis	Alexandra Tomlinson	Food and Environment Research Agency, UK
Bovine tuberculosis	Alexandra Tomlinson	Food and Environment Research Agency, UK
Brucellosis	Lindsey McCrickard	Food and Agriculture Organisation of the United Nations, Italy
Campylobacteriosis	Richard Kock	Royal Veterinary College, UK
Coral disease	-	-
Crayfish plague	Birgit Oidtmann	Centre for Environment, Fisheries & Aquaculture Science, UK
Duck virus enteritis	Paul Holmes	Animal Health and Veterinary Laboratories Agency, UK
Epizootic ulcerative syndrome (EUS)	Birgit Oidtmann	Centre for Environment, Fisheries & Aquaculture Science, UK
<i>Escherichia coli</i> poisoning	Richard Kock	Royal Veterinary College, UK
Harmful algal blooms	Henrik Enevoldsen	Intergovernmental Oceanographic Commission of UNESCO, Denmark
Lead poisoning	Paul Holmes	Animal Health and Veterinary Laboratories Agency, UK
Leptospirosis	Alexandra Tomlinson	Food and Environment Research Agency, UK
Oyster diseases	<i>FAO Aquaculture Service</i>	
Peste des petits ruminants	Ashley Banyard	Animal Health and Veterinary Laboratories Agency, UK
Ranavirus infection	Andrew Cunningham	Institute of Zoology, Zoological Society of London, UK
Rift Valley fever	Daniel Horton	Animal Health and Veterinary Laboratories Agency, UK
Salmonellosis	Becki Lawson	Institute of Zoology, Zoological Society of London, UK
Schistosomiasis	Paul Phipps	Animal Health and Veterinary Laboratories Agency, UK
Tick-borne diseases	Daniel Horton	Animal Health and Veterinary Laboratories Agency, UK
Trematodes of fish	<i>FAO Aquaculture Service</i>	
West Nile virus disease	Daniel Horton	Animal Health and Veterinary Laboratories Agency, UK

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