Waterfowl Husbandry and Medicine

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Birds of the Order *Anseriformes* include ducks, geese, swans and screamers. When considering 'waterfowl', flamingos are generally included as they are widely kept in captivity, often in combination with other members of the group. Table 1 lists common terminology for the different groups of waterfowl.

Table 1. Common terminology for waterfowl

	Male	Female		Young	First year
Ducks	Drake	Duck	Downies	Ducklings	Juveniles or adolescents
Geese	Gander	Goose		Goslings	
Swans	Cob	Pen		Cygnets	
Flamingoes	Male	Female		Chicks	

Anseriformes differ from most other birds in that the male has an erectile phallus, which may be seen if the cloaca is everted. To determine the sex, birds should be held head downwards between the knees, with the abdomen facing towards the handler. Firm, gentle pressure should be applied with the thumbs on either side of the cloaca, in a dorsolateral direction. The female has two small labia-like structures, whilst the male has a definite phallus. The ease of carrying out this procedure varies with respect to the age, breed and sex of the bird, and the season of the year. Care, skill and experience are required, all of which may be gained by practice. Species of waterfowl from tropical areas are sensitive to extreme cold weather, and are prone to frost bite and gangrene. These species should be housed during the winter. Others are tolerant of extreme conditions, although it is important that they have access to open (unfrozen) water.

All members of the group have nidifugous young, ie.. they are covered in down, and can eat, swim and dive almost immediately following hatching. Young birds may be readily imprinted. This should not be encouraged as it will cause problems when the birds reach sexual maturity (both aggression towards humans and failure to breed with their own species).

Table 2 below, gives a silhouette shape and brief description of the characteristics of each tribe, which make up the wildfowl family.

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Table 2. The wildfowl family (*Anatidae*) simplified.

Sub - family	Tribes	Details and characteristics.
ANSER-INAE	Anserinae - undergo a complete annual moult after the breeding season. The flight feathers are shed almost simultaneously, so that they are flightless for 3 - 6 weeks. The front toes are fully webbed in almost all species. In all species the plumage is monomorphic, no iridescent colouration even of the wing, of any species.	
	Swans and True Geese. Anserini	Swans and geese are closely related: they are long lived, the sexes are monomorphic (similar in appearance). Save for untimely fatalities they pair for life. The family remains together for the first year. Geese are well adapted to living on land, their legs are longer than swans or ducks, and are centrally placed under the body, which facilitates take off and walking on land.
	Whistling ducks. Dendrocygnini	Named for their whistling call, also known as tree ducks, as they often live and nest in or near trees. Sexually monomorphic. Longer legs and more upright stance distinguish these from other groups of ducks.
ANSERANAE	Magpie goose. Anseranatini (only member of the sub-family).	This species latin name means, goose duck with half webbed feet, which is a good description. It is more adapted to living on land than water. They have a specially lengthened hind talon, which is an adaptation for semi-terrestial life. They nest and rest in trees, and unlike other waterfowl, feeds it's young with food held in it' beak. They are polygamous, often breeding in trios consisting one male and two females. They have a specially elongated trachea, which forms coils, subcutaneously over the pectoral muscles. This adaptation is thought to be to enable low resonant vocalisation (Johnsgard, 1978).
	Anatinae - most members of this group moult twice a year, hence the breeding (nuptial) and non-breeding (eclipse or winter), plumage are different. Often the male breeding plumage is different from the female (ie. sexually dimorphic). The plumage of the downy young are patterned, (often spotted and striped including the head and neck). Males generally do not help in incubation but may assist in rearing young.	
	Shelducks and Sheldgeese. Tadornini	These birds, between true geese and ducks, and notable for their attractive and distinctive plumage patterns. They have long necks and legs and live mainly on land. Although they look like geese and eat the same food as geese, in may respects they are more like ducks. Some are sexually dimorphic, they moult twice a year and have patterned downy young.
	Surface feeding ducks. Anatini and Cairinini	This group includes all the dabbling ducks (Anatini) including mallard, that dabble in shallow water for their food. Widgeon are distinct and different in that they graze on short vegetation on land. Mallard, pintail and teal often up-end for their food, whilst the shoveller's wide beak has a ridged edge which is used as a sieve. The perching ducks (Cairinini) such as mandarins and carolinas are also mainly surface feeders. Most perching ducks nest in holes in trees.
	Diving Ducks	All tribes of duck which habitually dive tend to have round bodies, 'sit' low in the water, have feet set well back on the body. They have short straight tail feathers usually held parallel with or resting on the water surface.
		Steamer Ducks (Tachyerini) - large ungainly birds on land. Two species are flightless, they are high speed long distance paddlers. Generally found in coastal areas.
		Eiders (Somateriini) - found in open sea or coastal waters.
		Pochards (Aythyini) - with only the exception of scaup they are all fresh water ducks. Their bodies are short and rounded, individual species only vary in minor detail from each other.
		Stiff-tails (Oxyurini) - all species have stiff tail feathers used as a rudder and, most conspicuous during the courtship display. They have extremely large feet and find walking on land very difficult. They hardly ever leave water even nesting on floating reed platforms.
		Scoters, Goldeneyes, Merganser (Mergini) - found in both fresh and sea water. They are typically hole nesters. Their favourite foods are shellfish and crustaceans, whilst mergansers have pointed beaks with toooth-like projections to hold fish securely with.
	Flamingos Phoenicopteridae	these are considered to be the link between ducks, geese, swans and storks. There are six different species, all of which live in groups (sometimes thousands), in mainly tropical and subtropical climates. Both parents nest build and incubate, the single egg. At ten days the youngster, joins a crèche, comprising several young all minded by a few adults. Their specialised bill is held upside down in the water, they feed by sieving small particles of food out of the water. Additional carotene is required in their diet in captivity to maintain their bright pink / orange colouration.

Table 3 Average biological data for several of the commoner species of waterfowl.

Species	Male weight Kg	Female weight Kg	Sexual maturity	Clutch size	Incubat-ion.(days)	Longev-ity years	RR *	HR **	CT ***
Mute swan	12.2	8.9	5 years	4 - 8	35 - 40	25 -30	13 - 40	80 - 150	40.5
Pink footed goose	2.6	2.35	2 years	3 - 5	26 - 27	20 - 25			
Bar-heeded goose	2 - 3	2 - 3		4 - 6	27				
Hawaiian goose	2.2	1.9		3 - 5	29				
Red-breast- ed goose	1.3 - 1.6	1 15		3 - 7	23 - 25				
European widgeon	0.7	0.64	1 year	7 - 11	23 - 25	10 - 15	30 - 95	180 - 230	41.0
Mallard	1.26	1.1		8 - 12	23 - 29				
Eider	2.25	2.12		3 - 6	25 - 30				
Tufted duck	1.1	1.05		6 - 14	23 - 25				
Mandarin duck	0.44 - 0.55	0.44 - 0.55		9 - 12	28 - 30				
Muscovy duck	2 - 4	1.1 - 1.5	1 year	8 - 15	35	10 - 15	30 - 95	180 - 230	41.0
European goldeneye	0.99 - 1.16	0.7 - 0.8		9 - 11	27 - 32				

(Coles, 1985, Hayes, 1984, Todd, 1979).

RR * = Respiratory rate, breathes per minute.
HR** = Heart rate, beats per minute.
CT*** = Cloacal temperature, degrees centigrade.

HUSBANDRY

Handling

Anseriformes are relatively easily restrained. Their primary defenses are their beaks, wings and feet, none of which present any grave risk to staff as long as proper training has been received. Handling varies with respect to species. Swans and larger geese should be approached confidently. The neck should be grasped just below the head with the left hand, whilst the right forearm is swiftly placed under and around the body. The bird can be drawn in against the handler's body. With long-legged species, such as flamingos, great care must be taken to prevent damage to the legs during or after catching. As the bird is picked up with one hand, the legs are grasped with the other, just distal to the hocks, one finger is kept between the legs at all times in order to prevent pressure damage between the legs.

NB. Care should be taken when handling birds with pointed beaks, eg. herons. Such birds may use their beaks as weapons. After initial restraint, a ball of bandage, should be impaled onto the tip of the beak to prevent it causing any damage.

Hospitalisation

A dry, warm enclosure with non-slip flooring is suitable for brief periods of hospitalisation. Confinement, isolation and proximity to humans are frequently stressful to waterfowl; a quiet dimly-lit enclosure is preferable. During periods of hospitalisation in excess of 48 hours, the birds should be allowed access to water to swim in and a properly padded floor, eg. butyl rubber matting, should be available. Where birds have become oiled, the waterproofing of the feathers will have become damaged, thus losing the insulation properties and leading to risk of marked hypothermia. In these situations the ambient temperature should initially be maintained at 35 - 40°C. Encouraging birds to feed voluntarily during hospitalisation is a challenge. Attempts should be made to feed as

natural diet in a manner as close to nature as possible. Although there is considerable variation in the natural diets of different groups of waterfowl, there is also a great diversity within the natural diet of each species (see later). Most hospitalised waterfowl (except specialised eaters) will eat (a choice of) wheat (dry on the ground, and also some submerged in a water bowl) and fresh river weed. If birds are not willing to eat, they should be crop fed with convalescent type diet, eg. Reanamyl (Merial) or complan. The maintenance of captive decoy or other duck to act as a companion for hospitalised patients will often help stimulate feeding. Great care must be taken, however, to minimise the risk of such a duck acting as a fomite for infection. It should only be allowed to mix with healthy (rather than infected) birds, and should be regularly screened for sub-clinical infection. Waterfowl are generally strong swimmers, but poor walkers. For this reason, if the birds are recovering from leg injuries it is particularly important to allow access to water, rather than to force the bird to weight bear on an injured limb.

Housing

It is necessary to differentiate between ornamental wildfowl and domestic wildfowl. Domestic birds have been selected over the years for size, growth rates, carcase quality or egg production. They are accustomed to a degree of captivity, are less easily stressed and may be housed at night to help reduce the risk of predation. Ornamental wildfowl are commonly kept pinioned in large open pens and have access to a pond or stream. Ornamental wildfowl should not be kept unless the correct facilities are available as they will be subject to stress, whilst domesticated breeds will not.

Currently, more collections are using highly durable knotless nylon mesh netting to enclose pens. The advantages of this are that it dispenses with the requirement for pinioning of stock, and at the same time prevents access to the site by feral birds, which may present a major health risk to the captive birds. Pinioning may be carried out by lay persons in birds up to 10 days of age ; thereafter it may only be carried out by veterinary surgeons, who have a complete knowledge of the bird and the collection and believe it to be in the bird's best interest.

Enclosures should not be totally over-run with vegetation. Ingestion of long coarse grass can lead to crop impactions. Although planted aviaries provide shade and nesting materials, dark shaded areas will allow a greater environmental build up of *Mycobacterium avium* if the organism is present. The proportion of land to water will vary with the species. Grazing species, such as geese and swans, require a greater proportion of grazing land. Grazing areas should be cultivated once or twice each year and be thoroughly exposed to sunlight. Gizzard worm and gape worm ova over winter on grass, and present a particular risk to juvenile grazing birds. It is important, therefore, to have fresh grazing each year for juvenile birds (see parasite control later). Geese, in particular, are prone to nibble at any rough surfaces around the water margin; this generally leads to erosion of the bank. Furthermore, the water-land margin is a common area from which dabbling ducks may ingest *M. avium*. For both these reasons many waterfowl keepers use concrete or stone blocks around the water margin. Care should be taken with regard to the texture of the substrate on which the birds will be walking. Rough concrete surfaces may lead to considerable foot trauma and infection, some species, eg. black swans, appear particularly prone to this problem.

Ponds should have at least one island ; this allows privacy and nesting areas, and affords considerable predation control.

Water quality

Many potential sites for wildfowl collections will already have water in one form or another. The most important factor is that a constant supply of fresh water (it need not be large volumes) is available. Water from a nearby stream that can be diverted through some pools and returned will be ideal. Anti-erosion measures should be taken to maintain the integrity of the ponds and not allow the system to become clogged with mud and solids. However, routine de-mudding of ponds will prove necessary, even if only every few years.

Reed bed technology (using *Phragmites australis*) can act as a partial purifier of water. This means that small treatment beds can be installed at the entry and, particularly, the exit points of the water

flow of a collection. This is an important factor in obtaining water abstraction licenses from the National Rivers Authority.

SELECTION OF STOCK

There are many considerations that must be taken into account when selecting stock for a waterfowl collection. Irrespective of whether the collection is large or small, there are some basic questions to be answered :-

a). For what purposes are the birds being kept ?
b). Which species are the personal favourites of the collector ?
c). Which species can the collector afford to acquire and keep ?
d). How much space is available and what is the water quality ?
e). How much grazing is available if considering a grazing species such as geese?
f). Where and when will the birds be acquired ?
g). Species compatibility ?
h). Predator risk ?

These questions should be considered in the approximate order in which they are stated.

If it is intended to breed birds successfully, then good blood lines are important. Stud records should be kept and birds acquired from known backgrounds.

If only a few birds are being kept it is important to choose a species which is fairly independent, eg. domesticated mallard.

If a wild species is to be kept, other factors must be considered. Having ensured predator control (see later), space availability must be considered. The requirements of species must be considered, if these are not met the birds will not thrive, and may not even survive.

Sea ducks and diving ducks require a good deep water area. Dabbling ducks require an expanse of shallow waters edge. Grazers such as geese require adequate grass not only in the grass growing season, but all through the year.

Acquiring birds , either for the first time or as additions and replacements, requires much thought and a little luck. The best time to bring in young birds is as soon as they are fully fledged and at peak bodyweight, usually August or September. This will allow the birds to become accustomed to their new surroundings before the onset of winter. Alternatively, on can wait until early spring when the rigours of winter may have resulted in a need for some replacements. Birds which are in moult or pre-fledge should not be taken unless particular care in both transport and acclimatisation can be guaranteed.

Although it may seem ideal to keep a varied collection of single pairs, with the loss of one of a pair all too often this will result in mis-pairing and hybridisation. Action to avoid hybridisation:-

1. When releasing new birds on to a pond, allow birds from one species to go off together. Five minutes later release another species, but from another part of the pond and so on.

2. Try to replace a lost bird of a single pair as quickly as possible.

3. With most ducks and true geese, keep more of a single pair, eg. three pairs or three males and four females; more time is available when a single bird dies.

4. Avoid too many different species of geese or ducks in one pen, especially sub-species.

5. As far as is possible, rear young birds with their own species.

6. Acquiring young replacement birds is preferable. An adult bird suddenly available may or may not have spent its life with own kind.

7. When releasing a replacement single bird, make sure that its is done in such a way that the existing bird or birds cannot fail to meet it. They may part, but invariably not for long.

8. Try to replace a lost bird with a bird of similar age. This is not so important with geese and less so with most ducks, but care should be taken with swans. Widowed adult, female swans can be given a young male relatively safely as a mate at any time. Not so the other way around. An aggressive breeding male will often demand a lifestyle from a first year female that she is not physically equipped to deal with. Her bodyweight can fall and death will often occur. In this situation, and with no adult females available , try and avoid such an introduction until late in the younger bird's second summer. If this results in a male being on its own for too long, introduce the younger bird earlier, but establish the pair in a new area or pond.

   Similar actions can be useful with some species of geese. If a young bird is to be added to an established group, eg. five red-breasted geese or three eiders, consider adding a young pair instead. Neither of these examples are likely to breed in their first year and they will keep each other company through both the initial settling down period (during the group investigation) and the subsequent breeding season. They may stay as a pair within the flock so where possible try and ensure that they are unrelated.

9. Checking for different blood lines when acquiring birds is not easy and much has to be taken on trust. A good breeder, however, will have a vested interest in keeping the different broods identifiable.

10. Check that the birds you are acquiring will fit into your collection. Do you have the correct feed necessary for a pair of hooded mergansers? Will they be aggressive to other birds, or the opposite?

Species Compatibility

This is a very important aspect of stock selection, in particular when commencing a waterfowl collection. Having considered personal choice and all the previously mentioned criteria, some variation in species selected may be necessary in the interest of achieving harmonious and productive results. Table 4 below shows species which may not be mixed.

Table 4. Waterfowl species not to be mixed.

Keep isolated as a single pair.	Exceptions.	Specific non-mix combinations.
Swans especially coscorobas	Two pairs of black swans may be kept together, if the area is large enough, as long as they are released together. Never release a young pair into the territory of an established pair.	Even on large lakes never mix two pairs of trumpeter swans or a pair of Bewick swans with a pair of whistling swans.
Egyptian geese		
Shelducks		
Sheldgeese especially andean geese		
Crested ducks		
Steamer ducks	More than one pair of comb duck and white winged wood duck can be released together if the area is large, but do not release new birds into an existing group.	Hawaiian geese ('Nene') and cackling Canada geese
Cereopsis		
Bronze-winged duck		Avoid keeping any sub-species together
Pink-eared duck		
Hartlaub's duck		
Comb duck		
Spur-winged geese		
White-winged wood duck		
Musk duck		
New Zealand brown duck		

Further Considerations

Some of the ducks and geese do particularly well in small groups. Displaying and other behaviour patterns can be observed which may never occur with single pairs.

Stock should be selected to fit the collection area available and for ease of management. Large, less manageable ponds should be stocked with endogenous species, so that if young birds fledge and cannot be caught, there will be not contravention of the Wildlife and Countryside Act 1981 (as amended 1988 and 1991). More delicate birds should be kept in sheltered areas and not kept at all it the collection is particularly exposed to severe wintry conditions.

Diving ducks, eg. pochard and golden eye or ruddy ducks, should be kept in sufficient numbers on each large pond to try and keep an area ice-free in winter. Other birds will use these areas during the day and only the severest of weather will cause a total freeze.

Noise can be a factor. Some birds have very loud calls and this may be both a nuisance to you and to neighbours.

If stocking for a collection open to the public, consideration must be given to the education and conservation aspects of the birds kept. A mixed group of available ducks, exhibited out of context, does little for the birds, the keeper or the visitor.

Overcrowding and mixing too many different species are the commonest causes of disaster. Poor planning and husbandry are likely to lead to increased disease incidence and poor productivity.

NUTRITION

Wildfowl kept in captivity need to be fed. Some species which graze , dabble or catch fish will require less feeding, especially in the summer. In most wildfowl collections the number of birds kept is invariable too many to allow 12 month sustainable natural food production, and feeding is necessary throughout the year. Wheat is an excellent bulk food for wildfowl. Food must be well stored (maximum 16% moisture) close to the point of feeding. Several food companies now make proprietary diets for ornamental waterfowl. The range will often include:-

1. 'Maintenance pellets' with an approximate protein level of 14% for general non-breeding use.

2. 'Breeders pellets' with a protein level of 16% for the period prior to and running throughout the laying period.

3. 'Duckling or Chicken Starter Crumb' with an protein level of 20% for young birds in the first 2 - 3 weeks of life.

4. 'Grower or rearer pellets' with an protein level of 16% for adolescents and juveniles up to 4 - 6 months of age. Different diets are advisable for different ages and tribes of birds.

Anseriformes generally have an ability to grow at faster rates than poultry or game-birds, and this can be a particular problem with the grazers, eg. geese, swans, shelduck and widgeon. These species would normally only eat grass with a protein content of 16-17%. Using feeds with protein levels in excess of these can cause growth defects or kidney damage.

Fish-eating ducks and flamingos need a more specialised, slightly higher protein diet which is also manufactured specifically. It is generally more expensive than the simpler diets.

Additional food stuffs including various millets and seed can assist in the rearing process of young stifftails (Oxyurini spp.), and small insects (crickets/mealworms) for sea-ducks.

Grass is the main requirement of geese and goslings. Supplemental feeding will be required and is a beneficial (although not to excess as excessive growth rates may be detrimental), but access to grazing areas is important and this must be reflected in stocking levels.

QUARANTINE AND DISEASE CONTROL

Whether considering a new site, or additional birds to an existing collection, the same rules apply. If wild or feral birds are present, prevention of disease introduction and prevention of spread between pens is of limited value.

When starting a collection every precaution must be taken to prevent the introduction of disease, in particular infectious, chronic, debilitating disease, eg. tuberculosis. The collection may become contaminated prior to clinical signs being apparent. It is possible to set up a significant collection (1,000 + birds) of waterfowl by bringing in eggs and small ducklings that have not been exposed to disease.

However, this is not an easy option. Wherever possible, birds of the year (ie. juvenile) should be acquired, which have been reared on fresh uncontaminated pasture.
Incoming birds should be subjected to a careful clinical examination and prophylactic roundworm therapy, eg. one of :-

Mebendazole 5 - 15mg/kg daily for 2 days (Benzicare, Virbac, 50g/L)
Mebendazole in feed 120 ppm daily for 14 days (Telmin Horse wormer granules 100mg/g Boehringer Ingleheim)
Flubendazole in feed 240 ppm for 7 days (Flubenvet, Janssen - in Australia?))
ivermectin 200 µg/kg (0.02ml/kg) once (Ivomec, Merial Australia)

If possible all birds should be subjected to a blood screen. The one single test which will give the greatest information regarding a bird's state of health is the fibrinogen level (normal< 4g/1).

Where possible a full blood screen and a *Mycobacterium avium* ELISA or better still PCR should be performed. Birds with a fibrinogen level above 4g/l who are thin or appear ill in any way should not be introduced into the collection.

All incoming birds should be maintained in quarantine accommodation or small groups for at least six weeks. It is appreciated that this is not easy when dealing with small numbers of young birds (for fear of imprinting), but it is important. Maintaining a waterfowl collection is similar to maintaining a loft of fit racing pigeons. The health of the collection is paramount, rather than that of the individual. For this reason it is important that thorough post-mortem examinations are carried out on all stock which die or are euthenased. Parasitism must be minimised by regular rigorous controls. As mentioned earlier, juvenile birds should have access to clean pasture, not previously grazed by adult birds. All breeding adults should be wormed in early spring prior to the breeding season, and all birds should be wormed each autumn.

M avium in waterfowl collections

The author is not familiar with the situation in Australasia, but there seems little reason for it to be different to Europe or USA. Avian tuberculosis tends to be the single largest and most important disease of waterfowl collections. Although careful choice and sourcing of new stock is vital, it is well accepted that feral birds flying in the feed off available food (unless the exhibit or collection is netted) will inevitably introduce *M avium* sooner or later.

The biggest problem in dealing with avian tuberculosis is the fact that birds tend to be suffering from the condition for many months if not years, (whilst faecal shedding the pathogen into the environment) before they appear ill and eventually die or are caught up and euthenased. Once a site is contaminated there is little that can be done to recovery freedom from the organism and the disease.

Background

Avian tuberculosis is a common disease of captive waterfowl, especially where the same ponds and enclosures are used for stock, ear after year, allowing a gradual build up of *M avium*. The disease is enzootic in many wildfowl populations, particularly gregarious ground welling and water feeding species. The latter species may in turn act as a source of infection for other species. The bacteria live in damp and wet conditions, which inevitably is where waterfowl care to live. Those species which feed about the water land interface are particularly at risk. Species, feeding behaviour, environmental stress all have a role in the aetiology.

The causative organism is slow growing. Incidence and rate of pathogenesis vary greatly inter and intra species. Pathogenesis tends to be characteristically slow leading to an incidious, chronic, wasting disease, in which birds may faecally excrete the pathogen for many months or even 1-2 years, before they are significantly clinically ill, and eventually sucomb. The consequence is of massive environmental contamination by sub clinical cases. At post mortem lesions may be found in any part of the body, but is commonest in the liver and guts. The pathogen is cnfirmed on ZN stained slides. Birds are sensitive to serotypes 1, 2 and 3, but in the Uk at least serotype 1 is by far the commonest.

Diagnosis Ante-mortem

Acid fast positive faecal smear is indicative, but not diagnostic (subject to significant false positives and negatives)

Haematology – hypochromic, microcytic anaemia, leucocytosis (often $>18x10^3$/L), monocytosis, heterophilia and hyperfibrinogenaemia.

If suspect the condition, endoscopy of the liver may often confirm the presence of white focal lesions, which may be confirmed on biopsy.

Treatment

Is not recommended for clinically affected waterfowl.

Action to prevent *M avium* infection

Careful selection of new, young clean stock, or bring in new stock lines as eggs/hatchlings.
Quarantine of new stock, blood screen, to include *M avium* ELISA or PCR if at all possible.
Preclude feral birds from the collection, or if not netted control as best as possible
Good water quality (not down stream from any other significant waterfowl) and flow.
Control of the water-land interface, control of bank erosion
Prevent excessive vegetation development in the environment
Do not keep particularly sensitive species
Do not keep spp outside their normal geographical range / environment
Post mortem all euthenased or dead birds
Maintain individual bird identification and records of all breeding and housing
Maintain a closed flock if possible

Action to control *M avium* once present (in addition to all points listed above)

Vaccination
Do not sell or export any surplus stock
Regular screening (ELISA may be more practical in respect of catch test and euthenase if positive, than PCR in view of time to result availability)
Remove birds prior to an age at which you would expect them to suffer from tuberculosis.
Change top soil
Consider that your collection is not now put at risk by ferals, rather that infection of ferals by your collection presents a risk to wild populations

HATCHERY AND INCUBATION HYGIENE AND TECHNIQUES

The health status of young waterfowl is initiated when the egg is formed and laid. Genetic, nutritional, infectious or husbandry factors all play a part from this time onwards. Some breeders will allow birds to incubate naturally; for others, artificial incubation facilitates greater control and a potentially greater production. If eggs are to be artificially incubated a decision must be taken whether to artificially incubate throughout, in which case eggs should be collected as soon as possible after laying, whilst eggs are still minimally contaminated, or to allow the female to 'set' the clutch, ie. to incubate it herself for the first 5 - 7 days. The latter method leads to improved fertility rates, but also leads to higher rates of egg contamination, which may be a major factor when one is incubating many eggs together, as one infected egg may contaminate the whole incubator. Eggs should be collected in a clean padded receptacle. Storage should be at 70^{o}F (LaBonde, 1992) in racks or boxes with the air sac (round end) uppermost. Many breeders will fumigate (with potassium permanganate and formaldehyde), wash or dip eggs (with commercial egg sanitizing solutions). Sterilizing of eggshells using ultraviolet light (Monachon, 1973) prior to incubation is routinely used by some waterfowl breeders. Eggshells are typically more heavily contaminated than other avian species, due to the damp nest sites often chosen by waterfowl. Any grossly contaminated or cracked eggs should be discarded. Eggs should not be stored for more than 14 days. The incubator should be housed in the hatchery, which should itself be a self-contained micro-environment. The hatchery should be easily cleaned and well ventilated, and dust should be minimized; it should be maintained at a constant temperature and humidity. Hatchery hygiene should be monitored using microbiological settle plates. Blood agar and Sabouraud dextrose media plates are left open in the hatchery for 10 minutes, then incubated for 24 - 48 hours to give a bacterial and fungal colony count. This gives an assessment of hatchery hygiene. Accurate hatchery records detailing numbers of eggs per pair, dates laid, dates incubated, fertility rates,

weights during incubation, hatchability, and neonatal survivability are essential. Both naturally and artificially incubated eggs should have a hatchability of 85 - 90%, although this is often not possible due to unavoidable contamination of eggs prior to incubation. Causes of infertility are as follows :

Parental Factors

Age.
Diet (protein, fat, carbohydrate, energy content, calcium and vitamins must all be adequate).
Antibiotic usage (many antibiotics fed to birds prior to laying cause reduced chick hatch weight).
Concurrent disease.
Immature / Behavioural / Social stress / Psychological problems.
Poor parental incubation.
Clumsy incubation causing repeated egg damage.

Environmental Factors

Unsuitable nesting sites.
Dirty, contaminated or unsuitable nest material.
Beware inter or intra-species aggression which may prevent breeding.
Insufficient access to food and water.
Ecto-parasites or other disease vectors in the nest.
Unsuitable macroclimate for that species.
Unsuitable microclimate (temperature, humidity) of the nest site.
Toxic substances in the environment (pesticides, herbicides, exhaust gases etc.).
Medical, fungal or toxin contamination of the food.

Candling Eggs : eggs should be candled first at 6 - 7 days. The importance of candling is that it allows the removal of cracked, infected or non-viable eggs. Moreover it allows the early detection of failed development. Assessment of the stage of egg failure, greatly facilitates determination of the cause of the failure. All 'dead in shells', irrespective of stage of failure, should be fully investigated. Egg deaths may be predominantly divided into early (0 - 5 days from start) and late (peri-hatching) deaths. Early deaths are most likely to be caused by faulty incubation temperature, jarring, and inbreeding, whilst late deaths are likely to be caused by faulty humidity, temperature or turning. Infection of the egg before or after egg laying can lead to early or late death, or weak young.

Egg Weights : eggs should loose 12 - 13% of their start weight by pipping, with a further 2-3% by hatch. At least a sample of the eggs should be weighed down, to check that the humidity levels are correct. There may be problems when incubating eggs of different size, or shell of differing porosity in the same incubator, as each will require different humidity control.

Neonatal Care: most species are precocial, and eat readily for themselves after hatching. Food and grit should be given within 24 hours of hatching. A starter or chick crumb with a protein level of 20% should be given for the initial 2 - 3 weeks. Thereafter a grower ration with a protein level of 16% is suitable for most species up to 4 - 6 months of age. Young waterfowl, are very active. Water for bathing should be provided within 24 hours of hatch, in shallow pebble filled bowls, to prevent drowning. Hay, straw, shavings, newspaper etc. should not be used for bedding, it may tangle around feet, be eaten and cause impaction or act as a source of *Aspergillus* spp. Plastic mating or artificial grass (e.g. Astroturf), is suitable, although bacterial survival and proliferation can occur on astroturf (or similar) so regular cleansing should be used. Some young may be reluctant to eat, and suffer 'starve out', although in ducks this occurs at 7 - 14 days, rather than earlier as seen in other species. Green and yellow colours appear to be a powerful triggers to elicit feeding (Kear 1986). Reluctant eaters may be encouraged by crèche rearing, feeding greens or sprinkling hard boiled egg on compounded food. Fresh greens are particularly important for young swans and geese. Brooder temperature should be 32 - 34 oC, and decreased by 3oC weekly until 5 weeks of age. Ducklings appear to do best if provided with a temperature gradient, ie. a heat source which they can opt to be close to, or move away from. Young should never become chilled, although if heated they recover initially, they frequently suffer gastrointestinal or septicaemic

disease soon afterwards. Overcrowding, and mixing of different age groups should be avoided. If birds are to be pinioned this should be carried out at 2 - 5 days of age. At this age any suitably trained member of aviculture staff may carry out the procedure. After this time, the procedure may only be conducted by a vet, 'who is fully conversant with the whole collection and the individual bird, and believes that it is in the birds own individual benefit'. The procedure cannot be used as an alternative to good management. Once passed the 2-5 day stage, a full anaesthetic and surgical procedure is required. Young birds are ready to go outside at 3 - 5 weeks of age, depending on the weather. First year birds should be raised in clean, well drained, covered enclosures, with access to clean shallow water. Although precocial, young waterfowl feathers are not water resistant. Excessive swimming or rain will rapidly cause water logging, chilling and death.

Diseases of Neonate and Growing Waterfowl

Musculo-skeletal diseases are relatively common in developing birds. Lack of exercise and diets with excessive protein levels have been implicated in angel wing, splay leg, and splay flexor tendon (perosis). Growth rates should not be excessive, particularly in geese and swans whose natural diet (predominantly grass) is lower in protein. Table five below sumarises the main infectious diseases of waterfowl.

Table 5. Infectious and Parasitic Diseases of Waterfowl.

Aetiology	Clinical Signs	Diagnosis and therapy.	Comments.
Duck viral hepatitis. (Picornavirus)	Lethargy, convulsions, opisthotonous, death in ducklings up to 6 weeks of age. Wild birds act as vectors or fomites.	Post-mortem - liver, kidney, spleen, enlarged with petechial haemorrhage.	High mortality, vaccination of breeders in risk areas.
Goose viral hepatitis. (Parvovirus)	Fibrinous plaques under the tongue, coryza, diarrhoea and ataxia. Mortality 100% in birds under 20 days, resistant once 70 days old.	Post-mortem - serofibrinous pericarditis, ascites, hepatomegally with petechiation and necrotic foci.	Vaccination of breeding stock at 3 - 6 week intervals prior to breeding. The virus is very temperature labile (LaBlonde 1992).
Pasturella anatipest-ifer.	Lethargy, anorexia, ocular discharge, torticollis, green diarrhoea, in birds 1 - 8 weeks of age. Older birds may suffer a more chronic disease.	Clinical signs, microbiology. Fibrinous air sacculitis, hepatitis and meningitis.	Acute disease in young birds. Medicate in water or food with lincomycin, tetracyclines, amoxycillin etc..
Salmonella spp., *E. coli,* Listeriosis, *Erysipelas* spp. *Pseudomonas* spp..	Transmission from carrier birds, exacerbated in crowded conditions. Salmonellosis - may cause significant mortality. Listeriosis - may cause chronic wasting and nervous signs. *Erysipelas* spp. may cause an acute, highly fatal haemorrhagic enteritis.	Clinical or post-mortem signs, bacterial isolation. Most bacterial infections cause a acute or peracute fulminating septicaemia death.	Antibiotic sensitivity testing and medication is necessary. Good hygiene and minimising stress will reduce incidence. The use of probiotics in the first 14 days of life, reduces the incidence of bacteraemia.
Mycoplasma spp.	Infectious sinusitis, high morbidity, low mortality.	Nasal discharge, conjunctivitis, stunted growth. Difficult to culture.	Respond well to tylosin (nasal flush, im 20mg/kg tid or orally 1/2 tsp per Litre).
Aspergillus spp.	Causes brooder pneumonia in young stock. Prevalent in poorly ventilated, humid over crowded brooder accommodation.	Post-mortem - fungal lesions (see chapter 18).	Improve husbandry. prophylaxis of susceptible species.
Cyathostoma	Both worms common in swans	'Gaping', stretching or	Both parasites may cause
Coccidiosis.	Not as common as in poultry. may cause acute haemorrhagic enteritis. Standard poultry prophylactic levels may be toxic, only treat if clinical disease confirmed. Renal coccidia (*E truncata*) may cause acute illness and leg weakness or paralysis, oocysts are unlikely to be found in the faeces.	Faecal or post-mortem diagnosis.	Treat with pyrimethamine and sulphaquinoxaline, 60mg/L of water 3 days on, 2 days off, 3 days on (Microquinox, Microbiologicals), or clazuril 5 - 10mg/kg po daily 3 days, on 2 off, 3 on (Appertex, Harkers) . or toltazuril (baycox) 25mg/kg once po.

Nervous Diseases of Waterfowl

INTRODUCTION

Waterfowl, as with other avian groups, commonly suffer from nervous disease. The causes of these conditions may be broadly divided into the following groups :-

1. **Poisons**. Poisons may be exogenous, ie.from outside the body, or endogenous, ie. produced within the body (frequently arising as a consequence of infections). Exogenous agents may be divide into naturally occurring poisons and man made poisons.

2. **Nutritional / Metabolic**: comprising nutritional deficiencies and metabolic diseases. The latter give rise to abnormally high levels of metabolic by-products.

3. **Traumatic:** waterfowl, particularly larger species, such as swans and geese, are less maneuverable in flight than smaller species. Therefore they are more prone to in-flight collisions, especially with power cables. Collisions can directly give rise to nerve damage; however, they frequently result in a 'crash landing' and it is often the landing which gives rise to the majority of nervous signs of traumatic origin. Waterfowl are frequently shot, legally or otherwise. Inevitably, a number of birds will receive non-fatal injuries. Some of these cases will present with nervous signs due to nerve damage (very rarely due to non-enteric lead particles giving rise to lead intoxication).

4. **Infectious** There are a number of common infectious conditions of waterfowl which give rise to acute or chronic nervous signs.

5. **Congenital** These are extremely rare.
A thorough introduction into nervous diseases of birds has been discussed previously. Table 6 gives a breakdown of causes of nervous conditions in waterfowl.

Table 6. Nervous Diseases of Waterfowl.

Clinical signs	Cause	Diagnosis	Control and comments and prognosis
Endogenous Poisons			
Lethargy, weakness, acute central nervous signs (cns).	Bacterial Toxaemia.	Toxin tests, microbiology Histopathology.	Rare, spasmodic occurrence, rapidly fatal, unless treated early and extensively.
Exogenous Poisons			
Man-made			
Lead (see later)	See later	See later	See later
Posterior paralysis, weight loss, anorexia.	Zinc poisoning, ingestion galvanised wire, coins etc.	Blood levels. Radiography.	As for lead poisoning see later. Prognosis good if treated before condition is chronic.
Acute onset, many different possible cns signs. Ataxia, convulsions, blindness, torticollis, May occur with drift from crop spraying, or leaking into water course. Delayed onset, 1 - 3 weeks.	Acetylcholinest-erase inhibitors (eg. carbamates malathion, dichlorvos) Organophosph-ates, Fenthion	Diagnose on clinical signs and history. Blood assay is possible Acute onset, many different nervous signs. (acetylcholinesterase inhibition slowly reverses). Weakness, ataxia, paresis. (Irreversible acetylcholinesterase inhibition)	Sedate (diazepam), nursing Atropine / pralidoxime chloride. Prognosis fair, with good nursing . Medicate with atropine (0.1 mg/kg i/v or i/m every 3 - 4 hours) or pralidoxime mesylate (10 - 40 mg/kg)(Non proprietary, contact National Poisons Bureau for availablity) No specific antidote Increase fat reserves. Prognosis poor unless signs very mild.

Table 6. Nervous Diseases of Waterfowl (Continued)

Clinical signs	Cause	Diagnosis	Control and comments and prognosis
Natural			
Limber neck (bird is not able to lift or support neck properly), acute onset flaccid paralysis of voluntary muscles. Summer or autumn. Sudden death sometimes in mid swim; many birds die from drowning. Ducks may be poisoned by ingesting only 2 - 4 maggots.	**Clostridium botulinium** Usually toxin type C. In hot weather, water quality deteriorates. Fish or invertebrates die, their carcasses acting as a propogator for toxin. Maggots may act as source. Type C toxin does not affect mammals.	Clinical signs, history, toxin isolation from clotted blood.	If can still walk but not fly, good nursing will often be effective. If can swim but not walk, prognosis not so good, but may recover. Standard treatment is oral fluid therapy with activated charcoal and bismuth (Forgastrin, Arnolds). If unable to lift neck, require antitoxin. If antitoxin and fluids are used to flush toxin from gut and bloodstream, 75 - 90% of affected birds may recover (Olsen, 1994). Carcasses must be removed from water to prevent further toxin production. Define area of water affected and prevent birds from entering the water; use bird scarers etc.. Toxin is stable in the environment. Increasing water flow, (autumn floods) will remove toxin from water system.
Sudden death, blinking of eyes, hyper-salivation , repeated swallowing. Prostration.	Algal toxins Occur in hot water, when water flow slow.	Clinical signs, presence of pathogenic algae in environment,	Difficult. Increase water flow rate. Use copper sulphate, although this in itself may be toxic. Prognosis poor.
Ataxia, paralysis. Occurs more frequently in young birds.	Plant poisons, eg. Oleander.	CNS toxic plants in environment. If acute poisoning presence of plant in gastro-intestinal tract.	Exclusion of toxic plants from immediate environment of young inexperienced birds. Prognosis is dependent on plant involved and volumes ingested.
Nutritional			
Opisthotonous ('Star gazing')	Thiamine Deficiency.	Response to therapy.	Beware thiaminase containing fish fed to fish eating ducks (Kear, 1973). Treat with thiamine in drinking water (100ug/l). Prognosis good.
Ataxia, paralysis of chicks (Olsen, 1993)	Vitamin A Deficiency.	Response to therapy, blood analysis, histopathology.	Good diet. Prognosis good.
Opisthotonous, muscular dystrophy. Often die <3weeks of age.	Encephalomala-cia. Vitamin E / selenium deficiency.	Clinical signs, history, response to therapy. Histopathology.	Good diet, no excessive storage period. Prognosis good if treated prior to permanent damage.

Table 6. Nervous Diseases of Waterfowl (Continued)

Clinical signs	Cause	Diagnosis	Control and comments and prognosis
Metabolic			
Hepatic encephalopathy	Many pet ducks become excessively fat. Fatty liver degeneration. Many different causes (infection, toxin, obesity etc).	Biochemistry, liver biopsy. CNS signs, worse shortly after eating (more pronounced in birds fed majority of daily food at one time rather than grazers). Post mortem.	Prevent obesity and exposure to hepatic pathogens or toxins.
Ataxia, fits.	Renal failure.	Biochemistry. Post-mortem.	Not common. Prognosis hopeless.
Trauma			
Capture myopathy	Vitamin E / selenium deficiency or cellular trauma.	Signs, history, biochemistry, histopathology.	Minimise stress in catching, reduce time restrained. If severe prognosis grave, if mild good.
Any brain, spinal, peripheral nerve deficits.	Shooting / trauma. Wire strikes or impact injuries.	Clinical signs, radiology, neurological examinations.	Reduction of over-head wires, applying markers on wires. Steroid, manitol, sedation, require good nursing, recovery may take up to six
Infectious			
Photophobia, ataxia, lethargy inco-ordination, tremors, haemorrhage, diarrhoea, nasal discharge. Sudden death. (see below)	Duck viral enteritis (Herpesvirus).	Occurs April-June. Post-mortem. Haemorrhage from damaged blood vessels. Bloody enteritis. Necrotic/haemorrhagic ring at oesophageal - proventricular sphincter. Virus isolation.	Vaccination immediately prior to risk period. May - June (Occasionally see August-October). Prognosis hopless, usually find birds dead. Vaccinate at risk species prior to risk season. As wit all herpes virus infections, surviving birds are likely to be carriers which will infect other populations in subsequent years.
<6w of age. Spasmodic contractions of legs, opisthotonous rapid death.	Duck virus hepatitis (Picornavirus).	Diffuse haemorrhage, Virus isolation.	Isolation of affected birds. Vaccination of breeding females. Prognosis for affected birds hopeless.
Tremors <1-2 weeks of age.	Avian enceph- omyelitis (Picornavirus).	Virus isolation.	No treatment. Prognosis hopeless except in very mild cases. Vaccinate.

Table 6. Nervous Diseases of Waterfowl (Continued)

Clinical signs	Cause	Diagnosis	Control and comments and prognosis
Infectious (continued)			
Ataxia, diarrhoea, coryza. Goslings <30d of age (Sandhu 1986).	Goose virus hepatitis. (Parvovirus).	Serofibrinous pericarditis, hepatitis, ascites. Virus isolation.	Vaccination of breeding birds.
CNS, respiratory, Gastro-intestinal tract signs, conjunctivitis.	Newcastle disease. (Paramyxovirus).	Not common, history, clinical signs, , virus isolation, serology.	Vaccinate.
Inco-ordination, collapse. Meningitis, septicaemia, enteritis.	Salmonella spp..	Caseous caecal plugs, focal liver necrosis, enteritis. Nervous signs not common.	Good hygiene , vaccination.
Ataxia, weight loss (see Chapter 19 and 39).	M. avium.	Granulomata can form in any site in the body. Commonly cause hindlimb lameness/ CNS signs (rare).	Hygiene, screening and eradication, vaccination.
Paralysis, convulsions, dyspnoea.	Pasturella spp..	Severity of outbreak and antibiotic sensitivity varies	Vaccination, sensitivity testing and antibiosis.
Congenital Lesions			
Torticollis, or any signs of inco-ordination.	Developmental abnormalities of cervical vertebrae.	Clinical appearance and radiography.	Birds with mild clinical signs often cope well, despite major bony abnormalities. If severe may require euthanasia.
Progressive hind leg ataxia.	Hereditary disease of Hawaiian geese. Arises due to cerebral lipidosis.	Clinical examination, breed line history, no gross lesions at post-mortem confirmed on histopathology.	Individual bird identification and careful breed line records should be kept for Hawaiian geese.

Duck Viral Enteritis (further background information)

Duck viral enteritis is a herpes viral disease, otherwise known (in USA and some other countries) as Duck Plague. The disease is seasonal (occurring almost exclusively in April and May in the UK), and certain species or groups (shelldducks, sheldgeese, most dabbling ducks, particularly the mallard types and subspecies, also the perching ducks (including mandarin, carolina, muscovy and white winged wood duck) are particularly susceptible. In a clinical situation it is often Muscovy ducks which are first reported to the vet as having died suddenly.

Any birds surviving an outbreak will remain as carriers acting as a source of infection for outbreaks in subsequent seasons. It is possible that some species are sub clinically infected, and subsequently act particularly well as natural carriers. Clinical disease is seasonal occurring in April - June, with an occasional minor outbreak in the autumn. Disease is characterised by acute death, photophobia, ataxia, lethargy inco-ordination, tremors, haemorrhage, diarrhoea, nasal discharge. Post-mortem signs include haemorrhage from damaged blood vessels, (haemorrhagic enteritis frequently with blood staining around the vent), often with a necrotic or haemorrhagic ring at oesophageal - proventricular sphincter.
This disease is an international recognised disease, with a marked affect on game bird production Gough et al 1987, hobby keepers, wildfowl sanctuaries and the wild bird migratory population. To date disease outbreaks have been restricted mainly to zoos, municipal parks, private waterfowl collections, swan and wildfowl sanctuaries as well as large game rearing farms. In the outbreak

affecting the rearing site in East Anglia, the majority of 100,000 ducks and 20,000 geese were affected. Several such game bird rearing companies have become insolvent following disease outbreaks in unvaccinated stock.

The disease first entered the USA in 1967, and the UK in 1972. Despite extensive efforts in the USA, as a consequence of carrier birds they have been unable to eradicate it. Both in the US and UK, the disease incidence has risen steadily ever since first occurring. In the US massive epidemics have occurred in wild migratory birds, causing the death of many thousands of birds (Brand). The vaccination of collections of wildfowl will assist in reducing the chances of major outbreaks in wild birds. DVE has been identified on 87 occasions since 1992 in the UK, although in many additional occasions virus identification has not been attempted as the clinical signs have been pathognomonic, or due to financial constraints. Evidence stated by CVL indicates that the increase in incidence seen over the last few years will be maintained. In part this has occurred due to the drastic increase in the number of hobby keepers. In the past if there was 50 miles between each hobby non migratory keeper, then disease was not readily spread on from one infected site to others. However now that we have small ponds with duck collections in very close proximity, disease spread (by wild or migratory wildfowl) is rapid and uncontrollable.

Vaccine is available in some countries. All susceptible spp should be vaccinated prior to the seasonal risk period. Vaccine may also be used in the face of an outbreak.

Lead poisoning Lead poisoning remains one of the largest most significant causes of nervous disease in waterfowl. It is estimated that as many as 4,000 swans are affected annually in the UK (Goode, 1981). Lead is ingested whilst feeding (waterfowl normally ingest particulate gravel to aid ventriculus action). Lead pellets may be buried in mud, where fishing or shooting has occurred previously. Waterfowl may ingest small numbers of lead shot intermittently or, in circumstances of reduced water levels, lead previously unavailable may suddenly be ingested in large amounts by large groups of birds, leading to acute outbreaks of severe lead intoxication.

International pressure is growing to ban the use of lead shotgun shot. However, even if this occurs, environmental contamination will lead to continued incidence for many years. Since 1987 the sale and use of lead ledger and split shot under 28gm in weight by fisherman has been banned in the UK. Since this time the incidence of poisonings has reduced markedly (Owen, 1992). Swans with CNS signs should be considered as a possible lead poisoning cases.

Diagnosis The characteristic clinical signs are weight loss, weakness, limb weakness, limber neck (see plate 1), bright green faeces. Whole body radiography may be of value in recent cases.

However, the grinding action of the ventriculus renders particulate lead into an undiagnostic state in a matter of 1 - 2 weeks. Chronic cases frequently show dilatation and impaction of the proventriculus, therefore diagnosis may be presumed in the absence of lead particles. Blood lead levels may be assayed (normal <0.4ppm, diagnostic 0.5-2.0ppm, severe >2.0ppm). Haematology may show moderate anaemia (20 - 38% haematocrit) (Degernes et al, 1989).

Treatment If particulate lead is present in the ventriculus, it should be removed by gastric lavage (Degernes, 1989). Birds are fasted for 8 - 12 hours, anaesthetised and suspended by their back legs, inclined (head down) at an angle of 45o. A stomach tube (.5cm diameter)is passed and held in place in the ventriculus. The ventriculus is irrigated with warm water using a stomach pump. Gravity and water pressure will remove most of the lead. Radiology will indicate if it is all removed. If lead is still present, birds should be allowed to recover and the process repeated the next day. Fragments of lead are usually trapped in crevices in the koilin. Once consciousness is regained and the muscular activity of the ventriculus has returned, the particles will precipitate and be able to be removed the next day when the process is repeated (Forbes, 1993).

All affected birds should receive chelation therapy. Sodium Calciumedetate (Sodium Calcium Edetate, Animal Care) is effective at 10 - 40mg/kg bid for 3 - 6 weeks. Birds should be monitored closely during therapy, by recording weight, behaviour, nervous signs, haematology and lead levels. Rebound toxicosis is not uncommon weeks after cessation of therapy. If therapy is stopped too

early, even if blood lead levels have returned to normal, lead toxicosis can occur again as lead returns to the circulation from bone and soft tissues.

Respiratory Diseases of Waterfowl.

Avian respiratory disease has already been discussed in a separate paper (avian respiratory disease), this section describes only waterfowl respiratory disease as it varies from commoner avian respiratory disease. Table 7 gives an overview, together with additional details on diseases specific to waterfowl.

Table 7. Overview of Respiratory Diseases of Waterfowl.

Agent	Signs	Treatment & control
Aspergillosis	Weight loss, respiratory signs in terminal state. Ducks have anatomical variations in the syrinx which should not be misinterpreted as pathological lesions. Swans and geese do not have a syringeal bulla, although	Minimise exposure, prophylactic therapy of at risk species. Penguins particularly susceptible. Diving and sea ducks most susceptible of waterfowl. Infection most commonly occurs by feeding mouldy corn or straw. Always commonest in stressed birds, eg. post oiling etc. In such cases prophylactic therapy may be advised with itraconazole at 5-10mg/kg sid or bid. Eggs can be infected prior to or during incubation. Retrieval of eggs from ground level nests helps to reduce incidence.
Pasturella multocida. Strains of varying pathogenicity (Humphreys, 1973)	Most species susceptible. Epidemics in captive and wild collections. Diagnosis by signs, history, microbiology. Carrier status -> infection. Peracute death, dyspnoea,	Isolate cases, antibiosis, dispose of carcasses, vaccination.
Avipox	Typical (wart like) pox lesions on feet; rarely in pharynx or eyes. Respiratory signs if in pharynx. Mild cases common, rarely serious.	Self healing. General support and nursing care. Control insect vectors. Fowl or pigeon pox vaccine may be effective, however not tested and rarely warranted. May be more prevalent in Vit A deficient birds.
Orthomyxo-virus	Fowl plague. Captive wildfowl rarely affected. No record of disease in wild. Sinusitis, mucopurulent /	Improve hygiene, reduce stock levels, nursing care.

Table 7. Overview of Respiratory Diseases of Waterfowl

Agent	Signs	Treatment & control
Chlamydiosis	Conjunctivitis, sinusitis, rhinitis, air sacculitis, diarrhoea, weakness.	Waterfowl are common carriers of this disease which is a serious pathogen and zoonosis. Treatment by use of chlortetracycline (1000ppm ie. 18.2g/kg food daily for 45 days) (Aureomycin Soluble Powder. Cyanamid) or doxycycline (8-25mg/kg bid p/o or 240ppm in food daily for 45 days) or(i/m 75mg/kg weekly on six occasions (Sterijet, Pfizer), or enrofloxacin (500 ppm in food). Azithromycin at 40mg/kg po sid for 10-14 days may also be efficacious. Despite medication no test is available to check that the bird is no longer a carrier. Where collections are open to the public, with children feeding waterfowl by hand etc. this condition should be considered a significant zoonotic risk. In modern days of public health and safety full consideration of these issue of potential exposure of the public to zoonotic infections should be made.
Newcastle disease (Paramyxo-virus)	Rare in waterfowl. Respiratory, conjunctivitis, Gastro-intestinal or central-nervous signs.	Vaccination, isolation and nursing of affected birds.
Sinusitis (bacterial / mycoplasma)	Common in species being maintained in an unnatural conditions, unilateral or bilateral infra-orbital swelling	Nasal flushing or local infusion of the affected sinuses. If inspissated material is present, then surgical debridement may be required.
Leeches (*Theromyzon tessulatum*).	Young birds most commonly affected. Causes head shaking, rhinitis, conjunctivitis. Impaired inspiration and sometimes vision. Debilitation occasionally deaths.	Treat with ivomectin (200mcg/kg, ie. 0.2ml/10kg) (Ivomec, Merial). Restrict access to water with significant leech infestation. Release of less susceptible prophylactically treated less susceptible spp into the environment will help to reduce the leech levels.
Air sac mites (*Cytodites nudus*)	Cough, dyspnoea.	Seen in trachea and bronchi, rarely cause significant disease Treat with ivermectin (200mcg/kg), repeat 3 times at 10 day intervals (Ivomec,Merial).
Gape worms (*Cyathostoma bronchialis* and *Syngamus* spp.).	Carrier adults, direct life cycle. Clinically affects goslings. Coughing, depression, sanguinous tracheal mucous.	Treat breeding adults in early spring prior to breeding season: all birds in autumn. Treat with any of the following :- 1. Mebendazole 5 - 15mg/kg daily for 2 days or 120ppm for 14 days (Mebenvet, Janssen), 2. Levamisole (25 - 50mg/kg p/o), 3. Ivermectin (200mcg/kg) (Ivomec, Merial) 4. Flubendazole in food for 7 days at 240ppm ie. 2.4kg/tonne.

Many clinicians have constant problems advising and dealing with rehabilitation organisations, the notes below are designed as a frame work for such situations.

Guide-lines for the Rescue, Assessment and Treatment of Injured and Diseased Swans by Rescue Groups

Introduction:- the aim of these notes is to raise the standards, and unify the level of treatment and care given to swans.
Efficient, accurate and complete record keeping.
Hygiene.
Adequate quality and quantity of food supplies.
Success in treatments.
Condition and size of accommodation.
Condition of in patients.

Answering of Calls from the Police/Public & Others.

Each group should endeavour as best as possible to provide a 24 hour telephone system. This may be accomplished by leaving an answer machine in place, (when away attending a bird, or indisposed), suggesting a method of reaching them or another source of assistance in the event of an emergency.

Swans should be rescued at the earliest convenience, ensuring the minimum of stress to the individual, as well as to other swans and wildlife. Every precaution should be taken to avoid damage to any private property, fences etc.. Permission should always be sought where necessary to enter private property, and the latter should be treated with the utmost respect. In the event of finding difficulty in obtaining permission, then assistance should be sought from the police. Persons who report damaged or ill swans should be treated with courtesy even if they are the perpetrators of the injury. (If the latter are excessively castigated, the next time they may not bother to report the incidence, in this situation it is the swans who will suffer).

A rescue group should act as an emergency rescue and short term treatment centre. Any birds requiring long-term treatment or requiring sheltered husbandry, should be passed on to other workers in the field. Any group should have a maximum stock level. In the event of an emergency the numbers may increase above these, but for no longer than 48 hours. This limit is set to prevent over crowding, but also allows time to arrange for birds to be moved on if necessary.

Swans should be transported in a jacket or other restraint in order to reduce the possibility of self trauma.

Treatment of specific injuries:-

1. **Suspected lead poisoning**. Swans effected by this poison will be easy to catch, suffering from a weakness or flaccid paralysis of legs and wings. Any such affected swan must be radiographed for the presence of large pieces of lead still present in the gut. Any lead residual in the proventriculus should be removed by a veterinary surgeon, under anaesthesia, by flushing of the proventriculus. The absence of lead does not negate lead poisoning, and blood testing or response to chelating therapy should be used to investigate. Many cases of chronic lead poisoning will have no residual lead, but will instead have high residues in liver, bone and other organs. Such birds will require anti-chelating therapy for several weeks. This is best accomplished using oral therapy (such as D Penecillamine), which may be given to a swan wrapped in bread, from a distance, thereby removing the necessity of keeping the swan in close confinement for longer than necessary.

2. **Fishing lines**.

    a. Lines tangled around limbs/neck. These should be immediately removed, the distal limb should be checked for blood supply. If the distal limb is cold, then the swan

must be restrained until such time as the limb becomes warm (this should take no longer than 10 minutes) or failing this taken to a veterinary surgeon. The limb should be checked for breakages in the skin or of infection. If either of the latter are present, veterinary treatment should be sought and antibiosis instigated.

b. Hooks in the skin and superficial appendages, these should be removed with the minimum of further trauma, this usually accomplished by cutting the bend of the hook, and advancing the point of the hook forwards and out of the skin rather than attempting to pull it back, or cut it out.

c. Hooks in the mouth and throat, if a hook can be seen in the mouth, then if not deeply embedded may be removed by the rescuer.

d. Swan with line trailing from the mouth, with experience the use of a disgauging tube may be used. If however the hook is firmly embedded then the bird should be presented to a veterinary surgeon. The latter will use a sedative or tranquilliser injection (such as ketamine 5-10mg/kg intra venously) in order to minimise further stress to the bird.

Radiographs will almost invariably need to be taken in order to ascertain the position of the hook. If the hook is present in the gizzard, then the line may be cut short and the hook left to be ground up. If the hook is attached to the lining of the oesophagus, then it should be removed, with the minimum of further trauma to the bird, this may well require surgery.

e. Cuts and abrasions, any birds with cuts more than 1cm in length should be presented to a veterinary surgeon for treatment.

f. Weak Birds, if birds are simply weak and exhausted, they should be fed on highly nutritious foods. They should receive therapy for round and tape worms on arrival, and they must be weighed. Any birds which are seriously ill, or who fail to gain weight within 48 hours should be referred to a vet.

g. Traumatic Injuries, any bird with severe traumatic injuries, from severe bruising, marked lameness to broken bones it must be examined by a vet. It is recognised that simple plaster of paris casts will rarely be sufficient treatment for fractures. In particular with leg injuries, restoration of the limb to rapid and normal structure is paramount, and maintenance on water, rather than on land is preferable. All such treatments must be carried out by a vet, who must then monitor the subsequent progress.

h. Oiled Birds, oiled birds must be initially treated for shock, and they must be prevented from ingesting further oil from their feathers. Once stabilised, (or immediately if they are in a fit state), they should be thoroughly washed with a suitable degreasing agent. Attention should be made to minimising further damage to the plumage. Re-water proofing of the feathers may be of assistance, and a period of recuperation in wardened areas will be necessary in case of water logging, metabolic disorders and other complications..

i. Orphaned cygnets, cygnets which are orphaned or separated from their parents for one reason or another will require special consideration. Ever effort must be made in order to locate their parents, and a reunion attempted. True orphans must be raised with an absolute minimum of human contact. If this can be done without the birds ever seeing humans so much the better. Particular attention must be paid to providing a suitably nutritious diet in order to facilitate proper skeletal development.

j. Parasitic Infestations, it is now recognised that swans in the Cirencester, Fairford & Ashton Keynes areas are frequently infested with tape, as well as round worms. In

view of this all swans which are handled should receive treatment for both. Ivomec (injection) should be used for the control of round worm, given orally or by injection, at a dose rate of 0.1ml per 5kg body weight. Droncit injection or tablets should be used for the treatment of tapeworm, at a doseage of 1ml or 1 tablet per 8kg bodyweight.

k. Gun shot wounds any swan which mis suspected of having been shot, must be presented to a veterinary surgeon for examination and radiology. In the event of confirmation the police and the RSPCA must be informed.

l. Dead Birds if swans are found dead, whether in the course of treatment or unexplained deaths in wild birds these must be referred to a veterinary surgeon, or to Martin Brown for autopsy.

Accomodation, the accomodation provided for the care and rehabilitation of birds must be of suitable size, hygiene, and water quality

Veterinary Care, this will be provided by what by what so ever veterinary surgeon as the rescue group in question should choose. When swans are examined it is generally recognised that unless the procedures involved are very superficial and minimal, that the use of a sedative is advisable, in order to minimise additional stress.

Record Keeping

It is an essential requirement of both groups to keep accurate and complete records of all swans treated.

For each swan the following points must be recorded and monitored.:

Source of bird, date and time of day.
Any relevant history as to reason or cause of rescue.
Weight on arrival.
Assessment of initial condition.
Complete list of treatment given, whether by vet or self.
Progress report, including weighing at least every second day if under weight.
Conclusion of case, including post mortem report, or release success as appropriate.
If released, at what site.
Ring number of bird on release.
Details of post release success.

Ringing

All swans must be rung with a 'darvid' ring on release, such that a record can be made as to the success or failure of treatments. Such rings must be applied by an authorised person.

Release of Swans, it should be remembered that a wild bird will need to be 100% fit, prior to release, in order for it to have a good chance of survival. Swans should be released into safe areas of water. The latter should preferably be remote, with minimal human interference, preferably without fishing at the site. The water quality must be good, and in the winter months, the site should be near moving water, to avoid the risk of freezing in. The possibility of over-stocking a release site must be considered, in particular if some of the released birds become resident rather than moving on.

Advice to would-be waterfowl keepers – the following points should be considered:

1. Water quality is the first and most important pre requisite. Water should be sustainable through out all seasons, and should not be subject to risk of pollution.

2. All new birds purchased should be from as good a source as possible. Many dealers keep birds in an overstocked situation resulting in high levels of contamination, in particular with *M. avium* (Tuberculosis). Very many established waterfowl collections have a heavy endemic infection with *M avium*. This organism is certainly the biggest scourge of all waterfowl collections and one should make ever attempt to keep it out.

   We have learnt that wild mallard is a large source of infection, hence these should be discouraged.

3. It goes with out saying that all new incoming birds must be held in quarantine for at least 2 weeks.

4. Duck Viral Enteritis, certain species, namely mallard and all related groups, canada (and some other) geese, and swans are all very susceptible to this fatal disease. All these birds should be vaccinated, we are currently using anserivac, which is produced at Weybridge (contact Dick Gough) on a named trial site basis. Intervet do also sometimes have a vaccine available. The disease usually hits in mid april, and all vaccinating should be done by then. As with many of these viral disease this is a moveable feast and as each year passes we expect further strains to develop which may affect other species.

5. Parasitology, this is a major and important topic.
   Initially you need to treat all incoming birds for tape and round worms. Use droncit 1 tablet or 1ml/8kg bird. Ivomec diluted 1:9 with water (fresh) injected or orally at a rate of 1ml/ 5kg (for round worm & ectoparasites). Ivomec is far more effective than benzimidazoles, however they may well have there place in long-term worm programmes. Long-term you will need to find out if you locally have a tapeworm problem. If yes then you will need to droncit 2x year. If not too bad but some then benzimidazoles (ie mebenvet in food for 2w) may be possible. Alternatively we may find the new MSD round, tape, fluke injection may be safe & useful.

   Our programme is that we try & catch all birds 2x yearly and use ivomec, then on two other occasions we use mebenvet in food, primarily for it's tapeworm activity (which is not brilliant but better than nothing).

   I hope the above is of some use to you, if there are any further points do not hesitate to contact me. When I started on waterfowl I found the international zoo year book of value. I will try and remember to note the relevant year which is of greatest value.

   As far as wild bird casualties are concerned, this is another whole can of worms. If it includes raptors, then might I suggest he attends a course which I am running at Kent University in July, (details enclosed). This course will describe the essentials of shock & first aid treatment, what ever the species. Other than that all wild injured/rescue birds should be wormed (or faecal exam) on entry as many carry a burden which becomes a clinical problem when injured and stressed.

REFERENCES

Brand CJ. In: Field Guide to Wildlife Diseases Vol 1. General Field Procedures and Diseases of Migratory Birds. Milton Friend (ed). US Dept Int Fish & Wildlife Services. Resource Publication 167. Washinton pp 117 - 129.

Coles, B. H. (1985). Aviary Medicine and Surgery 2nd Edit. Boston, Blackwell Scientific.

Degerenes L.A., Frank R.K., Freeman M.L. & Redig P.T. (1989) Lead Poisoning in Trumpeter Swans. 144-55 Proceedings Association of Avian Veterinarians. E. Northport.

Forbes, N.A. (1993). Treatment of lead poisoning in swans. In Practice 15 (2), 90.

Goode, D.A. (1981). Lead poisoning in swans. In: Report of the Nature Conservancy Council Working Group. London.

Gough RE, Borland ED, Keymer IF, Stuart JC. (1987). An Out Break of duck viral enteritis in commercial ducks and geese in East Anglia. Vet Rec 121, 85.

Hayes, M. B. (1984). Rehabilitation Guidebook for Birds and Mammals. Brukner Nature Centre. Ohio.

Humphreys, P.N. (1973). Some veterinary aspects of mainatining waterfowl in captivity. International Zoo Year Book. 13, 87.

Johnsgard, P. A. (1978). Ducks, geese and swans of the World. University of Nebraska Press. XVII.

Kear, J (1973). Fish for captive waterfowl. International Zoo Year Book 13, 94.

Kear, J. (1986). Ducks, geese, swans, and screamers : Feeding and nutrition. In : Zoo and Wild Animal Medicine Edit. 2. M. E. Fowler (ed). Saunders. Philadelphia.

Labonde J. (1992). The medical and surgical management of domestic waterfowl collections. In : Proceedings Association of Avian Veterinarians Annual Conference. New Orleans.

Monachon, G. (1973). Sterilising goose egg-shells with ultra-violet light. In : International Zoo Yearbook. Ed. N. Duplaix-Hall. Zoological Society of London. London.

Olsen, J.H. (1994). Anseriformes. In: Avian Medicine Principles and Application. B.W.

Ritchie, G.J.Harrison and L.R. Harrison (eds) Wingers, Florida.

Owen, M. (1992). Progress on lead-free shot in the UK. 1991. Wildfowl 43, 223. Wildfowl and Wetlands Trust. Slimbridge.

Sandhu, T. (1986). Ducks, geese, swans and screamers: infectious diseases. In : Zoo and Wild Animal Medicine. 2nd Edn. M.E.Fowler (ed). W.B.Saunders, Philadelphia.

Todd, F. S. (1979). Waterfowl: Ducks, Geese and Swans of the World. Seaworld Press. San Diego.