V. WATERFOWL*

A. INTRODUCTION

1. Propagation and Uses

The word "waterfowl" refers collectively to the 145 species of ducks, geese, and swans which make up the family Anatidae. This family is subdivided into seven tribes which represent a wide spectrum of sizes, habitats, requirements, and behavior patterns. It follows that conditions which may be suitable for one species in captivity may not be suitable for another.

Waterfowl propagation is a practice dating back to antiquity. The Mallard (*Anas platyrhynchos*) was probably brought into captivity and used as a food source during the time of the Roman Empire and subsequently domesticated during the Middle Ages.

Modern day waterfowl propagation is practised for several reasons: game farm-raised ducks are released prior to hunting season to improve hunting success; captive-reared wild birds are released in order to augment local populations; zoos and private hobbyists find an esthetic value in keeping collections of waterfowl; and scientists, partially motivated by the alarming decline in waterfowl numbers during the 1930s, began to study wild waterfowl in captivity during the 1940s. As a result, captive waterfowl are used in scientific research involving ethology, embryology, parasitology, physiology, and nutrition.

2. The Mallards

One waterfowl tribe, the Anatini (dabbling duck) comprises the majority of ducks held in captivity. The ubiquitous Mallard, from which so many domestic strains have been developed, belongs to this tribe. This chapter focuses primarily on the requirements of captive dabbling ducks and, in particular, the wild Mallard. Where relevant, information will be provided on the more specialized requirements of the Aythini or bay ducks, as well as the Anserini, the goose and swan tribe.

Waterfowl should conform in general conformation, plumage, and coloration as well as in general behavioral characteristics, to the standards of the species (Todd, 1979). The wild Mallard should be bright eyed and have a sleek, well-groomed plumage which should appear clean, remaining dry at all times. When in the water it should sit erect and buoyantly, with its wings drawn tightly against its flanks.

The Mallard's rectal temperature is 39.5^{o}C + 0.5; its respiration rate ranges from 8.2 to 12.6, averaging 10.8 per minute; its heart rate is 185 per minute with a range of 175-194. Hematological data for these ducks are given in Appendix A.

B. PROCUREMENT

1. Sources

The sources from which wildfowl are procured for research will depend upon the requirements and the objectives of the investigations being undertaken. In addition to establishing a more or less permanent facility and flock for their propagation and supply (see under Breeding), two main options for the acquisition of waterfowl are open to the investigator:

a. Breeders

There are several thousand established breeders in the United States (U.S.) and Canada from whom waterfowl can be obtained. Many breeders advertise in trade magazines such as the Game Bird Breeders Gazettes** and Modern Game Breeding***. Lists of regional breeders are also usually available from provincial wildlife agencies. Acquisition from a more or less local and reputable breeder is, in most instances, the preferred method of obtaining wildfowl for research purposes.

b. Legal Considerations of Capture

Methods for capturing wild waterfowl are numerous (Hunt and Dahlka, 1953; Weller, 1957; Rogers, 1964; Krapu, 1976; Szymczak and Corey, 1976; Higgins, Kirsch, Duebbert *et al.* 1977; Mechlin and Shaiffer, 1979), reflecting the diversity of waterfowl and their lifecycles.

In North America, all wild species of waterfowl are classified as migratory birds and come under the jurisdiction of the Migratory Birds Convention Act. Federal authority is required by anyone wishing to hold any wild waterfowl or their eggs in captivity. In Canada, a special scientific permit to take migratory birds must be obtained from the Canadian Wildlife Service (CWS).

The shipment of birds between Canada and the U.S. requires special permits. In the U.S., these permits are issued by the U.S. Department of Agriculture, Animal Health Division, and in Canada by the Health of Animals Directorate, Agriculture Canada. In addition, the exporter requires an export permit. Finally, arrangements must be made for federal veterinarians to check the birds before they leave the country of origin and again before they are released from customs in the receiving country.

2. Transportation

The transportation of waterfowl should be completed within a 48 hour timeframe. Food and water need not be supplied to healthy birds for that period.

Air express is the preferred method for long distance shipping. Over short distances, it is best to transport the birds personally, if possible, to minimize handling and delays.

It is important that the birds receive adequate ventilation and be protected from extremes of heat or cold whilst in transit.

Cardboard poultry cartons are adequate containers for shipping most species of waterfowl. Egg shipping cartons are available commercially and are suitable for most wildfowl egg shipments. Both are obtainable from poultry supply dealers.

On arrival, birds should immediately be uncrated, examined to ensure that they have suffered no damage from transportation, and placed in quarantine (see under Health Care).

3. **Marking**

Identification of individuals is accomplished by affixing metal or plastic numbered bands to their legs. Ducklings whose legs and feet are too small to receive leg bands can be web-tagged or wing-tagged with special markers. Bands and tags for marking captive waterfowl are commercially available. Plastic nasal paddles can also be used on ducks (Sugden and Poston, 1968) and neck collars on geese and swans (Sherwood, 1966).

C. **HOUSING**

1. **Caging and Environment**

The housing requirements of waterfowl depend mainly on the species being held. Dabbling ducks are among the easiest to keep in captivity and can be housed in a variety of ways. Mallards (Foster, 1976), Black Ducks (Wooley and Owen, 1977), and Blue-winged Teal (Owen, 1970) have been held for prolonged periods (greater than two months) in poultry battery cages or similar types of wire cages. The minimal space requirement for holding a wild Mallard in a single pen, even for a short period, would be 0.33 m^2 (1 $ft.^2$) floor area with a 35 cm (14 in.) height; for small groups in loose housing, 0.66 m^2 (2 $ft.^2$) floor space per animal should be provided.

While it is feasible to hold dabbling ducks in small cages for experimental purposes, large pens provided with wire loafing platforms and enough water for swimming and preening will be more suitable for housing waterfowl over long periods. In fact, diving duck species can only be properly held in pens in which abundant swimming water is provided.

Pens should be designed so that they are predator-proof and easily maintained. Predators can be excluded from outdoor pens by covering the tops and sides with 2.5 cm (1 in.) bar wire. A sloping concrete floor equipped with a floor drain and set over a gravel base will facilitate the maintenance of sanitary conditions. The floor should be designed so that a water depth of 20-30 cm (12-18 in.) can be maintained.

If the birds are to be held over winter, and if prolonged below-freezing temperatures are "the norm" in the area, an indoor facility must be provided so that the water can be kept free of ice. Most species of North American

waterfowl will readily adapt to below-freezing temperatures as long as they have access to open water. The temperature of the winter facility should be kept just high enough to prevent condensation from forming on the walls about 5°C (41°F) if the air is circulated. A powerful exhaust fan will prove helpful. Temperatures ranging from 5°-30°C (41°-86°F) throughout the year are generally tolerated, as is a relative humidity ranging from 45-80%.

Since waterfowl are photosensitive with regards to reproduction and molt, it is highly desirable to have as a feature of the winter facility, as many windows as possible with a southern exposure.

There are a number of rules of thumb which, if followed, will maximize the quality of a captive flock:

a. The carrying capacity of a duck pen is about one Mallard-sized wild duck per 0.65 sq. m (7 sq. ft.); one domestic Mallard per 0.37 sq. m (4 sq. ft.). Waterfowl become stressed when overcrowded; stress manifests itself in feather picking, poorly groomed plumage, loss of appetit, and abnormal posture.

b. A constant flow of water through the duck pen will prevent the swimming tank from becoming excessively dirty.

c. Waterfowl should be broken up into small breeding groups or breeding pairs as early in the spring as possible. If you have Mallards and do not intend to allow them to breed, provision should be made for separating males from females in the early spring. This measure helps to curtail the aggression which is prevalent in wild waterfowl during the breeding season.

D. NUTRITION

1. Diets

Most waterfowl are omnivorous in their feeding habits. Animal foods, mainly invertebrates, make up the bulk of the diets of nesting females and growing ducklings which require high protein levels to meet the demands of egg production and tissue synthesis respectively. During the late summer, fall, and winter, babbling ducks tend to concentrate on plant foods.

Because of the wide variety in food selection and seasonal dietary shifts, there exists a plethora of recommended diets for captive waterfowl. The key to any successful feeding regime lies in attaining the correct levels of dietary protein and carbohydrates. A combination of wheat and commercial turkey starter containing 25% protein is a satisfactory diet for captive waterfowl (Ward and Batt, 1973). The addition of a powdered vitamin mix to the wheat-turkey starter combination results in a diet which adequately meets the nutritional requirements of most waterfowl species. The antibiotic, furazolidone, is also often added to the turkey starter by the manufacturer at the rate of 0.9 kg (2 lb.) per ton. This diet is probably a little richer than necessary for certain times of the year, but has been used and found adequate for a wide variety of waterfowl for many years in situations where

the primary concern was to keep good, healthy birds for investigational purposes other than nutritional research.

Two rations, a starter diet and a holding diet, are sufficient for all routine feeding purposes in captive waterfowl.

2. **Starter Ration**

Starter ration is fed to ducklings until they reach 28 days old. Initially, the starter ration will consist solely of turkey starter; after 21 days, wheat is gradually added until it constitutes 50% of the mixture by day 28.

Major exceptions are species of the Mergini tribe and Ruddy Ducks which require very high dietary protein levels throughout the period of juvenile growth. In these species, turkey starter should continue as the sole diet until their juvenile plumage is fully developed.

Basic starter diets can be supplemented with green foods. Duckweed (*Lemna minor*) is an ideal green food for use by ducklings of all species. A vitamin mix is added to the wheat-turkey starter combination after day 21. At the same time, fine granite grit should be offered, ad libitum, in shallow pans.

Failure to maintain proper levels of nutrition as contained in the starter diet, may result in improper development.

3. **The Holding Ration**

The holding ration consists of a 50-50 mixture of wheat and turkey starter with a vitamin mix added and fine granite grit offered *ad libitum*. This should be the standard diet used for feeding all captive waterfowl after 28 days of age, with major exceptions as noted above. Oyster shell should be added during the breeding season to supply calcium necessary for eggshell production.

4. **Feeding**

Feeding the birds is a simple task requiring relatively little time and labour. Suggestions include:

a. Feed the birds daily. This allows the animal attendant to examine the condition of the birds and their holding facilities on a regular basis.

b. Put out only as much food as they will consume daily. Do not allow excess feed to accumulate. Old feed that has become damp is an ideal cultural medium for aspergillosis, a fungal disease which affects the respiratory system (see Health Care) and is particularly deadly to swans and eiders.

c. Birds that are held in outdoor pens should be given only wheat during rainy weather. Wet turkey starter forms a hard crust and is not eaten.

d. Evenly distribute an adequate number of feeders throughout the pen. If only one or two feeders are used, the birds will crowd around them, increasing the possibility of aggressive interaction and accidental trampling.

E. REPRODUCTION

1. Breeding

a. Behavior

The general breeding habits of most wild waterfowl species will include the following steps:

i. Males will compete with one another and interact with females in a ritualized fashion in order to attract the attention of females.
ii. A pair bond will be formed when the female selects one of the males as her mate.
iii. The pair will then set up a home range the boundaries of which are defined partially by habitat quality and partially by intraspecific encounters with other pairs. These encounters act as spacing mechanisms.
iv. The female will select the nest site and lay her eggs over a one to two week period until the clutch is complete, at which time she will begin incubating them.

While these patterns are common to most wild species of waterfowl, each exhibits its own characteristics and must be dealt with individually. Nowhere is the diversity of waterfowl more apparent then in their breeding habits. For example, while domestic Mallards are polygamous, most wild waterfowl species are seasonally monogamous, the exceptions being geese and swans, which form permanent pair bonds. Moreover, dabbling ducks and many species of bay ducks breed in their first year, while ducks of the Mergini tribe do not breed until their second year. Geese and swans do not breed before their third or fourth year. A few of the parameters concerned in breeding and reproduction of the more common waterfowl are given in Appendix B. A detailed chronology of the breeding activity, breeding behavior, nest site preferences, clutch size, incubation period and renesting tendency, all of which are highly variable reproductive parameters, is dealt with in detail by Bellrose (1976).

Certain species breed more readily in captivity than others. The wild Mallard and its domesticated offshoots are particularly suited to captive breeding. Canada Geese, Trumpeter Swans and Mute Swans are also commonly bred in captivity. Other species such as Gadwall, Canvasback, Pintail and Blue-winged Teal have also been bred experimentally in captivity (Ward and Batt, 1973).

b. **Methods**

Two general methods are used for the breeding of waterfowl:

i. Mass production involves placing a group of males and females in a pen which contains its own swimming water, loafing areas, feeders, and nest boxes. A ratio of five hens to one drake is suitable for domestic Mallards (Hunter and Scholes, 1954) while wild Mallards should be penned at a ratio of 2:1. Domestic Mallards will tolerate much higher densities than wild Mallards.

ii. Pair marking involves isolating individual pairs in small compartments. This technique usually results in higher production and also facilitates record keeping.

A few general comments are relevant to the captive breeding of waterfowl:

iii. Wild species are more likely to breed in captivity if they have been hand-reared from downy young.

iv. Overcrowding in the breeding pen precludes breeding. Reducing visual contact between groups of birds by the use of dividers will reduce aggression.

v. Human disturbance should be kept to a minimum.

vi. Feeders should be spaced evenly throughout the pen so the birds will not be forced to group together.

vii. Artificial nest structures will provide seclusion for the breeding hen. A variety of designs has been developed from which to chose a suitable nest structure (Ward and Batt, 1973; Hunter and Scholes, 1954; Dill and Lee, 1973). Nesting material should be placed in the nest box; dry straw is suitable for most species.

2. **Artificial Incubation**

a. **The Incubator**

Incubators are designed to regulate heat, humidity, ventilation and egg rotation in order to achieve normal embryonic development. Proper control of these four factors is essential if high hatchability is to be attained. Sanitation in the incubator is vital. Incubators should be cleaned with ammonia-based cleansers prior to, and at the end of every season. They should also be fumigated at the beginning of the season while in operation, but before eggs are placed in them. A suitable fumigation procedure will usually be outlined in the incubator manual.

b. **Procedures**

Temperatures should be maintained at 37.5°C (99.5°F) over the entire period of incubation for all species. The wet bulb (humidity) reading should be between 29-30°C (84-86°F) for duck eggs (Ward and Batt, 1973) and 31-32°C (88-90°F) for Canada Goose eggs. Incubators are equipped with adjustable ports for ventilation. The manufacturer's instructions regarding the use of these ports should be followed. Finally, most modern incubators are equipped with automatic egg rotating mechanisms. Eight rotations through a minimum of 90 are necessary to prevent the extra-embryonic membrane from adhering to the eggshell.

It is best to allow at least five days of natural incubation by the hen before collecting eggs for artificial incubation. Eggs which receive some natural incubation are more likely to hatch than those which are incubated artificially from day 1. Moreover, many species will re-nest following removal of the first clutch and increased production will result.

Eggs should be candled once a week. Candling is a technique which illuminates the interior of the egg for the purpose of detecting dead or infertile eggs. It is especially important to remove dead and infertile eggs because they may explode and spread disease through the incubator.

The incubation period for most waterfowl eggs ranges from 24-28 days. Goose and swan eggs take between 30-35 days.

c. **Hatching**

Provision should be made for separating eggs which are about to hatch from those in earlier stages of incubation. If a separate hatching compartment is not a feature of your incubator, then a second incubator will be required solely for hatching. "Pipped" eggs should be placed in the hatcher. Pipping occurs 24-48 hours before hatching and is marked by a puncture near the large end of the egg. Downy young should be allowed to remain in the hatcher until they have dried off, a process requiring from six-24 hours. Ducklings which are dried off and fluffed out are ready to be moved to the brooder.

3. **Brooder Rearing**

Brooder rearing involves the combination of six essential elements: heat, food, water, sunlight, sanitation, and space, the requirements of each of which are discussed below:

a. **Heat** is supplied by brooder lamps until 14 days of age, after which they will no longer be needed, under normal summer temperature conditions. The lamps should be suspended in such a way that the ducklings will distribute themselves evenly under them and not pile up on top of each other. Young waterfowl should be kept indoors out of inclement weather for their first week. Ducklings whose ages differ by more than four to five days should not be mixed.

b. **Feeding** must initially be encouraged in newly-hatched ducklings by sprinkling starter on the floor. Natural curiosity will lead them to peck at the scattered food. Once the ducklings have learned to feed, the starter should be supplied only in dishes in order to prevent waste and maintain sanitary conditions.

c. **Drinking water** should be provided for the ducklings for the first three days following hatching. After that, it is essential to provide them with enough water for swimming so that their plumage and posture will develop normally.

d. **Sunlight** is essential for the development of natural plumage. By day 8 ducklings should be given access to an outdoor pen. This is most easily done by having wall ports between indoor and outdoor pens, allowing them free movement between the two.

e. **Sanitary quarters** are vital to prevent the young birds from becoming soiled. Unsanitary conditions can cause stress as well as disease. A proper degree of cleanliness is most easily maintained in pens which have concrete bases and floor drains.

   Wire screens should be provided so the ducklings can get off the concrete floor. This ensures against the birds becoming soiled in their own droppings and also helps prevent "bumblefoot." Bumblefoot is an abscess on the bottom of the foot, which in addition to making the duckling lame also provides a route of infection for debilitating diseases such as staphylococcal arthritis. The wire mesh should be small, preferably around 0.5-0.6 cm (0.2 in.). Larger mesh sizes fail to prevent bumblefoot and may, in fact, even contribute to its occurrence (Wobeser, 1981).

f. **Space** must be provided for exercise if the ducklings are to develop normally. Up to 25 dabbling ducks can be raised successfully until three weeks old in a combination indoor-outdoor pen the dimensions of which are approximately 1.5 x 1.5 m (5 x 5 ft.) with a swimming area covering about one-half of the total surface area. The group size in this pen for diving ducks should not exceed 20 and for goslings, only 10. After day 21, the birds should be moved to large outdoor pens where they have access to abundant water space for exercise. This is especially important during the period of wing feather growth, which occurs when the birds are approximately 30-60 days old. Birds which are overcrowded or confined in a small area may develop drooping wings; in the extreme, this may be expressed as "airplane wing" (see Health Care).

   The young of most waterfowl species are essentially full grown by the time they reach 60 days old. Once they are fully grown, they may be placed with adult birds.

4. **Aging and Sexing**

There are numerous techniques available for aging and sexing waterfowl to those who are familiar with their morphological characteristics. Age and sex in most species can be determined by the shape and coloration of certain wing

feathers. The classical procedure for aging and sexing waterfowl is by cloacal examination as originally described by Hochbaum (1942).

F. RESTRAINT AND HANDLING

1. Capture and Handling

Captured waterfowl should be handled only when absolutely necessary. Proper capture (Hunt and Dahlka, 1953; Weller, 1957; Rogers, 1964; Krapu, 1976; Szymczak and Corey, 1976; Higgins, Kirsch, Duebbert *et al.* 1977; Mechlin and Shaiffer, 1979) and handling techniques will minimize stress. When large numbers of waterfowl are to be caught, they should be herded into specially designed, portable catching crates approximately 3.6 x 2.1 m (12 x 7 ft.), covered with poultry netting (Ward and Batt, 1973).

If only a few birds are to be captured, a fish landing net will suffice. The mesh of the catching net should be 2.5 cm (1 in.) to avoid feather damage and to discourage climbing (Ward and Batt, 1973).

The proper method for handling waterfowl is to grasp them at the base of their wings with one hand, preventing them from flapping and possibly injuring themselves. This procedure may be carried out with one hand, leaving the other free for manipulations, when removing ducks and small geese from a catching crate or net. With larger birds it will be necessary to wrap one arm around the body whilst pinning down the wings with the other (Ward and Batt, 1973). Care must be taken not to squeeze the bird too tightly, so as to avoid shock which may lead to death.

2. Physical Restraint

There are a number of simple devices which can be used to physically restrain most waterfowl species (Fredrickson, 1970; The Trumpeter Swan Society, 1977). Small net or mesh bags equipped with drawstrings will restrict movement by the birds. Even a nylon stocking can be adapted to restrain ducks, although there is some danger of the material scratching their eyes. There are also a number of specially designed restraining jackets which can be used to restrict movement by waterfowl for short periods of time (Fredrickson, 1970; The Trumpeter Swan Society, 1977).

3. Anesthesia

A wide variety of chemicals have been evaluated for effectiveness as anesthetics for waterfowl (Cline and Greenwood, 1972; Schafer and Cunningham, 1972) and practical procedures for inhalation anesthesia have been reviewed (Gandal, 1982). Inhalant anesthesia levels of 4-7% methoxyfluorane or 0.5-1.5% halothane have been recommended (Dr. G.J. Glover, Pers. Comm.). Recovery is usually smooth and rapid following removal of the anesthetic.

An anesthetized bird should not be returned to the flock until it has completely recovered.

G. HEALTH CARE

1. Disease Prevention

The key to maintaining healthy waterfowl lies in the avoidance of conditions conducive to the onset of disease; prevention rather than treatment. In particular, this means paying strict attention to nutrition, sanitation and population density. A regular cleaning schedule designed to prevent excessive fecal buildup, and to assure enough clean water at all times for swimming and drinking, must be strictly adhered to. Special attention should be paid to the feeders, as these, if neglected, can become a focal point for the spread of such diseases as aspergillosis.

2. Accident Prevention

Accidents, unfortunately, can be all too common, particularly in flying waterfowl, which are much more accident prone than non-flying species. Many accidents to waterfowl will be prevented if all the birds are either clipped or pinioned:

a. **Wing Clipping** simply involves cutting the primary feathers of one wing with a pair of shears. This procedure will make the bird unable to fly until it grows new flight feathers during the summer molt. Care must be taken not to clip primary feathers until their shafts are hard and white. This is strictly a temporary and not always total deterrent.

b. **Pinioning** involves removal from the wing of that portion of the bone, tendons, and muscle which supports the primary feathers. It will render the bird permanently flightless and, therefore, should be performed only on those that are to remain permanently in captivity. The procedure for pinioning necessitates the removal of most or all of the joined second and third metatarsal bones and adjacent tissues, but not the allula (spurious wing). The operation is least stressful and, therefore, best performed on birds under a week old; it should not be done between one and four weeks or when the quil, feathers are in the pulp stage. The operation is more serious in older birds in which hemorrhage may need to be controlled and the procedure will involve cutting through more or less hardened bone, suturing and the practice of strict surgical asepsis (Ward and Batt, 1973). The use of a local anesthetic (Procaine HCI) injected proximal to the amputation line at the joint, about two minutes before commencing the operation, is recommended in large birds (geese, swans). Hemorrhage can be prevented by threading separate tape tourniquets medially between the 2nd and 3rd metacarpal interosseous space. Prior removal of all feather quills is a further important factor in hemorrhage control (Gandal, 1982).

3. Problems During Development

A number of nutritional and developmental problems may be encountered in a captive waterfowl flock. As these conditions are usually due to errors in nutrition, sanitation, and/or housing, they should be guarded against and

watched for at all times, and when noticed, immediate preventive measures implemented.

Bumblefoot, which has been briefly described above (see Brooder Rearing) is one of the more commonly encountered conditions associated with overcrowding, stress, and failure to provide proper hygienic conditions.

"Airplane wing" was referred to previously as being associated with overcrowding and insufficient space as an extreme expression of the drooping wing syndrome. It is manifest by a wing projecting out at an angle, usually in a young duck that will paddle awkwardly. Excessively high protein levels in the diet have also been suggested as being causally associated in the development of this physical deformity (Kear, 1973).

Bowed legs is another developmental defect that may be encountered in Pekin ducks that is considered to be a nutritional disorder, the onset of which will be precipitated by lack of exercise and overcrowding (Hunter and Scholes, 1954; Heuser and Scott, 1953).

4. **Intectious Diseases**

The clinical signs of the most common waterfowl diseases are dealt with in a number of publications (Wobeser, 1981; Davis, Anderson, Karstad *et al.* 1971; Wallach, 1974). As a general rule, sick birds appear ragged, often have conjunctivitis, and are usually sedentary, spending most of their time at a distance from the rest of the flock.

If birds begin to exhibit these symptoms, it is best to send one or two live specimens to a veterinarian or avian (veterinary) pathology laboratory for identification of the disease and recommended treatment.

Some natural mortality is likely to occur, particularly amongst the older birds which are susceptible to such diseases as amyloidosis and tuberculosis.

Acute hemorrhagic enteritis (duck plague), is an acute herpes virus infection responsible for severe enteritis with bloody diarrhea, extravasation of blood into the abdominal cavity and massive congestion of the intestinal lymphoid aggregates. Although most often seen in ducks, it may affect and be spread by all species of waterfowl. It may best be prevented by limiting access to the water supply by free-flying waterfowl.

Outbreaks of hepatitis may occur in domestic ducks and geese flocks, but are rare among their wild counterparts.

The causal viruses of Newcastle disease and avian influenza may infect captive waterfowl and, although clinical signs are rare, high antibody titres have been shown and there is a distinct probability that wild waterfowl may be involved as carriers in the spread of these and other common avian infectious diseases (Humphreys, 1976).

Aspergillosis, caused by the fungus, *Aspergillus fumigatus* is spread by inhalation. Affected birds exhibit increased respiration rates and wheezing. Young birds and birds which are stressed are most susceptible. Prevention depends upon the maintenance of sanitary conditions, particularly around the feeders.

Botulism is caused by the ingestion of a toxin produced by *Clostridium botulinum*. Production is dependent on warm temperatures and decaying food matter. Botulism stricken birds become partially paralyzed. In the extreme, they let their heads sag in the water or on the ground. This condition is known as "limberneck." Death is usually due to drowning, respiratory failure, or dehydration. Botulism is best prevented by curtailing access to ponds with fluctuating water levels and gently sloping banks.

H. **EUTHANASIA**

1. **Physical**

Cervical dislocation is the most commonly employed technique for killing captive waterfowl. An equally effective technique is stunning. Both must be applied quickly and with some force if pain is to be minimized. The proper application of these methods will render the bird unconscious almost immediately.

2. **Chemical**

Extensive coverage of techniques for chemical euthanasia is available in Chapter 10 of Volume 1 of this *Guide*. The marginal vein on the ventral aspects of wings or the saphenous vein on the medial aspect of the tarso-metatarsus are the most common sites for intravenous injection of chemicals (Wobeser, 1981).

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APPENDIX A

BLOOD VALUES - WILD MALLARDS

	Mean	Range
Blood Volume (ml/kg)	-	95-110
Hemoglobin (g/100 ml)	13.1	-
RBC x 10^6/mm^3	2.4	2.0-2.7
Thrombocytes x 10^3/mm^3	46.7	30.7-62.6
WBC x 10^3/mm^3	26.8	23.4-31.5
Lymphocytes %	46.9	26.6-68.0
Heterophils %*	-	22.0-52.0

* Heterophil values shown are for domestic Mallards (male and female Pekin and male Indian Runner)

APPENDIX B

BREEDING AND REPRODUCTION DATA

Breeding Age Range	7-12 mo. - Domestic Duck 1-2 yrs - Wild Mallard 2-3 yrs - Goose
Breeding Behaviour and Season	Oct. - June - Domestic Ducks March-June - Wild Ducks Polygamous - Domestic Ducks Seasonally Monogamous - Wild Ducks Monogamous - Geese
Gestation Mean (d) Range	24-28 - Ducks 30-33 - Geese
Brood Size and Range	4-12 (Average clutch size of wild ducks)
Optimal Reproductive Span	1-2 yrs - Domestic Ducks - Wild Ducks
Light Heures	- Domestic Ducks 13-16 - Wild Ducks