BREEDING BIOLOGY OF THE AFRICAN WHITE-BACKED DUCK *(Thalassornis leuconotus)* IN CAPTIVITY

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ABSTRACT

Due to the dwindling numbers of wild ducks in Southern Africa, it is hoped that, with the help of this research project, the African White-backed Duck, *(Thalassornis leuconotus)*, will be better understood, thus enabling more to be done for this species and its conservation, whether in a wild situation or in captivity. Every aspect of their general and breeding biology is investigated and comparisons are made between birds in the wild and those in captivity.

As young birds, African White-backed Ducks are reluctant to eat basic food types placed in a bowl in front of them and therefore, reliable rearing techniques, with high survival rates, are much needed. Different feed and feeding techniques are experimented with, with the aim of enabling aviculturalists, breeders and conservationists to increase their rearing success rates significantly.

Reasons as to why the African White-backed ducklings are so difficult to rear are researched.

Factors affecting viability and hatchability are investigated so as to ensure that breeders give their birds, eggs and embryos the ideal conditions under which to develop.

Age at sexual maturity is determined so as to help breeders utilise their birds to their fullest potential.

Possible relationships between a number of variables are investigated such as:

egg mass and hatchability
duckling mass and survivability
egg mass and duckling mass
biological parameters of duckling mass

Fertility and the various factors affecting fertility are investigated, so as to be able to increase fertility in a captive situation and in wild habitats.

Growth rate of ducklings on different feeding regimes are investigated and recorded and it is determined whether survivability and/or fatality can be predicted.

With the results obtained from four different breeding seasons, a number of conclusions can be drawn which should help breeders to successfully breed and rear higher numbers of African White-backed Ducks in the future. However, further research is still ongoing so as to improve techniques and successes.

Key words: waterfowl, ducks, eggs, hatchability, fertility, viability, African White-backed Duck, captivity, breeding, hand-reared.

UITTREKSEL

Afrikaanse Witrugeende, (Thalassornis leuconotus), *soos ander wilde eende, word al hoe skarser in Suider-Afrika en daar is hoop dat, deur middel van hierdie ondersoek, die spesies beter verstaan kan word en dat meer gedoen kan wees vir hierdie spesies en die bewaring daarvan in die natuur en in gevangenskap. Elke aspek van hulle algemene- en broei-biologie is nagevors en vergelykings is opgedra tussen vöels wat in die wild is en vöels in gevangenskap.*

Terwyl Afrikaanse Witrugeende nog baie jonk is, eet hulle nie maklik eenige normale tipe kos wat voor hulle in 'n bakkie gesit is nie. Daarom is daar 'n groot noot vir betroubare metodes van kos gee, wat kan veroorsaak in hoer suksese van grootmaak. Verskillende kos en kos gee metodes is ondersoek so dat vöelboere, broeiers en natuurbewaarders betekenisvolle beter resultate kan kry.

Dit is ook ondersoek hoekom hierdie spesies soveel probleme met grootmaak het.

Die faktore wat lewens vatbaarheid en uitbroei sukses veroorsaak is ondersoek so dat broeiers van hierdie voëls kan vir hulle voëls, eiers en embrios die beste omstandighede en kanse kan gee vir oorlewing.

Die ouderdom waarop die voëls kan broei is uitgewerk sodat broeiers die volle potensiale van hulle vöels kan gebruik van maak.

Verwantskappe tussen verskeie veranderlike word uitgewerk bv:

eiermassa en uitbroei kanse
uitbroeimassa en oorlewings kanse
eiermassa en uitbroeimassa
biologiese parameters van uitbroeimassa

Vrugbaarheid en die faktore wat vrugbaarheid verander is ondersoek so dat vrugbaarheid in gevangenskap en in die wild kan verbeter word.

Die groei van kuikens en hulle kos gee metodes is ondersoek om te sien of oorlewing voorspelbaar is.

Met die resultate van vier verskillende broeiseisoene, kan verskeie gevolgtrekkings gemaak word wat broeiers sou kan help om groter hoeveelhede en gesonder Afrikaanse Witrugeende uit te broei in die toekoms. Ondersoek word egter nog gedoen so dat metodes verbeter kan wees asook suksese.

Sleutelwoorde: watervöels, eende, uitbroei ,vrugbaarheid, lewens vatbaarheid, Afrikaanse Witrugeend, gevangenskap, broei, hands-grootmaak.

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Chapter 1: Introduction

1.1 MOTIVATION

1.1.1 **CONSERVATION AND STATUS IN THE WILD**: According to the CITES schedules and the Department of Nature Conservation, the African White-backed Duck (*Thalassornis leuconotus*) is not a threatened southern African bird species. This species could maintain itself if the necessary habitats were available. However, due to the systematic destruction and depletion of natural wetlands in South Africa and other countries where African White-backed Ducks occur, any species such as this, which is dependent on well-balanced wetlands for its food supply and breeding requirements, could be considered severely threatened in the near future. A species such as this which is dependent for successful breeding on a high annual rainfall, is also threatened by the changing weather patterns prevailing currently, caused by the green house effect and phenomena such as El Nino.

According to Todd (1996) African White-backed Ducks may be increasing in number, due to the increase in the number of farm dams. I disagree with this sentiment and feel that, due to a lack of education and awareness, most of these farm dams are unsuitable for African White-backed Ducks to breed on. This is because they do not meet the three basic requirements for breeding waterfowl:

- security from predators such as domestic cats and dogs, mongooses, genets, otters and pythons
- there is a lack of natural food for them to forage on
- there are no suitable nesting sites

The birds, therefore, cannot increase in number although the water-bodies may be there (pers. obs.). Johnsgard (1978) stated that hunting pressure on this species is not significant in determining their status as their meat is undesirable. According to Todd (1996) the mainland African White-backed Duck population in the eastern and southern parts of Africa is stable, if not increasing, although their distribution is patchy and nowhere are they abundant. Sharp declines have occurred in the Southern Rift Valley, due to the use of gill-nets, resulting in incidental deaths in the nets (Irwin 1981). Todd (1996) stated that, although African White-backed Ducks are common to uncommon in South Africa, their occurrence in numbers is very unpredictable, due to local movements. The East and South African population is estimated at between 10 000 and 25 000 birds (Todd 1996).

The sedentary West African population is possibly on its way to extinction with only about 500 birds left (Del Hoyo, Elliot & Sargatal 1992). The species could be under some threat in certain areas from the presence of *Tilapia rendalli*, which competes with the African White-backed Ducks for aquatic vegetation. Some populations have disappeared from several waters for this very reason (Irwin 1981).

The status of the Madagascar White-backed Duck *(Thalassornis leuconotus insularis)* could be more vulnerable due to its restricted distribution, namely suitable areas on the island of Madagascar (Burn & Madge 1988). According to Del Hoyo *et al.* (1992) the Madagascar White-backed Duck was formerly common throughout Madagascar except on the high plateau, but is now rare and by 1989 it was thought that they were extinct at Lake Aloatra. The only areas where they are now common are in marshes at Soalala. The

decline has been attributed to trapping and hunting, even though they are said not to be very palatable.

1.1.2 STATUS IN CAPTIVITY: In South Africa, prior to the importation of the first birds, there were no known birds held nor bred in captivity. Now there are, including those at Treehaven Waterfowl Trust (TWT) a maximum of six South African waterfowl collections at the most which house them. They are valued at a high price locally (ZAR 7 000 per pair) and a permit from the Department of Nature Conservation is required to keep them. Both of these reasons make it an unattainable species for the majority of hobbyist waterfowl collectors and aviculturalists. In Zimbabwe, they have been kept and bred in captivity for many years, most famously at the home of Mr. Colin Wintle in Bromley. The first time that he successfully bred his own African White-backed Ducks was in January 1980. Previously to this, he hatched and reared numerous ducklings from wild eggs collected in his area. Some of these captive-reared birds were then sent to the Slimbridge Wildfowl and Wetlands Trust in England (Wintle 1981).

African White-backed Ducks have been kept in England since 1950, although not very successfully at first as a high mortality rate was experienced (Delacour 1959). Eventually some birds began breeding in 1966 (Johnsgard 1995). The first successful breeding occurred only in 1978, in a private collection (Todd 1979). They are now kept in numerous of the more renowned collections in England, such as at Ludgate House of Keith and Marie Zabell, and are breeding well. There are a number of collections in Europe, especially in Holland, which house and breed African White-backed Ducks. They are currently held in a few of the larger and more complete collections in North

America such as Sylvan Heights Waterfowl II of Mike and Ali Lubbock, in North Carolina, and some birds are bred and reared there on a regular basis. The scarcity of captive stock does not reflect disinterest on the part of the collectors and aviculturalists, but rather an unavailability of breeding stock and/or high prices (Todd 1996).

Captive African White-backed Ducks are currently housed at TWT in Vereeniging, Gauteng, South Africa. These were imported from Holland in November 1992 and their first attempt at breeding was in December 1993.

It was decided to hand-rear the ducklings and they were placed in a wire brooder cage. This attempt was not successful as the ducklings appeared not to eat by themselves. They did not increase much in mass and died after two weeks. Their heads and beaks grew but, their bodies remained the same size. It was at this time that it was realised that these birds were unusual. They were not just like any other duck species whose ducklings could easily be hand-reared with the above simple methods.

Not only does the species have the ever present and growing threat of habitat destruction in South Africa, but the Madagascan subspecies is under the threat of extinction, without anything being done to protect or preserve it. Todd (1996) stated that there are only about a thousand individuals left in Madagascar. For these reasons, a simple, reliable method of hand-rearing the ducklings of, at least the nominate subspecies, needs to be worked out, so as to be able to successfully captive breed and rear ducklings for release into the wild.

A thorough knowledge of the African White-backed Duck could provide valuable information if the Madagascar White-backed Duck needs to be rescued from the brink of

extinction. An awareness and knowledge of how to breed and rear African White-backed Ducks in captivity will make it easier and more attractive for more aviculturalists to keep them. This will in turn lead to more of them being bred and released, and eventually a general increase in their population.

1.2 OBJECTIVES

The main objective of this study was to evaluate the success of the captive breeding programme conducted at TWT in comparison to the breeding of African White-backed Ducks in the wild so as to facilitate future captive breeding programmes. Possible reasons for the differences between captive and wild breeding birds were explored. Parameters of comparison between wild and captive bred African White-backed Ducks which were investigated are as follows: physical differences, habitat preference, food preferences and feeding habits, general behaviour, nesting habits, nest construction, breeding behaviour and incubation, breeding seasons, age at which sexually maturity is reached, egg comparison, clutch size, mass of ducklings vs. their shell mass, susceptibility to medical problems.

Other objectives of this study which will assist in future captive breeding programmes were investigations into: relationships between biological parameters of African White-backed Ducks, affects of breeding season conditions on breeding success in captivity, factors which affect fertility, predicting fatality of a developing duckling, rearing successes of ducklings, differences between ducklings of African White-backed Duck and other species.

Little is known and recorded about African White-backed Ducks in the wild and published literature has to form the basis of comparison with the captive breeding data. An extensive literature survey, therefore, formed an integral part of this study.

From the findings noted during accomplishing these objectives, a summarised procedure for hand-rearing African White-backed Ducks will be presented, as well as the conservation implications of captive-breeding and hand-rearing.

1.3 LITERATURE OVERVIEW

1.3.1. DESCRIPTION

African White-backed Ducks are almost grebe-like in overall shape and swimming posture (Todd 1979). According to the latter author, males and females are practically identical in size, shape and colour. He described them as being dumpy, stubby-bodied diving ducks with the slightly larger males' heads being more bulbous than those of the females. The males' nape feathers are more dense and their black bill is more profusely mottled with yellow. He stated that the white back, referred to in the name, is only seen when the birds are flying. He noted that the white circular patch between the eye and bill is far more diagnostic.

Milstein (1977) described their swimming posture by saying that the back slopes steeply into the water, almost hunch-backed style. This is confirmed by most illustrations of the species. Burn & Madge (1988) described them as having the crown and back of the neck black with buff spots, with a clear, white oval spot between the eye and bill. The front and sides of the neck is plain buff. The breast and under parts are tawny-buff with black

bars which are finer on the breast and broader along the flanks and lower belly. The ventral region is duskier. Upperparts are tawny-buff with black bars. The upper back, rump and upper-tail coverts are black with white barring. The lower back is white. The wing-coverts and scapulars are dark brown with buff and white spots and bars. The under-wings are buffish-brown. The tail is referred to as vestigial. The bill is described as large with a prominent strong nail and is black with yellow to green speckles. The iris is said to be dark brown and the legs and feet greenish-grey. Johnsgard (1978) stated that immature birds are generally darker and less distinctively patterned, with the sides of the face and neck more heavily spotted with black.

Due to the African White-backed Duck's aquatic life style, their legs are placed far back on the body to facilitate diving. They are clumsy and awkward on land and in flight they appear tail-less with their long legs extending well beyond the tail (Todd 1996). External body measurements have been taken by some authors and these are shown in Table 1.1.

Table 1.1: Body measurements of African White-backed Ducks recorded by various authors (median and range shown)

AUTHOR	BODY MASS (g)	BEAK LENGTH (mm)	TAIL LENGTH (mm)	TARSUS LENGTH (mm)	BODY LENGTH (cm)
Brickell (1988)		41,5 (38 – 45)	47,5 (45 – 500)	38,0 (35 – 41)	
Madge & Burn (1988)	707,5 (625 – 790)	40,0 (35 – 45)		38,0 (35 – 41)	
Johnsgard (1978)	707,5 (625 – 790)	40,0 (35 – 45)			
Maclean (1985)	674,0 (558 – 790)	37,5 (36 – 39)	48,0 (43 – 53)	36,5 (34 – 39)	40,5 (38 – 43)

1.3.2 DISTRIBUTION AND HABITAT PREFERENCE

As can be seen from Figure 1.1, African White-backed Ducks are widespread through most of tropical Africa, except for the equatorial rain forest zone. The birds are separated into two distinct populations (Todd 1996). The population in the West is much smaller than the remaining population and includes birds in Senegal, Nigeria, Cameroon, Mali, Chad and the Congo. The larger eastern and southern population includes South Africa, northwards to Namibia, Botswana, (wet areas only), Zimbabwe, Mozambique, southern Angola, Zambia, Malawi, Kenya, Uganda, southern Ethiopia, southern Sudan, and eastern and southern Zaire. They are found on the Pemba and Mafia Islands on the East Coast of Africa (Brickell 1988).

Figure 1.1: Distribution (shaded areas) of African White-backed Ducks in Africa according to Brickell (1988)

As can be seen from Figure 1.2, in southern Africa, African White-backed Ducks are confined to the wetter, eastern areas. They are resident with local movements taking

place during wet seasons, to take advantage of newly flooded wetland areas. In South Africa, they occur in Gauteng, North West Province, Mpumalanga, eastern parts of the Orange Free State, KwaZulu-Natal, and coastal regions in the Cape along the Indian Ocean. They occur in Mozambique, throughout Zimbabwe, in Botswana around the Okavango Delta area and in Namibia in the Etosha area (Brickell 1988).

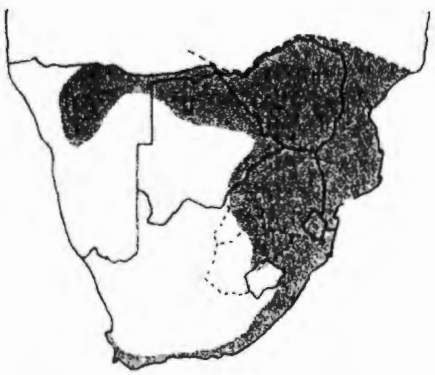

Figure 1.2: Distribution (shaded areas) of African White-backed Ducks in southern Africa according to Maclean (1985)

According to Maclean (1997) the distribution of African White-backed Ducks in southern Africa is similar to that of the Fulvous Whistling Duck (*Dendrocygna bicolor*) being largely tropical to subtropical. The African White-backed Duck's distribution is centred on the wetter parts of southern Africa and the larger bodies of still water. As confirmed by Figure 1.3 from Maclean (1997) the African White-backed Duck is widespread in southern Africa. It is scarce and irregular in Zimbabwe, but more widely spread than before (Irwin 1981). They are widely but not densely distributed in KwaZulu-Natal, the former Transvaal, Swaziland and the Free State. In the southwestern Cape it is an uncommon resident with higher numbers in summer. In Namibia, it is confined to

large rivers in the Caprivi Strip and a few other scattered dams. Reports from the Bird Atlas project (Fig 1.3) showed low numbers overall. The birds were concentrated in major wetland areas and around urban areas (Maclean 1997). Maclean (1997) referred to the African White-backed Duck as being unobtrusive and he suggests that this could affect results. Maclean (1997) also inferred that this species is somewhat nomadic, with no clear pattern of movement. However, Burn & Madge (1988) stated that, although the seasonal movements are poorly understood, the ducks disperse during the rainy season to take advantage of newly formed shallow waters. According to Maclean (1997) its southern African range has not changed in recent times, except possibly in Zimbabwe where it may have increased slightly. He noted that it was historically recorded to have been seen from Verlorenvlei, along the southern coastal regions into Natal, the former Transvaal and Botswana.

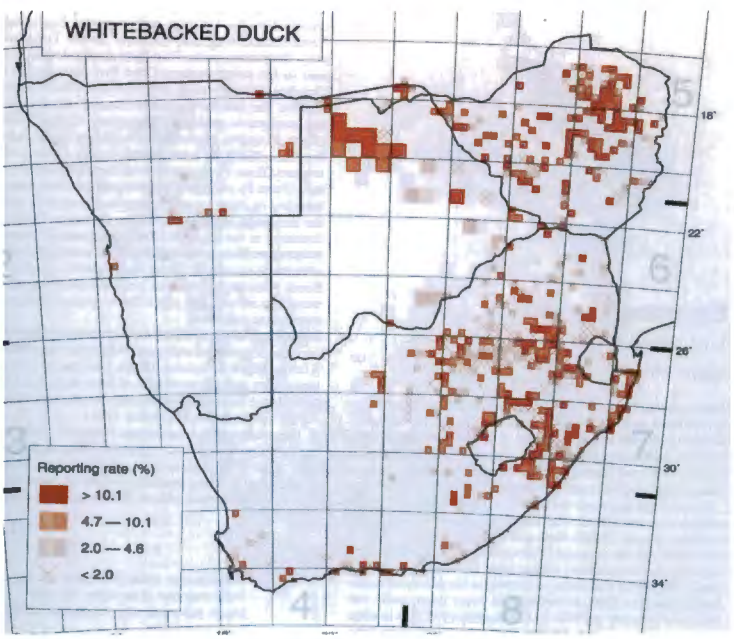

Figure: 1.3: Map showing densities of sightings of African White-backed Ducks in southern Africa (Reproduced from Maclean, 1997)

African White-backed Ducks occur in quiet wetlands, marshes, bays and inlets, pools, lakes and swamps, from sea level to 3 000 metres above sea level, so long as there is plenty of marginal vegetation in the form of reeds and sedges and/or floating vegetation such as water lilies. The floating vegetation must not be too dense as this hampers long dives, but it must be thick enough for the birds to take cover under or near it (Brickell 1988, Maclean 1985, Soothill & Whitehead 1988). They do not appear to be selective as to whether the water is fresh or brackish (Brickell 1988). Johnsgard (1978) notes that open water is avoided and according to Burn & Madge (1988) African White-backed Ducks tend to avoid deep water unless there are extensive shallow margins. According to Maclean (1997) the species has adapted to impoundments with the right conditions.

Discussions with other aviculturalists and birders has revealed that, for successful breeding of African White-backed Ducks to occur, water-bodies fringed with vegetation are needed, as they commonly make the nest within easy and quick access to the water. It has been observed in wild situations that when the water level in dams, where African White-backed Ducks are resident, drops due to drought, the ducks tend not to breed at that time and sometimes they then leave the area. Johnsgard (1978) noted that African White-backed Ducks reappear at the onset of the rainy season. Todd (1996) found that hundreds of African White-backed Ducks might be present in an area one year but hardly any the next year.

Maclean (1997) stated that, owing to the similar habitat requirements, African White-backed Ducks are often found together with the African Pygmy Goose (*Nettapus auritus*) in places where their ranges overlap. Johnsgard (1978) found them together with

African Pygmy Goose and Hottentot Teal (*Anas hottentota*). Delacour (1959) saw African White-backed Ducks and Maccoa Ducks (*Oxyura maccoa*) on the same lake in Abyssinia.

1.3.3 FOOD AND FEEDING HABITS

African White-backed Ducks are excellent divers and procure a large percentage of their food whilst diving to the pond-bottoms. They also feed on floating vegetation and other floating foods and, as adults, they are mostly vegetarian (Brickell 1988). In Zambia, crop contents of wild birds were checked by Douthwaite (1977). On average 97% of the dry food matter consisted of *Nymphaea* (water lily) seeds while the rest was made up of *Nymphaea* vegetative parts. Animal matter was totally absent from the crops examined. One bird was found to have eaten fruit of *Echinochloa stagnina* only. Sand granules were usually present in their crops. This is, however, normal for all species of waterfowl (pers. obs.). According to Clark (1979) African White-backed Ducks dive to the bottom of ponds and sift food particles from the mud and debris, often remaining submerged for 30 seconds at a time. Zaloumis (1989) is in agreement with the above, but states that animal matter does form an important part of their diet in the form of molluscs, etc.

Foraging times are said to be from dawn until shortly after sunrise and again from late afternoon to sundown. They are crepuscular, not nocturnal (Johnsgard 1978).

Ducklings feed mostly on insect larvae obtained from the muddy pond-bottoms (Todd 1996). According to del Hoyo *et al.* (1992) the ducklings feed mainly on gnat larvae (Chironomidae) and *Polygonum* seeds, both of which they procure by diving. Brickell

(1988) noted that ducklings are capable of diving shortly after hatching and they start foraging for themselves shortly after leaving the nest. Kear (1967) noted that all efforts to feed ducklings conventional foods failed. *Daphnia*, shrimps, water beetles, tiny snails, tubifex worms, mosquito larvae and pupae, duck weed, maggots, ant's eggs, patent fish foods and other crumbs, mince meat, meal worms, and other small worms were tried to no avail. However, chironomid larvae were eaten voraciously.

1.3.4 GENERAL BEHAVIOUR

Although seemingly not streamlined in shape, African White-backed Ducks make excellent divers, capable of submerging quickly without a splash or hesitation. Their legs are positioned wide apart and to the rear of the body, so as to facilitate diving. They can swim 50 – 60 m underwater when diving (Todd 1996). When uncertain of pending danger, they swim away from the source of concern with their necks stretched upwards, uttering squeaks and squeals. They often float motionless, even in moving water, and are well camouflaged at this time (Johnsgard 1995).

Todd (1996) described their legs as extending well beyond their short tail whilst flying. They have relatively short wings and use rapid wing beats. They can fly fast but generally fly very low at about two metres off the ground. To take off they need to patter along the water surface, and they swim downwind prior to attempting to take off. Being reluctant fliers, they try to dive to safety rather than fly off in times of danger (Zaloumis 1989). They are said to have 'quaint' pre-flight movements, in common with whistling ducks. Birds appear to be very alert, with outstretched necks. They then perform lateral head movements and occasionally rub their cheeks on their scapulars. They then utter a few

short squeaks and attempt to fly off, usually running along the water surface before taking off (Johnsgard 1967). He also stated that they often call whilst on the wing. Flying is rarely undertaken for long distances, nor at great heights above ground- or water-level (Johnsgard 1978). Delacour (1959) stated that they fly to other areas mostly at night as do the stifftails. He noted that, when flying, the wing beats are fast, but the wing arc is also very large.

African white-backed Ducks are not normally gregarious in large numbers but in the wild they may be encountered in pairs, family groups or small parties. It is possible to find groups of up to 100 individuals on large water-bodies, especially out of breeding season (Todd 1996). They are quite aggressive and generally of a sluggish nature (Soothill & Whitehead 1988). They are most active at dawn or dusk when feeding, mating and staking out their territories, but are quiet for the rest of the day when they spend time sleeping near the edges of marginal vegetation. They have soft, clear, two-syllabled, squeaky whistles, similar to those of Whistling Ducks and resembling the call of guinea pigs (*Cavia* sp.) according to Todd (1996). According to Brickell (1988) they are clumsy and awkward on land. Zaloumis (1989) found them sleeping with their heads under their wing and one foot sticking out above the body. Wintle (1981) and Brickell (1988) also noted this unusual posture which can be seen in resting birds whereby either one or both feet are placed over the back like two fans and the head is tucked in under the wings.

1.3.5 BREEDING BEHAVIOUR, NESTING HABITS, NEST CONSTRUCTION, INCUBATION

Todd (1996) noted that the courtship displays of African White-backed Ducks are not as elaborate as those of some other ducks. This is indicative of a life-long pair-bond, thereby eliminating the need for demonstrative, attention-seeking displays where more than one male competes for one female. The relatively dull plumage of both the male and female, with no eclipse plumage, also indicates a strong pair-bond (Todd 1996). Prior to copulating, the male exhibits drinking movements while he approaches the female. He then utters a few soft, melodious whistles as he swims towards her with his neck outstretched vertically. After copulation in the water, both birds utter a few squeaky whistles and do exaggerated stepping movements in the water, which stirs up the water. The birds then swim off quietly together for a short distance (Johnsgard 1978). Other possible pair-forming or pair-maintenance displays consist of mutual bill dipping on the part of the presumed pair and the two birds swimming towards each other and then swimming parallel for a while, calling to each other (Johnsgard 1978).

Delacour (1959) stated that breeding wild birds tended to be tamer and more confident than non-breeding birds. Todd (1996) stated that aggression against intruders at the nest site, was very intense. An intruder is greeted by hissing mouth agape, raised wings, churning water and very defensive, repeated lunges and distress whistles. This was confirmed by Johnsgard (1978). This defense takes place from the water towards the intruder. When a pair is breeding and another male approaches the nest too closely, the male will chase away the intruder. However, when another female approaches the nest area, she may either be chased away, or the defending male may try to mate with her

(Johnsgard 1967). If a pair is incubating eggs and they are disturbed at the nest, the male is invariably the first one to return to the nest and eggs, being more protective over both nest and eggs than the female (Johnsgard 1967).

According to Johnsgard (1978) nests are built in reeds or papyrus beds, often in quite deep water, with the nest near the edge of the water. A deep (up to 10cm) nest bowl is constructed by both male and female, by bending bulrushes and sedges on top of each other, to form a floating mass of vegetation (Zaloumis 1989). The nest often resembles those of coots and grebes and old nests of these birds are sometimes used as foundations by African White-backed Ducks (Johnsgard 1978). African White-backed ducks usually construct an overhead canopy with reeds which covers the nest bowl. This helps to conceal the nest and incubating bird and it helps to protect both from bad weather such as hailstorms which may be prevalent in the areas in which they occur. Some nests are occasionally made in quite open areas (Brickell 1988).

According to Todd (1996) they can breed colonially where populations are high, but then nests are well spaced at about 0,5 m. Todd stated that the African White-backed Duck's nest areas are very distinct and well guarded. Little or no down is added to the nest (Johnsgard 1978). Johnsgard explained that this may be because, like the Whistling Ducks, the male and female share incubation duties and therefore the eggs are only unattended for very brief moments and they do not lose temperature in that time. (For species in which the female leaves the nest unattended to go and feed, copious amounts of down are needed in the nests to keep the eggs warm while the female is away). Johnsgard (1978) stated that in some cases, the male plays a larger role in incubating than

the female. Wintle (1981) observed, in a captive breeding situation, the following incubation change overs. At about 07:30 am the male would take over incubation until about 12:00 noon. The female would then incubate for an hour or so. Then the male would incubate until about 05:00 pm. The female would incubate during the night. Wintle noted that the male uttered a soft, trilling, flute-like whistle when he wished to leave the nest. The female would then make her way over to the nest, sometimes diving, and would call back to the male. Only once she was on the nest did he leave the nest. She would then turn the eggs for a while and then settle down to incubate. Both male and female partake in the rearing of the ducklings, according to Brickell (1988).

African White-backed Duck nests usually have one or more ramps leading to the water, enabling quick and easy access to the nest and exit from the nest during times of danger. It also helps very young ducklings to get up on the nests to be brooded (Johnsgard 1978). Often a few nests are made by a breeding pair so that there are a few spare nests (Todd 1996). Occasionally, if the first nesting attempt in unsuccessful, the female can quickly lay eggs in one of the other nests, without first having to build a new one (Wintle 1981).

Estimations of incubation periods, as found in literature, are very variable. The ranges given are from 27 days (Brickell 1988) to 36 days (Del Hoyo *et al.* 1992). The median of the ranges would be from 29 to 33 days. It is very difficult to work out an exact incubation period in days when observing wild birds, unless regular access to the nest is possible. If the male and female do not interchange their turns in incubating, the breeding attempt is often unsuccessful (Wintle 1981). Infertility can thus be the result from lack of pair involvement with each other. Wintle notes that the mutual participation in the

breeding duties and tasks seems to be very important in this tribe of waterfowl. The change-over at the nest site takes only a few minutes, with much calling and whistling to communicate the process. The female incubates the whole of the first three and the last three days of the incubation period herself. The female also assists the ducklings to hatch and she broods them for a day before leaving the nest with them (Wintle 1981). Both male and female ducks help tend the ducklings (like the Whistling Ducks and unlike the stifftails) according to Brickell (1988). The ducklings are water-proof from their first day because their down is coated with oil from the female's feathers, which are always oiled by her own oil gland and preening. Although the ducklings do preen from their first day onwards, their own oil glands are not active until two to three weeks of age (Del Hoyo *et al.* 1992). This is the case with most waterfowl species (pers. obs.).

1.3.6 BREEDING SEASONS AND CONDITIONS

Wintle (1981) recorded a successful peak breeding season in Zimbabwe in the wild of February to June, even August. This coincides with minimal predation by ectothermic predators such as pythons, bass, barbel, monitor lizards and terrapins, as they are hibernating during these cooler months. However, during October 1979 to May 1981, breeding records for the months of October, December, January, February, April, May, July and September were noted. This constitutes all seasons of the year.

Different breeding seasons in different countries were recorded by Brickell (1988) and are shown in Table 1.2 below. The differences in seasons in the different countries reflected may be due to varying intensities of studies conducted in those areas.

Table 1.2: African White-backed Duck breeding seasons noted by Brickell (1988) and Johnsgard (1978) (* denotes breeding; ** denotes peak)

COUNTRY	J	F	M	A	M	J	J	A	S	O	N	D
Ethiopia						**						
Kenya	*	*	*	*	*	**	*	**	*	*	*	*
Uganda				**								
Zambia	*	*	*	*	*	*	*	*				*
Malawi				*		*	*	*				
Zimbabwe	**	**	**	*	*	**	*	**			*	*
Botswana	*	*	*	**	*	*	*	*	*		*	*
Namibia	**											
South Africa	**	**	**	**	**	**	*	*	*	*	**	**

African White-backed Ducks have some migratory patterns associated with rainfall patterns. They arrive in certain areas in Zimbabwe to breed, once the rainy season has begun (Johnsgard 1978). According to records available, a prolonged breeding season is typical of this species. Benson *et al.* (1971) listed breeding records for nine months of the year, from December through August, with the largest numbers in February, April and May. In Zimbabwe, egg-laying occurs mainly in February to June, and in the former Transvaal mostly between March and April. Breeding has been recorded in all months of the year in those areas. In the East, the breeding season is mainly March to September and in the south-western Cape, breeding seems to be from January to May. There seems to be much controversy about the breeding seasons of African White-backed Ducks as,

according to Soothill & Whitehead (1988), the ducks breed in most months except in April, August and September, with peaks in November and December. This contradicts some of the other records above. Clark (1979) studied the breeding of African White-backed Ducks on the Witwatersrand and found that the breeding depended primarily on the stability of water levels. He found levels of breeding to be particularly high the year after the succession of very wet summers, such as during 1976. He noted that breeding was variable during the winter months but it did continue.

1.3.7 SEXUAL MATURITY

Very little has been recorded on this topic. According to breeding records of Wintle (1981) birds which hatched from wild eggs attempted to breed for the first time at 18 to 24 months of age, indicating sexual maturity at this age. According to Maclean (1985) ducklings are full sized at three months of age, but this does not indicate sexual maturity.

1.3.8 EGGS

Todd (1979) described the eggs as rather large, pale rusty brown to light ocherous brown in colour. They are among the darkest of all waterfowl eggs and Todd (1979) suggested that this may serve to distinguish their eggs from the white eggs of the Maccoa Duck which sometimes parasitizes the African White-backed Ducks' nests. Johnsgard (1995) stated that the large size of the eggs is an adaptation for producing highly precocial ducklings that can dive soon after hatching. Delacour (1959) described the African White-backed Duck eggs as rough in texture. Zaloumis (1989) recorded that the mass of the total clutch can equal the female's body mass. Wintle (1981) and Ginn & McIlleron (1982) stated that in nests that they had observed, the eggs were laid at about 48 hours

interval. Table 1.3 below shows the mass of African white-backed Ducks recorded by various authors.

Table 1.3: Mass of African white-backed Duck eggs recorded by different authors

AUTHOR	AVERAGE EGG MASS (g)	RANGE (g)	NO. OF EGGS
Johnsgard (1978)	81	-	-
Kear (1967)	82,5	-	-
Maclean (1985)	81	77 - 94	31
Zaloumis (1989)	80	-	-

Table 1.4: Dimensions of African White-backed Duck eggs recorded by different authors

AUTHOR	AVE. EGG SIZE (mm)	RANGE	NO. OF EGGS
Brickell (1988)	61,6 X 48,5	55,0 - 66 X 44,9 - 51	42
Delacour (1959)	66 X 50	-	-
Johnsgard (1978)	68 X 48	-	-
Kear (1967)	61,8 X 48,0	-	-
Maclean (1985)	61,9 X 48,7	55 - 68,8 X 44,9 - 51,7	85
Soothill & Whitehead (1988)	62 X 49	-	-
Zaloumis (1989)	62X 49	-	-

From Tables 1.3 and 1.4 the mean mass and egg size of African White-backed Ducks were calculated as 81,5 g and 63,3 mm X 48,7 mm, respectively.

1.3.9 CLUTCH SIZE

The average clutch sizes of African White-backed Ducks recorded in previous literature are listed in Table 1.5. As can be computed from the data in Table 1.5, the mean of the medians of recorded clutch sizes is 6 eggs per clutch (6,28).

Table 1.5: African White-backed Duck clutch sizes recorded by different authors

AUTHOR	CLUTCH SIZE	MEDIAN
Brickell (1988)	3 - 8	5,5
Del Hoyo *et al.* (1992)	4 - 10	7
Delacour (1959)	3 - 7	5
Johnsgard (1978)	6	6
Maclean (1985)	4 - 6,8 - 9 (usually 6)	6
Soothill & Whitehead (1988)	6 - 10	8
Todd (1978)	6 - 8	7
Wintle (1981)	2 - 9 (usually 5 - 6)	5,5
Zaloumis (1989)	4 - 9	6,5

Johnsgard (1978) stated that a number of African White-backed Duck females can lay eggs in one nest resulting in large clutches of up to 14 eggs. Brickell (1988) refers to the eggs in this phenomenon as 'dump - eggs'.

Kear (1967) reported on 22 African White-backed Duck eggs which were laid by three different females. She worked out that each egg constituted 11,2 % of the female's body mass. As a comparison she gives the equivalent figure of 5,3 % for Yellow-billed Ducks

(*Anas undulata*). If the female lays seven eggs in 10 to 14 days, she has laid 78,4% of her total body mass. To produce this amount of eggs, the female has to partake in an immense energy and protein uptake, just prior to laying the eggs.

1.3.10 DUCKLING MASS AND SHELL MASS

Kear (1967) commented that in a clutch of eight eggs, newly hatched, dried ducklings averaged 53,8 g and empty shells had a mean mass of 7,9 g. From this she concluded that, on average, 25% of the original egg mass is lost to water evaporation and to waste material which is left behind in the shell.

1.3.11 HEALTH PROBLEMS

Wintle (1981) advised that processed foods which contain coccidiostats as an antibiotic cause very high fatalities in young ducklings. This was his experience with captive-reared ducklings.

During discussion with other aviculturalists it was mentioned that African White-backed Ducks are very prone to water-logging when hand-reared, leading to high mortalities from pneumonia. Poor water quality, poor hygiene and poor heating conditions were assumed to be causes of stunted ducklings with retarded growth rates. However, it was mentioned that these birds, if nursed intensively could come right over long periods of time. Other problems such as brittle feathering, eye infections and emaciation were found in some cases. These problems had only been experienced in captivity.

When SAFRING were consulted, it was found that not many African White-backed Ducks have been reported, indicating a possibility that if they survive up to fledgling age,

adult wild birds tend to be quite hardy and do not succumb easily to diseases. Other reasons for the lack of reports to SAFRING could be that African White-backed Ducks tend to spend most of their time in water, so if a bird did succumb to a disease or predator, it would most likely remain in the water and not be found by people.

Chapter 2: Material and methods

2.1 SOURCE OF THE SUBJECTS

Captive African White-backed Ducks are currently housed at Treehaven Waterfowl Trust (TWT) in Vereeniging, Gauteng, South Africa. Import permits were obtained from both the Department of Nature Conservation and the Department of Agriculture, in Pretoria, to import two pairs of these birds from Holland. The original breeding birds were obtained from a dealer in Holland, in November 1992. The birds were quarantined at the Government Quarantine Station at Kempton Park for a period of 30 days. Although the birds' blood test results were negative for all of their tests, one male died before the 30 day period had passed. A further male was imported to replace the dead one, in January 1993, via the same procedures. It survived the quarantine period and was put with the other three birds. The original three birds had already become bonded with each other and did not accept the fourth bird and it therefore became a loner and died seven months later in a cold spell during the winter of 1993.

It was necessary to import the birds because it was not possible to get permission to collect birds or their eggs from the wild locally and there were no African White-backed Ducks in captivity in South Africa at the time. These imported birds were bred and reared at Snawelhof B.V. in Zuidwolde, Holland. Their sires and dams were bred at Slimbridge Wildfowl and Wetlands Trust and other collections in England. The breeding birds in England originally came from Chinyeka Farm in Bromley, Zimbabwe. These original birds from Zimbabwe may be the ones referred to by Wintle (1981) which were reared from wild eggs in Zimbabwe in 1977. This would imply a lot of inbreeding.

2.2 CLASSIFICATION

Thalassornis leuconotus (literally meaning water bird/white back) can be distinguished from its closely related subspecies the Madagascar White-backed Duck *T. l. insularis* (water bird/white back/of an island) by the stronger markings, darker head and darker barring against a lighter buff ground colour of the latter. The latter subspecies is also smaller (Todd 1996).

There appears to be some disagreement between authors regarding the common name of *T. leuconotus*. Some authors refer to *T. leuconotus* as "African White-backed Duck" (Delacour 1959, Johnsgard 1978, Soothill & Whitehead 1988, Todd 1979, Todd 1996) while others refer to it simply as "White-backed Duck" (Brickell 1988, Clark 1979, Del Hoyo *et al.* 1992, Douthwaite 1977, Ginn & McIlleron 1982, Johnsgard 1967, Johnsgard 1995, Maclean 1985, Maclean 1997, Madge & Burn 1988, Milstein 1977, Wintle 1981, Zaloumis 1989). For the purpose of this study I will use African White-backed Duck throughout, so as to distinguish it from the Madagascar White-backed Duck.

The classification of this aberrant species has been the subject of much debate - and still is (Todd 1996). Initially both White-backed Ducks were grouped together with the stifftails (tribe Oxyurini), because they resembled them in shape (see Figure 2.1) and habits, and appeared to have similar tails. In fact, the White-backed Ducks' short, vestigial, non-rigid tails are quite unlike those of the stifftails and are at no time cocked by swimming birds, as in the stifftails (Todd 1996).

Figure 2.1: Visual comparison of African White-backed Duck (centre) to Maccoa Duck (left) and Fulvous Whistling Duck (right)

As recently as 1960 it has been proposed by Johnsgard (1995) to group them with the whistling or tree ducks (tribe Dendrocygnini) for the following reasons:

- The distinct network of reticulated scales on the lower legs resembles that of the whistling ducks. The scales are not scutellated as in the stifftails and other ducks. This is a primitive trait. These scale patterns are clearly illustrated in Figure 2.2.

Figure 2.2: Scutellated leg scales of Maccoa Duck (left) and reticulated leg scales of African White-backed Duck (centre) and Fulvous Whistling Duck (right)

- Whistling vocalisations - the similarity in syrinx shape indicates a close relationship to the whistling ducks. The trachea of the male has no bulla as in the whistling ducks, but has a bony plate from the insertion of the muscle to the bifurcation, forming a simple elongated box (Delacour 1959). Even the distress calls of young whistling ducks and young African White-backed Ducks are very similar (Johnsgard 1978).
- Feather proteins have been analysed by electrophoretic methods indicating similarities (Todd 1996).
- Relatively long necks (Todd 1996).
- Similar courtship displays, pair bonds, mutual participation of male and female in incubation and rearing duties (Todd 1996).
- Similar colouring of downy ducklings (Todd 1996).

2.3 CONDITIONS IN CAPTIVITY

2.3.1 CLIMATE: The TWT property is situated 3 km north of Vereeniging on the Highveld. It is on the west bank of the Klip River, and being in the lowest section of a river valley, it has its own micro-climate which differs from the nearby, higher-lying land. The ordinates of the property are 26° 37' 43" S and 27° 58' 00" E and the altitude is 1 562m above sea level. Autumn and winter are cold to very cold and dry. Absolute minimum and maximum temperatures of - 14,3 °C and 23,5 °C, respectively were recorded during July in the last five years, while daily minimums and maximums averaged - 0,3 °C and 17,2 °C respectively. Frost occurs most mornings from May through to August. These are also the months when little or no rain falls. Ambient relative humidity varies, at this time of the year, between 30 and 40%.

Spring and summer are warm to hot and wet. Absolute minimum and maximum temperatures of 7,3 °C and 34,3 °C, respectively were recorded during January in the last five years, while daily minimums and maximums averaged 15,1 °C and 27,9 °C respectively. The rainy season begins in September and with this, the frost stops. The rain can continue until March and even April. Annual rainfall is approximately 600 mm. Ambient relative humidity varies, at this time of the year, between 50 and 65%. Late afternoon thunderstorms are frequent, with heavy rain and sometimes hail. Although wild African White-backed Ducks have been seen at TWT and in large water-bodies nearby, this was only during the summer months.

2.3.2 HABITAT: The four imported African White-backed Ducks were placed in a five ha area. The area has eight large ponds, each on average 80 to 85 m long, 30 to 60 m wide and 1 m deep. Each pond is surrounded by *Eragrostis curvula*, bulrushes, kikuyu grass, water irises and papyrus. The water is continually moving as fresh water is pumped through the ponds on a 24 hour basis from the Klip River. The ponds are earth-bottomed. There are no concrete edges whatsoever, thus promoting a well balanced ecosystem in the water. Shade is provided by means of willow trees. The fish in the ponds are carp from the family Cyprinidae and *Tilapia* sp.

2.3.3 FEED: When the birds were first imported from Holland and still in Government Quarantine, they were fed only on EPOL Laying Pellets. Although a balanced meal, it in no way supplemented the natural live food which African White-backed Ducks could consume in a natural earth-bottomed pond. The nutritional composition of the EPOL Laying Pellets is shown in Table 2.1.

Table 2.1: Nutritional composition of Epol Laying Pellets (taken from the label on the bag)		
	g/kg	
	Minimum	Maximum
Protein	180	-
Moisture	-	120
Fibre	-	100
Calcium	55	-
Phosphorus	8	-
Lysine	5	-

When the birds moved from the Government Quarantine Station to TWT, they were fed on EPOL Laying Pellets and untreated wheat. The laying pellets were served in feeders which stood on racks, suspended over water (see Figure 2.3). This promotes hygiene as any food spilled into the water is eaten by passing fish or diving ducks. The new birds had to learn how to get to the food in the feeders by watching other birds. The wheat is served in stainless steel bowls, under ten cm of water which has a salt concentration of 3,5% volume. Only a very small amount of wheat is served as it tends to make the ducks overweight. The birds must submerge their heads completely into the salty water to get to the wheat. The salt ensures that no fresh-water leeches go into the birds' nostrils because the leaches do not tolerate salt at all. Leaches in the bird's nostrils would be fatal.

In March 1994, a duck floating pellet, especially designed by Coristo CC and later manufactured by Lopis, was produced in South Africa. This was then used as a 'treat' for some ducks including the African White-backed Ducks. They now consume as much as they are given three times a day. (They still get their laying pellets and wheat as well.) Their floating pellet ration per feed is limited to 1 kg for 16 birds. The nutritional composition of the floating pellets (Lopis Waterfowl Pops) is given in Table 2.2.

Table 2.2: Nutritional composition of Lopis Waterfowl Pops			
Biotin	0,25mg/kg	Niacin	180,00mg/kg
Calcium	8,60g/kg	Pantothenic acid	5,00mg/kg
Choline	2250,00mg/kg	Phosphorus (minimum)	3,90g/kg
Chlorine	0,30g/kg	Potassium	7,00mg/kg
Copper	22,00 mg/kg	Pyridoxine	5,50mg/kg
Crude protein	190,00g/kg	Riboflavin	7,00mg/kg
Fat (minimum)	56,00g/kg	Selenium	0,20mg/kg
Fibre	45,00g/kg	Sodium	1,50g/kg
Folic acid	1,50mg/kg	Thiamin	3,00mg/kg
Iodine	0,60mg/kg	Vitamin A	15000 IU
Iron	80,00mg/kg	Vitamin D	1400 IU
Lysine	10,00g/kg	Vitamin E	200 IU
Magnesium	2,00g/kg	Vitamin K	2,0 IU
Manganese	74,00mg/kg	Vitamin B12	0,02mg/kg
Methionine	3,90g/kg	Zinc	93,00mg/kg
Moisture	100,00g/kg		

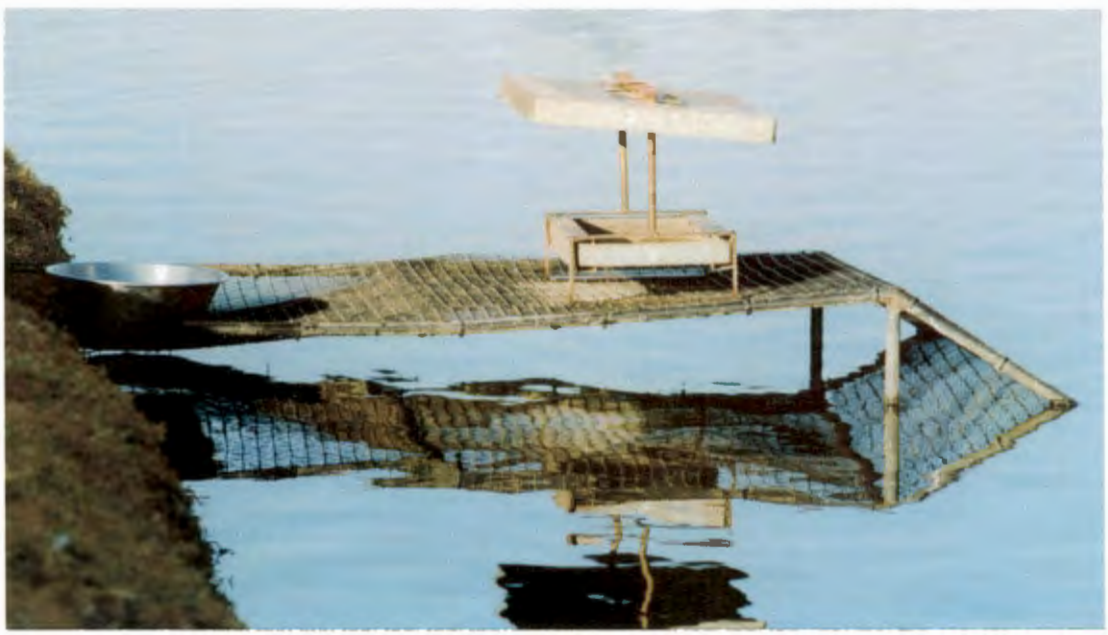

Figure 2.3: Feeding station at TWT showing the tray of laying pellets and wheat bowl

The adult African White-backed Ducks relish these floating pellets and since the introduction of the pellets the birds spend less time diving and foraging on the pond-bottom. They appear to be less active and spend more time resting up in the shade,

waiting for feed times. There is, however, a high concentration of bloodworms in the mud and *Daphnia* in the water. There is very little floating green food available to the ducks but even when it is offered they show no interest in it. The only plant seeds which are available are the grass seeds which blow off the heads of *E. curvula* onto the water.

2.4 SELECTION OF INDIVIDUALS FOR RESEARCH

The individual African White-backed Ducks under study are the three surviving imported adult birds, one male and two females, and any of their offspring. By the end of the study, there were sixteen individuals which had been set aside for breeding. These were made up of the original three birds plus thirteen of their offspring from the 1993/94 and 1994/95 breeding seasons. (These thirteen offspring reared in these two seasons adapted to living on the main preferred dam.) The other offspring, not included in the sixteen breeding birds, which were bred later, were used for measurements and experimentation on different feeding techniques. All sixteen breeding birds had reached sexual maturity during the period of study (December 1993 to January 1997).

2.5 SEX DETERMINATION TECHNIQUES

Little sexual dimorphism is displayed by this species, especially prior to sexual maturity. Even at a mature age males and females are very difficult to tell apart but there are a few general tendencies:

1) Males of similar ages to females are generally slightly larger and heavier than their female counterparts. All of the males' measurements are generally higher than those of the females, including beak sizes, wingspan, body length and tarsus length.

2) The males' heads are larger and more bulbous than those of the females and the nape

feathers are more dense and form a more distinct indentation at the base.

3) According to Wintle (1981) there appears to be a correlation between beak colour and sex. He says that males tend to have more yellow spots on the beak than females. Unfortunately this system of sexing is very variable and is apparently dependent on the origin and lineage of the birds. It is only feasible to compare beaks of birds which emanate from the same area. This method is also dependent on the birds' ages, making it a very unreliable method (Wintle 1981).

There appears to be no notable difference in voices between males and females. Unlike most other species of waterfowl, including close relatives such as the whistling ducks, African White-backed Ducks are not possible to vent sex at a young age. One needs to wait a full 18 months before a clear difference is seen, and even then, it is in no way as clear as that of other species of ducks. Vent sexing (see Figure 2.4) is done by carefully and systematically pulling the cloacal walls outwards to expose the anus and oviduct or the anus and the phallus inside. At a young age both males and females have a phallus which appears as a tiny lump on one side of the cloacal wall. As the birds mature, the male's phallus develops into a small tubular structure (see Figure 2.5) and the female's does not (see Figure 2.6).

Figure. 2.4: Vent sexing

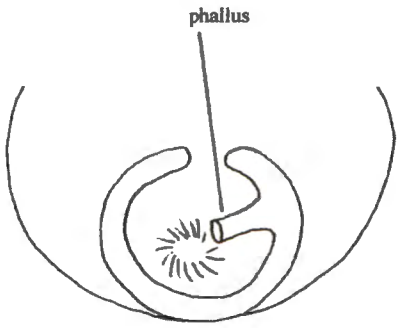

Figure. 2.5: Male cloaca

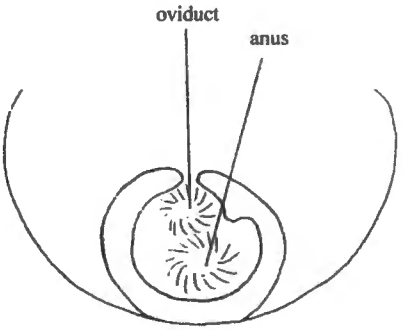

Figure. 2.6: Female cloaca

2.6 OBSERVATION TECHNIQUES AND RECORDING

Observation of the adult African White-backed Ducks was mostly obtrusive. In fact it was very difficult to get the ducks in view without them being well aware of the observer's presence. Even if one crept up on them it was quite obvious that, by the time you got to them, they already knew they were being watched. This was evidenced by the fact that they started swimming from the far side of the dam to the near side, in the hope of some floating pellets coming their way. Even when they had no visual cues they still knew that someone was on their way. It could be other cues that they used such as the gate opening and closing even though the gate was about 150 m away.

Most of the observation of the adult ducks took place in the early morning and late afternoon because these are the African White-backed Ducks' most active times. Observation, by means of sitting and watching, took place daily for the whole study period (December 1993 to April 1998). All recording of information was done by taking notes and by dictaphone, both of which had to be transferred at a later stage to a notebook. During the breeding season, observation was more intense (a minimum of two hours per day) and was not confined to mornings and afternoons as was the case with non-breeding seasons (a total of one hour per day).

With the young African White-backed ducks, observation time was limited due to other duties and this caused some of the fatalities mentioned later in CHAPTER 3. More time observing them might have prevented some of the deaths.

In future studies the use of Closed Circuit Television to study behaviour should be used. Unobtrusive observation (e.g. by using cameras) might give more objective results, because it is a well known fact that birds do not behave in the same way when they know they are being watched as when they do not know that they are being watched.

2.7 MEASUREMENT AND STATISTICAL TECHNIQUES

Body measurements of the African White-backed Ducks were carried out by means of a pair of Mitutoyo calipers, accurate up to 0,05 mm. The following standards were used:

Beak length: The proximal edge of the bill to the most distal part of the hook.

Body length: The distal part of the hook on the beak to the distal tip of the tail. The bird was placed in a lying position on a towel and flattened out.

Tail length: The proximal part of the innermost tail feather, where it enters the epidermis, to the distal tip of the same feather.

Tarsus length: The right tarsus was measured from the outside of both the joints while the right leg was semi-flexed in a Z shape.

The mass of adults, ducklings and eggs were determined by using an electronic balance, accurate up to 0,01 g. The balance used was a Shimadzu Libror EB - 4000 H, which can measure mass up to 4 kg.

Standard statistical methods were used to quantify tendencies between various parameters such as medians, means, standard deviation and test statistics.

2.8 ARTIFICIAL INCUBATION

Artificial incubation in the form of incubators has a number of purposes and advantages:

- The easy to clean incubators are more hygienic and more reliable than using broody hens or natural duck mothers as incubators and they are less labour intensive.
- Breeding birds may be encouraged to lay again if the first clutch of eggs is removed. This phenomena can benefit research, breeding successes and conservation.
- Artificial incubation can also 'save the day' if eggs are abandoned or if something unforeseen happens to the incubating birds.

Figure 2.7: Grumbach incubator, Model: 8014 used during this study

The incubators used in this research project were the German manufactured GRUMBACH, Model 8014 incubators (see Figure 2.7). These incubators are fully automatic once set, but the eggs must be monitored regularly for correct and healthy development. Eggs must be removed immediately if they become addled, and pipping eggs need to be removed to a hatcher where the relative humidity is 85%. This high relative humidity allows the embryo to turn around easily inside the hatching egg,

without drying out and adhering to the membranes. The eggs were monitored weekly with a candling lamp for correct development. The incubator was fumigated, with a mixture of 3 ml of formalin and 1 g of potassium permanganate, before any eggs were put in it. (Caution was taken not to inhale the fumes released from the chemical reaction and eye contact was avoided.)

Other conditions which artificially incubated African White-backed Duck eggs experienced were as follows:

- It was attempted to maintain a temperature of 37,4 °C, but variation between 37 and 37,8 °C was acceptable.
- Eggs were cooled twice daily at 07:00 and 17:00 for half an hour each time, (this is affected by the thermostat switching off automatically at the set times.)
- Relative humidity until external pipping stage was set at 60%. (After external pipping it was increased to 85%.)
- The eggs were turned every two hours with the eggs taking half an hour to turn around 180 degrees.

2.9 EGG VIABILITY

The viability of an egg is a measure of the chances that an embryo in a fertile egg will develop properly, fully and healthily and hatch successfully and completely. The following factors have an effect on viability and should be borne in mind when setting eggs in the incubator:

1) **Freshness of eggs at incubation commencement**: Eggs should not be stored in the dormant stage for longer than three weeks prior to incubation. During storage, the

eggs need to be turned at least twice daily and should be kept under ideal storage conditions: a) temperature: 15 to 20 °C

b) relative humidity: 40 to 50%

c) should be kept on a disinfected shock absorbent sand bed

d) should lie with the rounded end of the egg facing upwards at a 45° angle

2) **Fertility**: To be viable and to hatch, the egg must be fertile. This can be determined by candling the eggs after at least 3 - 5 days of incubation have taken place.

3) **Correct incubation techniques**: The turning, temperature, humidity and cooling of the eggs must all be correct.

4) **Handling**: It is very important, especially when the eggs are fresh or when the embryos are in the early stages of development, to handle the eggs very gently, as any bumps, shaking or fast rotation of the eggs can kill or cause irreparable damage to the embryo.

5) **Infections**: Fungal or bacterial infections, which can enter the egg shell at any stage, can infect the embryo causing the egg not to hatch, or even cause deaths in young ducklings. If the eggs are soiled with droppings, or the eggs were in contact with other bad eggs, it is advisable to rinse them in a disinfectant of warmer temperature than the egg itself. The warmer temperature keeps the pores in the egg shell open so that the bacteria can leave the shell. If a cold rinse is used the pores close up and the bacteria remain trapped in the pores of the shell (Harvey 1990).

THERE ARE THREE TECHNIQUES USED IN DETERMINING THE VIABILITY OF AN EGG:

1) One can check the fertility, condition and stage of development of an egg after three to five days by candling it with a very bright light (Figure 2.8). One should see the developing embryo and supporting blood vessels and the airsac. Avoid candling an egg for longer than one second at a time.

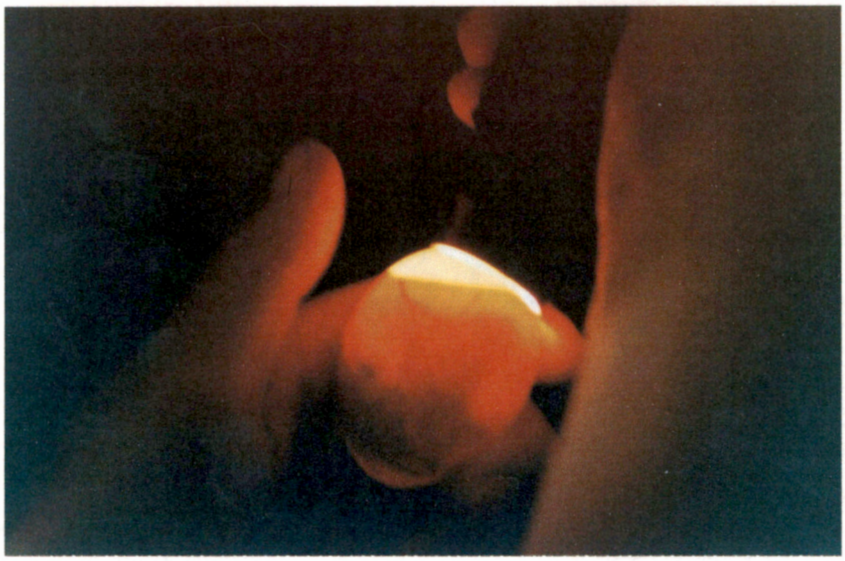

Figure 2.8: Candling an egg

2) The size of the airsac (seen during candling) is an indication if development is progressing as it should. If it is smaller than normal, the air surrounding the developing egg is too humid, resulting in the membranes being too limp. If it is larger than normal, the air surrounding the egg is too dry, resulting in the membranes contracting too much (see normal stages of airsac development in Figure 2.9).

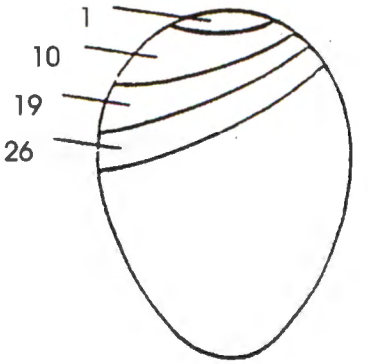

Figure 2.9: Normal stages of airsac development at days: 1, 10,19 and 26

3) Plotting the loss in mass of an egg can be done with the use of an electronic balance (Figure 2.10). Each species of bird has an ideal loss in mass during embryonic development, over the whole incubation period. This loss in mass is due to the loss of moisture from the developing egg to the air around it. This can be controlled by adjusting the relative humidity in an incubator. The rate of moisture loss is determined during the first 10 days of incubation and after this period it is very difficult to change same by changing the humidity settings. It is, therefore, important to monitor the loss of mass and plot it on a graph in the early stages of incubation and make the necessary adjustments early.

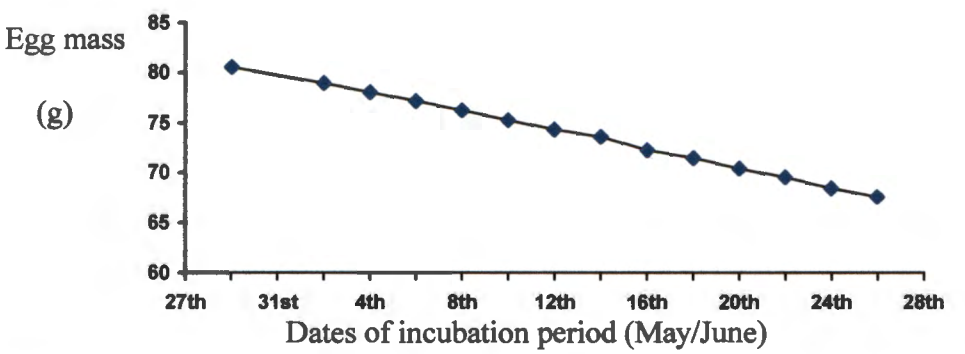

Figure 2.10: Graph showing loss in mass of a correctly incubated African White-backed Duck Egg

2.10 CAPTIVE REARING TECHNIQUES

2.10.1 PARENT-RAISING

Not many eggs were left with the breeding birds to hatch themselves because this tends to slow down production. If eggs were removed after two weeks of natural incubation, the birds would again be available for breeding. If the eggs were left with the adult birds, they would incubate for the full term, then rear the ducklings for at least two months. This would then be followed by a moult, thus putting a hold on further breeding for some time. On three separate occasions the eggs were left with the adult birds:

1) A mature, imported female laid six eggs. Two were taken from her, artificially incubated and hatched. The breeding birds hatched their four eggs on the 17th October 1994 and are shown with them in Figure 2.11. Floating pellets were offered to the whole family from the first day onwards.

Figure 2.11: Adult African White-backed Ducks with ducklings

2) On the 18th December 1994, a female hatched two of four eggs. The other two were addled. All wheat bowls in the area were temporarily removed. Again, floating pellets were offered to the whole family from the first day.

On the 6th of February 1996, a female hatched 10 ducklings. These were taken from her that same day to be hand-reared.

2.10.2 HAND-REARING

a) **Dry-feeding**: The first two African White-backed Ducks which hatched were treated just as dabbling ducks would be treated. They were put into a wire cage, 60 x 60 x 30 cm, with an infra-rubin globe 30 cm above them to keep warm and dry. A one litre plastic drinker with fresh water was provided and a bowl of EPOL starter crumbles. A piece of paper towel, which was also covered in crumbles, was placed in the cage. This normally encourages the ducklings to start pecking at food because they are surrounded in it all the time. They were then left to fend for themselves.

b) **Force-feeding**: The next clutch of ducklings were force-fed, with different types of food. The reason for this was because it was not yet determined if it was the type of food or the amount of food intake, causing the lack of growth in the ducklings. There were five ducklings and five different foods were tried.

1) AVIPLUS (game bird starter) + BETABAC (bacterial mixture used to boost protein content of food)
2) AVIPLUS (game bird starter)
3) EPOL (broiler starter crumbles) + BETABAC
4) EPOL (broiler starter crumbles)

5) 50% AVIPLUS + 50% EPOL + BETABAC

All food types were ground very fine in a coffee grinder and then sifted through a tea strainer, so that the crop needle used to force-feed would not get blocked. The dry mixtures were mixed with warm water to a soft porridge consistency. Each meal consisted of 0,5 ml of porridge. They were fed ten times a day from 05:30 to 23:00. Two mealworms were fed every second meal in the first week.

c) **Wet-feeding - crumbles**: The EPOL starter crumbles seemed to be a good food for the first three weeks of life, but it was impractical to force-feed 10 times daily as this is very binding and time consuming. For the next clutch of ducklings, the crumbles were served wet in the form of sprinklings in the drinking water.

d) **Wet-feeding - high protein**: Having observed the incessant diving of parent-raised ducklings it was decided to try and feed the hand-reared ducklings on something which they would naturally find on the pond-bottoms when diving. Frozen *Daphnia*, shrimp larvae and bloodworms were obtained from a local pet shop. For a group of up to five ducklings, two blocks of each type of food were put into the water in the drinker. These blocks would melt and the ducklings soon learnt to filter them out of the water. This filtering method of feeding suited them very well. A bowl of dry EPOL starter crumbles was placed next to the drinker. When the ducklings splashed water onto the crumbles during dabbling, it would wet the crumbles slightly and then they would start nibbling at the crumbles from 7 to 10 days of age. At about three to four weeks of age the crumbles were gradually replaced with EPOL laying pellets and the frozen foods were replaced with crushed and later whole floating pellets.

Chapter 3: Results and Discussion

3.1 DESCRIPTIVE COMPARISON BETWEEN CAPTIVE AND WILD INDIVIDUALS

It was felt that a description was necessary as the observations recorded here have not been recorded before.

The bill is very strong (as personally witnessed when being attacked by many African White-backed Ducks, resulting in blood blisters) and is sharply hooked at the end. The top mandible is very hard and appears to rub over the lower mandible, thus keeping the latter sharpened. The neck feathers taper inwards at the base of the neck, almost forming a line as though the neck is being constricted by something. The main body, wings and tail are mottled tawny brown and black (see attached feather, Figure 3.1) affording them excellent camouflage in the dappled shade of reed beds and sedges. This colouring gives the impression of a tiger's-eye stone at first glance. The black legs are placed well back on the body, making walking on land somewhat awkward but, unlike other authors' observations, they can still run surprisingly quickly when under pursuit. The legs are also placed quite far apart to assist in diving, a favourite pastime. The black, webbed feet are large in proportion to the small body. This also assists in diving. The toes are armed with sharp claws, enabling breeding birds to clamber quickly and efficiently through reed beds. Hidden by the folded wings, the back is almost pure white in colour. The white patch is in the shape of a four pointed star and takes up most of the back (Figure 3.2). It is very distinct in flight and when the birds flap their wings or rouse their feathers. Other characteristics such as colour and posture were as described by other authors for wild birds (see Chapter 1).

Figure 3.1: Contour feather of an African White - backed Duck

Figure 3.2: Exposing the white on the back of the African White - backed Duck

Sixteen randomly chosen African White-backed Ducks (8 males and 8 females) were measured. The results are reflected in Table 3.1 (the ducks were all within a month of 18 months of age). Males were slightly larger in all measurements, thus making visual sex determination by size more realistic. There was a highly significant statistical difference ($p < 0,01$) between males and females in body mass, wingspan, tail length and tarsus length. The difference in tail length was particularly significant. There was also a significant difference ($p < 0,05$) in beak length and width.

Table 3.1: Table showing body measurements of African White-backed Ducks

PARAMETER	FEMALES (8) (mean and range)	MALES (8) (mean and range)	OVERALL MEAN(16)	t-value	P-value
BODY MASS (g)	571,0 (554,4 – 591,8)	615,6 (591,4 – 667,2)	593,3	5,6154	0,000064
BEAK LENGTH (mm)	33,8 (33,1 – 34,3)	35,1 (34,0 – 36,4)	34,5	2,2478	0,041228
BEAK WIDTH (mm)	19,4 (18,9 – 19,9)	19,8 (19,2 – 20,7)	19,6	2,2905	0,038028
WINGSPAN (cm)	52,9 (51,5 – 54,5)	57,5 (55,1 – 61,1)	55,2	5,2142	0,000131
BODY LENGTH (cm)	36,7 (35,9 – 37,8)	37,7 (36,8 – 39,1)	37,2	2,8467	0,012934
TAIL LENGTH (mm)	42,0 (40,2 – 45,1)	53,1 (50,0 – 54,3)	47,6	14,4238	0,000000
TARSUS LENGTH (mm)	36,7 (35,9 – 37,6)	38,7 (37,0 – 39,9)	37,7	4,4917	0,000507

The ducklings were relatively large, long-downed and precocial. This large duckling size with the large reserves of yolk and fat appeared to be an adaptive feature associated with their vigorous and independent infantile feeding techniques. The shape of the ducklings was similar to that of stifftail ducklings: very rounded with very short legs, resulting in a duckling which is clumsy when on land but very proficient at moving in water. The head shape resembled that of whistling ducks. The beak was large and hooked - not spatulate as in stifftails.

As can be seen in Figure 3.3, the top of a duckling's head is black. The back is black in the middle, becoming brown to buff in colour on the sides. The lower part of the head and neck are a tawny colour. The chest is a pinkish tawny colour. The belly is a black to grey colour with a pale stripe on the sides.

Figure 3.3: Newly hatched African White-backed ducklings

Table 3.2: Body measurements of ducklings taken from Appendices 1 & 3			
Parameter	**n**	**Mean**	**SD**
Body mass (g)	82	51,0	7,44
Beak length (mm)	16	15,4	3,83
Tarsus length (mm)	16	23,7	5,85
Wing-tip length (mm)	16	15,6	3,85

Mass and measurements of ducklings hatched at TWT are shown in Table 3.2. Newly hatched ducklings have a unique, small, sharp hook on each of their alulas. This is used to clamber up through reeds and plants back to the nest. The ducklings may also have to follow their parents to other ponds through tall grass and reeds, with the help of these 'claws'. The only other African species which has this is the Spurwinged Goose (*Plectropterus gambiensis*) but in this species it grows much larger as the bird matures, and is used as a weapon during aggressive encounters. In African White-backed Ducks it becomes rudimentary. The ducklings are proficient divers from their first day on the water and, when under pursuit, can dive to safety with ease. The ducklings' distress calls are similar to those of young whistling ducks. The fledglings are a minimum of 8 weeks old when they take their first flight. Between 12 - 16 weeks of age they are fully grown and fledged. Immature birds are darker and less clearly marked, but they tend to have more black spots on the side of the head compared to adults (pers. obs). The general descriptions of body shape and colour, by a number of researchers, are very similar to those characteristics found in the captive birds. There are some differences in the measurements of adults, however, as shown by Table 3.3. The difference in body mass between the wild and captive African White-backed Ducks

could be explained by the fact that the captive birds measured had just reached maturity (18 months) and still had to fill out and/or the fact that the captive birds had been pinioned. Being pinioned results in a loss of mass from the missing half-wing. Breast muscle tone would also not be as high in flightless birds as it might be in flighted wild birds. Another possibility could be that the captive birds were not all living naturally on a large pond and, therefore, might not have been eating as freely and as much as wild birds would have.

Table 3.3: Wild (previous literature) and captive African White-backed Ducks' measurements showing percentage differences

CHARACTERISTIC	WILD (mean of medians, n=?)	CAPTIVE (means, n=16)	Percentage difference
Body mass (g)	696,3	593,3	- 14,79 %
Beak length (mm)	39,8	34,5	- 13,23 %
Body length (mm)	40,5	37,2	- 8,27 %
Tail length (mm)	47,8	47,6	- 3,77 %
Tarsus length (mm)	37,5	37,7	+ 0,51 %

3.2 COMPARISON BETWEEN HABITAT PREFERENCE OF CAPTIVE AND WILD INDIVIDUALS

Figure 3.4 shows the pond that the flock of African White-backed Ducks at TWT chose to inhabit. The pond is approximately 100 m long and 25 m wide. There is a peninsula running three quarters of the length of the pond. The peninsula varies between 4 to 6 m wide. Growing all along the peninsula is tall grass and reeds in which the African White-backed Ducks can nest. The West and South bank of the pond is also full of reeds and the North bank has water irises growing on it. These banks are also favourite nesting areas.

During the breeding season, due to some aggression between males, some pairs disperse to other adjacent ponds where, again, in the reeds at the edge of the water, nesting takes place successfully.

The pond they have chosen (they were not originally released on this pond) varies in depth between 0,1 m to 1,5 m. The water in all of the ponds is flowing continually and they are earth-bottomed, ensuring a well-balanced ecosystem. They have chosen a pond which is very open to the elements, both hot and cold, but they do not seem to be adversely affected by this. During the colder winter months starting with the May/June moulting period, the flock tends to congregate together closely, with minimal aggression and less vocalizations, in their favourite pond.

Figure 3.4: Favourite pond of the African White-backed Ducks at TWT

Wild African White-backed Ducks have on rare occasions visited TWT and many have been sighted on urban, permanent water sources in the Vereeniging area during wet summers, some even breeding (pers. obs. & pers. comm. with other aviculturalists.)

The pond that the captive African White-backed Ducks have chosen, fits very well into the description by Brickell (1988), Johnsgard (1978), Maclean (1985) and Soothill & Whitehead (1988) of African White-backed Ducks' preferred habitat. The differences between their chosen pond and the others in that pen are:

1) There are much fewer birds of other species on the pond (the few other species which are there are all indigenous).
2) There is a much longer edge to the dam, because of the long peninsula, affording more choice in nesting sites.
3) It is more private because it is surrounded by high reeds, so they can remain unobtrusive.
4) The pond itself is smaller than the others.

The fact that wild African White-backed Ducks have been sighted at TWT and at permanent water sources in the Vereeniging area during times of heavy rains, supports the view of other records that African White-backed Ducks are nomadic and tend to migrate to areas of recent rain. They have only been seen in the warmer months, suggesting that Vereeniging is too cold in the cooler winter months and possibly too dry.

The African White-backed Ducks at TWT tend to mix with the *O. maccoa* and some other indigenous duck species such as the *D. bicolor* and the Cape Shoveller (*Anas smithii*). They are free to move to other dams, but they tend to stay near these other birds. This is in

agreement with the records of Delacour (1959) and Johnsgard (1978). The African White-backed Ducks appear to avoid the company of exotic duck species.

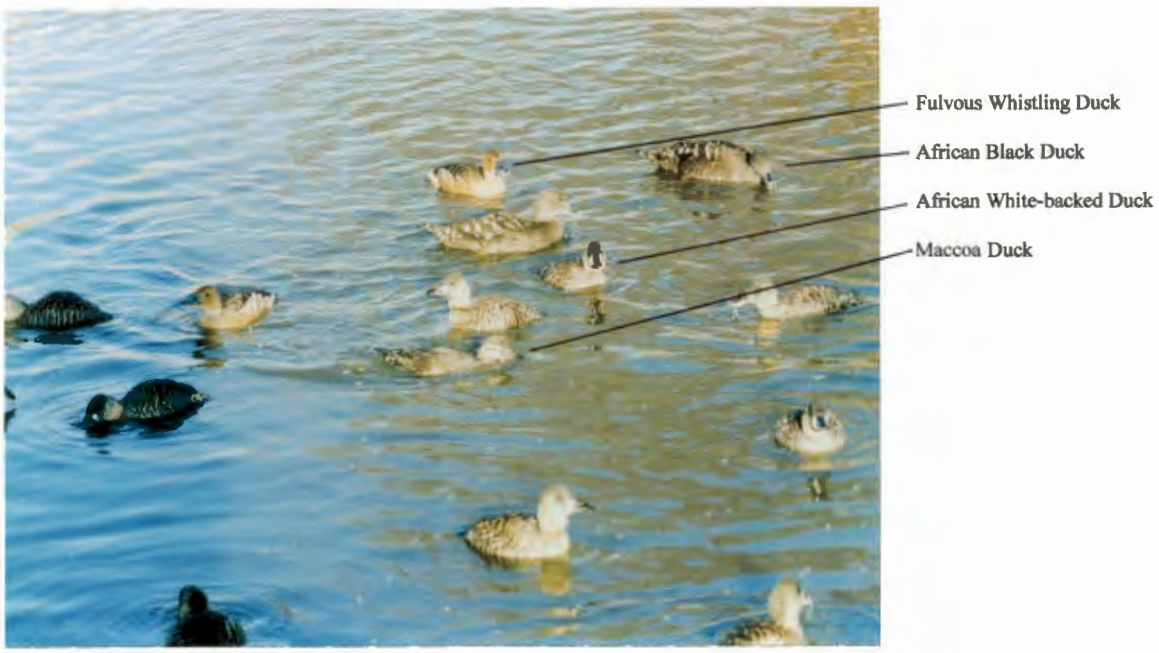

Figure 3.5: African White-backed Ducks feeding with other indigenous species: African Black Duck (*Anas sparsa*), Maccoa Duck (*O. maccoa*) and Fulvous Whistling Duck (*D. bicolor*)

3.3 FOOD PREFERENCE OF CAPTIVE INDIVIDUALS COMPARED TO WILD INDIVIDUALS

Anseriformes generally choose to frequent water-bodies which have a high nutrient value, with plenty of organic material to feed on, and African White-backed ducks are no exception (pers. obs.). This could explain, for example, why water-bodies such as the Okavango Delta in Botswana have a much lower density of waterfowl than what one might expect to find on such a large water-body. The water there is very clean and this does not serve to attract waterfowl as there is very little organic nutrients in the water for the adults and ducklings to feed on. It could also explain why bird sanctuaries, which are situated around public sewage works are always rich in successfully breeding waterfowl populations. This may be due to a

supportive ecosystem, consisting of abundant life in the water. The ponds at TWT are filled with water from the Klip River which is 'recycled' sewage water from seven different sewage farms upstream from the property. The high nutrient values in the water could explain the excellent breeding records of the waterfowl on these ponds.

The captive African White-backed Ducks have become very reliant on the LOPIS floating pellets which are fed to them three times a day at regular times. This could replace the natural tendencies to eat floating vegetation which they are said to eat in the wild. They do also dive for food to the bottom of the pond, but not as much in recent years since the introduction of the floating pellets. They fight each other to get to the very limited wheat supply and they also eat the EPOL laying pellets. It is known from checking mud samples that the pond-bottoms have a very high concentration of bloodworms and in the summer months the water is rippling with clouds of *Daphnia*. The ducks invariably must take in high numbers of *Daphnia*, even if inadvertently, during floating pellet feed times.

It was observed that parent-raised ducklings spent the first three weeks of their life diving to the pond-bottoms to forage. At three weeks of age their feeding habits changed and they became dependent on floating pellets. This indicates a high protein requirement in their diet for the first three weeks of life.

It is difficult to explain the differences in food preference between wild birds and captive ones because of the availability or lack of availability of certain foods in captivity. For example, if copious amounts of *Nymphaea* were available to captive African White-backed Ducks, then possibly they would become dependent on them, but all attempts to establish

Nymphaea in the ponds at TWT failed, owing to the cold winters and excessive consumption by the other duck species.

Before the advent of floating pellets, the diving habits of the captive African White-backed Ducks were similar to those of wild birds, diving down to the bottom of the pond for up to 30 seconds at a time. The birds were also crepuscular.

During the seed producing months, *E. curvula* seeds may be a significant replacement of vegetative feed matter (December to March).

The failure of ducklings to eat various foods as discussed by Kear (1967) may be due, not to the kind of food, but the way in which it is presented, which can be critical, and also the volume. However, Kear does not give these details. For example, it is hard to believe that the *Daphnia* was not relished by the ducklings when the hand-reared ducklings at TWT did so well on it. Possibly the birds were not in a good state of health when they were given the *Daphnia* or possibly the *Daphnia* was not available in those days in easy to serve frozen blocks as it is now.

3.4 GENERAL BEHAVIOUR OF CAPTIVE INDIVIDUALS COMPARED TO WILD INDIVIDUALS

The captive birds at TWT are stimulated into activity by human presence so their active times are regulated by humans which entail active times of:

early morning -	07:00 to 08:30
midday-	12:00 to 13:00
late afternoon -	17:00 to 18:30

Much excitement, vocalizations and quarreling occurs at these times. This is slightly different to observations in the wild where they are crepuscular, but it appears to be a captive adaptation resulting from the dependence on the floating pellets.

When they feel threatened or sense that there may be some disturbance such as during the catching of ducks, the birds may swim away with necks vertically outstretched and calling, while others surreptitiously dive away from the possible danger. This is in agreement with wild records. Dives have been timed repeatedly up to a minute which is longer than observations in the wild. In a long dive such as this, the bird is not very active and swims slowly. Just prior to surfacing, bubbles of air are released from the lungs and air sacs and this is a sure sign that the bird will bob up to the surface shortly, just in front of the bubbles. They often surface between floating vegetation and are extremely well camouflaged at this time, so much so that one would believe that the bird has completely disappeared.

During resting times, they may be observed on the banks of their pond (Figure 3.6), sometimes in the 'sail-boat' position (Figure 3.7) with the two feet in the air or on the water, either in 'sail-boat' position or with their head under their wings or just floating motionless and sometimes staring straight in front of them. It has been observed that, on very windy days, birds which are in the 'sail-boat' position actually get pushed along the water surface by the wind. This 'sail-boat' position appears to be unique to this species of waterfowl as it has not been observed in any other species. A similar resting position has been observed in some stifftails where one foot is tucked up under a wing (whilst in the water) and the other foot is paddling, but the resting foot does NOT stick up in the air like the African White-backed Duck. It is possible that this position has some thermo-regulatory function owing to

the fact that there are many blood vessels in the foot and that the phenomenon is observed mostly on hot days. Their feet seem to be very sensitive as even the skin on the ducklings' feet dries out when being hand-reared. This does not happen with any other species. No reason for this phenomenon is given in previous literature.

Figure 3.6: African White-backed Ducks resting on the bank of the pond

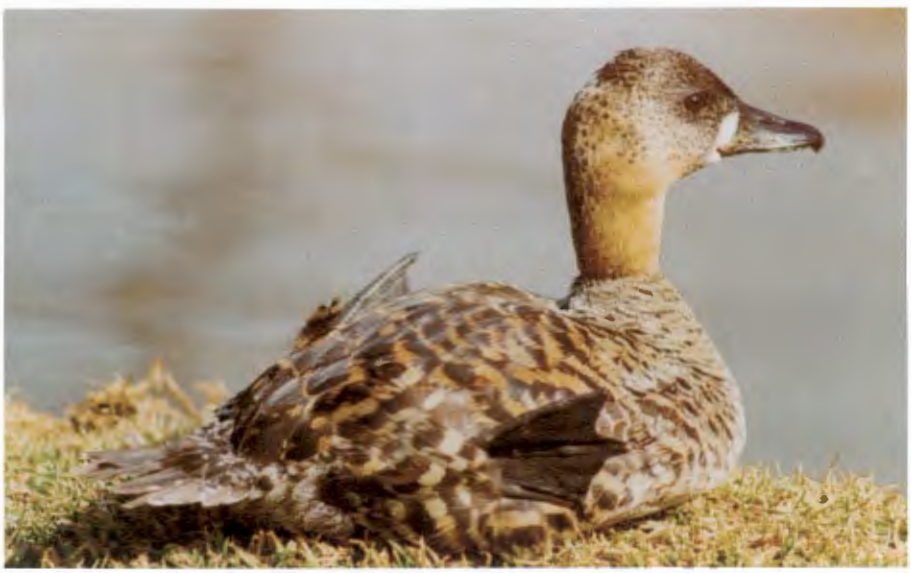

Figure 3.7: Characteristic 'sail-boat' position

Contrary to previous observations of wild African White-backed Ducks (Todd 1996), when on land, they are seen to walk comparatively well on their widely placed legs especially when compared to stifftails.

Although living contentedly with other South African ducks, and their conspecifics, there is a distinct pecking order in small groups with the dominant male continually making sure that none of the other males get too close to his female or the floating pellet food. This instinctive aggressive streak could explain why birds are often found in small family parties in the wild. As soon as one male starts behaving aggressively the other families may move off to other areas. Out of breeding season, they all form one large group, all living in their preferred pond. They feed together in this large group but then split up during the day to rest in pairs or small groups. During the breeding season pairs walk (because they are pinioned) to other ponds to establish breeding territories and commence nest construction. During quiet times of the day they may be observed actively bathing, during which time the white on the back is very conspicuous. On very hot days they are seen to take cover in the shade of the reeds along the pond edge. On colder days they sit facing the sun along the edge of the pond.

When this captive flock is faced with a human intruder, they display a high degree of tameness. After a few high-pitched squeaks and squeals, they eventually approach the intruder. Some individuals even exit the water to attack the intruder, attempting to bite and then they quickly retreat back to the water. If the intruder remains in their presence, they eventually continue with their normal activities, but maintain visual contact. When faced with an animal intruder such as a dog, they initially retreat to safety uttering their squeaks of alarm. After a while they come closer to the intruder. If the intruder makes a sharp

movement, they retreat in a hurry, only to move closer again a few minutes later.

When wild African White-backed Ducks have been seen flying at TWT, they flew very low, no more than three metres above the land or water surface. Their flight seemed laboured. This is in agreement with observations in the wild.

The captive African White-backed Ducks seemed to use a number of different calls to communicate between each other. A high-pitched, short squeak is used for alarm. Some of the birds have different tones or notes to others - this may be sex-related, but it was not possible to tell which birds were calling because the beak does not open much and the noise is uttered so quickly. A two-note, high-pitched squeak is used for locating birds which are out of sight of one another. A peculiar whining, high-pitched squeal was uttered whilst interacting during feeding times, especially if the food was temporarily suspended. Whilst waiting for food, squeals increased in tempo and intensity and aggressiveness increased.

3.5 BREEDING BEHAVIOUR OF CAPTIVE INDIVIDUALS COMPARED TO WILD INDIVIDUALS

At TWT the African White-backed Ducks were never once observed mating nor showing any kind of courtship rituals. The only signs of breeding which were observed were females which were very heavy with eggs and who had difficulty walking because of this, and one or both birds of a pair suddenly appearing from within reed beds and appearing very alert but quiet, with outstretched necks. Often the move to another pond by a pair was an indication that they were about to commence nesting.

The first ever African White-backed Duck nest at TWT was on the peninsula in the pond

they inhabit, between tall grass and Evening Primrose flowers. It was in a position that if one knew where it was, one could look straight at it from the main pathway but one could not see the incubating bird. After that occasion, the reed beds have been more popular (Figure 3.8) with nests being made less than 0,5 m from the water's edge and a maximum of 0,3 m above the water's surface. The reeds were pulled down to make a platform and then more were pulled down over the nest to form a canopy. More often than not ramps leading to the nest from the water were constructed. The water irises on the banks also leant themselves well to this kind of nest construction. No down was ever found in the nests. All of the above is in agreement with observations of other researchers (Johnsgard 1978, Brickell 1988, Zaloumis 1989, Todd 1996). Sometimes nests were made in reeds which were free-standing in the water, away from the edge of the pond. Quite regularly a number of nests were constructed within 2 to 3m of each other but only one of these was used at a time. This is in agreement with observations of Todd (1996) and Wintle (1981).

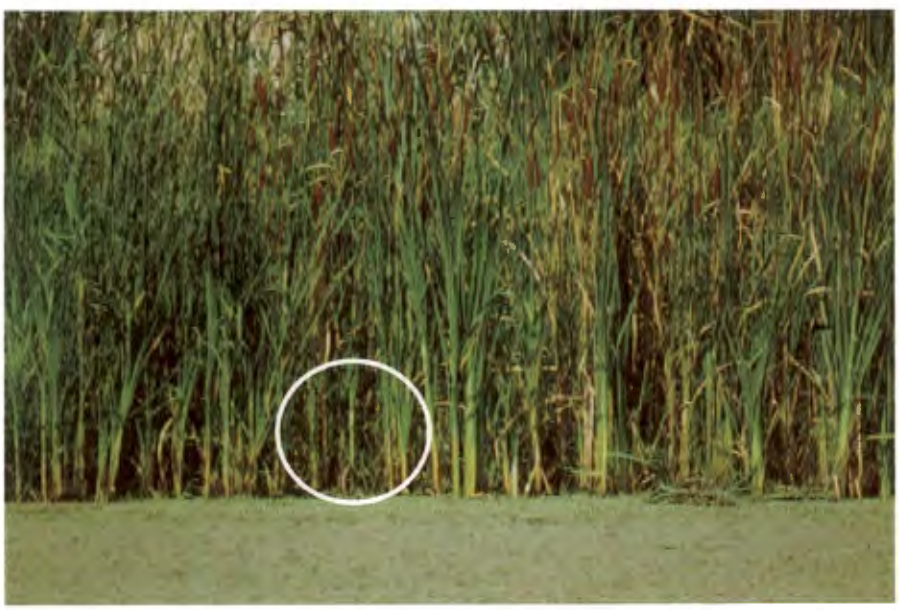

Figure 3.8: Circled area indicates where the African White-backed Duck nest is situated

Invariably, during the day when nests were checked, the male was found to be incubating and the late evening change over usually resulted in the female doing the night shift of incubation. This was also observed by other researchers, and this behaviour is similar to the closely related whistling ducks. Nest site aggression was very evident and if any intruder approached a nest, whether it was human or animal, the intruder would immediately be attacked. Repeated lunges with splashing water and open, hissing mouth were launched until the intruder left the area. Even if the birds were incubating they would not return to the nest for a while till they had seen the intruder disappear. It is very difficult to determine exactly when incubation starts because the female generally only starts incubating after the last egg is laid, although it can also be just before the last one or two eggs are laid. However, one complete incubation period was measured at 32 days in duration (artificial incubation). An adaptation which one incubating female made in captivity was that she left the nest every time floating pellets were fed. Immediately after she had eaten she would return to the nest, quite blatantly revealing the location of the nest. This unusually regular cooling of the eggs did not affect the hatchability of her eggs.

It was found in captivity, just as it was in the wild, that breeding birds were much more confident and aggressive, especially towards human intruders, than were non-breeding birds. The instinct to protect the nest, eggs or ducklings against potential threats was very strong.

3.6 BREEDING SEASONS IN CAPTIVITY COMPARED TO THOSE IN THE WILD

At TWT, African White-backed Ducks have been breeding and hatching in the months of October through to May. They have not bred in the winter months, where, in the coldest

month recorded at TWT during the study period which was July 1994, early morning temperatures dropped to a mean of -2.9 °C and the mean midday temperature was +18.1 °C (according to Weather Bureau records, which correspond with records kept at TWT).

The captive African White-backed Ducks have not hatched ducklings in April but one clutch hatched on the 27th May 1994. During April 1994 there were some unusually late rains (Table 3.4).

Table 3.4: Rainfall figures for April 1994 at TWT

DATE	RAINFALL (mm)
10/04/1994	7
19/04/1994	11
21/04/1994	3
TOTAL	21

The above case can be considered an exception rather than the rule, caused by a false spring climate at the time that those eggs were laid. One can assume, barring exceptions like this, that the breeding season for African White-backed Ducks in the Vaal Triangle would be October through to March, with the highest number of ducklings in October (20), December (22) and February (29) (during the study period). This can be deduced from Appendix #2. These months regularly have excessively high rains.

In a captive situation in Zimbabwe, Wintle (1981) observed a much broader breeding season. This could be due to the very mild winters in Zimbabwe compared with those experienced in the Vaal Triangle.

Wild records vary a lot but most of them incorporate mid-summer months or autumn or both. These seasons could well be climatically determined with a lot of emphasis on rainfall.

Another factor which could play a role is that certain ectothermic predators are less active in the autumn months when it is getting cooler and the African White-backed Ducks tend to be more successful at these times. Also, in some parts of Africa, although the heavy rains fall in mid-summer, it may take weeks and months for the water to reach other areas, filling lakes and stimulating the breeding of the African White-backed Duck.

3.7 SEXUAL MATURITY OF AFRICAN WHITE-BACKED DUCKS IN CAPTIVITY

The first three African White-backed Ducks at TWT were vent-sexed upon arrival and were found to be sexually mature. They were, therefore, over eighteen months of age. It was then one year before they bred. This means they were a minimum of two and a half years old when they bred. These birds' offspring were observed breeding successfully at eighteen months of age. At this age it is possible to vent sex-them conclusively which indicates sexual maturity, certainly in the male, (see section 1.3.7). The male phallus is at this age well developed and he is capable of fertilising eggs. This full development was not seen in birds younger than eighteen months, even with repeated attempts at sexing them every month until this age. As far as an upper limit for breeding is concerned, SAFRING, at the University of Cape Town, was consulted. They had very few records of African White-backed ducks. Only a few individuals which had been shot were reported and none of them were very old. They gave an estimate of 10 years of age for an upper limit of breeding, but advised that this was only an estimation based on records of other ducks. No other records for breeding age of wild birds could be found.

Based on personal observations with other small duck species, African White-backed ducks

could breed until about 12 to 15 years of age. The reason is that they take longer to mature than most other small duck species, and a general tendency occurs in waterfowl whereby the longer it takes to mature, the older the bird can be before successful breeding ability ceases.

3.8 COMPARISON OF EGGS IN CAPTIVITY TO THOSE IN THE WILD

As can be seen from Figure 3.9, African White-backed Ducks eggs are large and rusty brown in colour. Slight variations in the tone of the brown were observed. Some eggs had varying degrees of spotting on them in a darker colour which was not recorded for wild eggs. The eggs are oval, glossy and smooth-shelled and are normally coated in a layer of oil from the feathers of the incubating bird, making them slippery to the touch. This was not recorded for wild eggs. This does not coincide with the results of Delacour (1959) as he recorded a rough texture to the shell. Not typically egg-shaped, they are wide in relation to their length (see measurements below). They contrast sharply with the blue-white, rough shelled eggs of the Maccoa Duck which often parasitises nests of African White-backed Ducks and vice versa.

It was observed at TWT that African White-backed ducks took on average 10 days to completely lay an average clutch of six or seven eggs, making egg laying intervals about 36 hours. This is shorter than the 48 hours observed by Wintle (1981) and Ginn & McIlleron (1982). This could be a trait specific to different individuals and to how much those individuals eat. In captivity, there is an unlimited supply of food so the laying female might be able to accumulate enough protein to produce eggs quicker than in the wild because food is more readily available.

Figure 3.9: African White-backed Duck nest showing eggs

Table 3.5: Mass and size comparison between captive African White-backed Duck eggs and those in the wild in Vereeniging and other areas

	WILD (Waste water dam – Vereeniging) (n=36)	CAPTIVE (TWT) (n=105)	OTHER RECORDS (WILD) (n=?)
Mean mass (g)	75,6 ± 14,69 (55,09 - 91,70)	75,1 ± 8,84 (63,53 - 86,61)	81 (77 – 94)
Mean length (mm)	60,5 ± 10,62 (56,90 - 68,70)	61,9 ± 6,33 (56,00 - 66,90)	61,8 (55,0 - 68,8)
Mean width (mm)	47,9 ± 8,77 (45,30 - 50,75)	47,2 ± 5,10 (40,45 - 56,15)	48,6 (44,9 - 51,7)

With the results in Table 3.5, there is no significant difference between the mean mass of wild eggs in Vereeniging (an industrial waste water dam in town) and those laid at TWT ($t = 0,412$; $P = 0,680$). TWT and the wild site where the eggs were measured are about 20km apart with different water sources, so water pollution is an unlikely link. Altitude may have an effect on both the wild eggs in Vereeniging and the TWT eggs. The standard deviation in the captive eggs is smaller than that of the wild eggs, probably due to the more uniform conditions found in captivity. There is a difference between wild eggs laid in the Vereeniging area and at TWT, compared to the wild ones measured by other authors, but detailed data on wild eggs is not available to determine whether it is significant or not. Inbreeding in the captive birds could be a reason for their smaller size compared to wild

observations by other authors. The wild eggs were possibly from a completely different area or alternatively, the eggs were not all weighed at equivalent stages of development, and had lost varying percentages of moisture. An alternative reason could be that over the last decade there may have been a reduction in egg mass of wild eggs in the Vereeniging area due to pollutants in the industrial area in which those wild eggs were found and measured.

There is little difference between the captive and wild egg size. Eggs in captivity have a slight tendency towards being longer but narrower than the wild eggs. The eggs measured by other researchers tend to be slightly broader than the other eggs in the wild and the eggs in captivity. These differences should have no effect on hatchability.

3.9 CLUTCH SIZE IN CAPTIVITY COMPARED TO THOSE IN THE WILD

Clutch size is dependent upon the individual genetic diversity of the breeding birds, their condition, feeding and prevailing conditions and circumstances. At TWT, the mean to date has been 5,43 eggs per clutch (5 - 6) with a standard deviation of 2,28. This was calculated from the data in Appendix 2. With a mean mass of fresh eggs of 75,09 g and a mean mass of adult females of 571,03 g (SD = 13,88) it means that a female only needs to lay 7,60 eggs to have laid her own body mass in eggs. Most clutches are within this number and some exceed it. One egg equals 13,14 % of the female's body mass, which is why it is necessary for the female to eat more food than normal, prior to laying eggs. Johnsgard (1978) and Brickell (1988) noted that a number of females can lay in one nest, but this has not been observed at TWT yet. What has been observed is the dumping of *O. maccoa* eggs in the nests of African White-backed Ducks, sometimes up to three in a nest. This seems to restrict the number of eggs that the African White-backed Duck lays due to limited space in the nest.

The mean clutch size of African White-backed Ducks at TWT is slightly smaller (5,43) than those recorded by other researchers (6,28). This correlates with the smaller body mass of the TWT females, compared to wild birds.

TWT mean clutch size (5,43) is larger than that from wild nests in the Vereeniging area (5,14). This may be the first indication of an adverse affect which pollution and industry in the area could be having on the wild birds and should be investigated further.

3.10 DUCKLING AND SHELL MASS IN CAPTIVITY

Table 3.6: Shell and duckling mass of 41 African White-backed Duck eggs, showing moisture loss

	RANGE	MEAN	SD
SHELL & WASTE MASS (g)	6,10 - 9,76	7,7	1,67
FRESH EGG MASS (g)	65,90 - 84,64	75,8	13,84
SHELL & WASTE AS % OF EGG	8 - 13	10	2,15
DUCKLING MASS (g)	43,92 - 59,65	52,7	9,83
MOISTURE LOSS (g)	11,11 - 19,76	15,4	3,69
MOISTURE LOSS AS %	16 - 27	18,8	4,6

Duckling and shell mass from TWT African White-backed Duck eggs are presented in Table 3.6. These results come from eggs which have had a successful and trouble free hatching process. Therefore, it can be stated that ideal moisture loss during incubation took place in these eggs. This means that the ideal moisture loss for African White-backed ducks would be 18 to 19% on average. This enables corrections to be made on incubator settings, during artificial incubation, if the eggs were weighed and found not to be losing moisture at the correct rate. Correct moisture loss during artificial incubation can be affected by the ambient relative humidity in the incubation room. Therefore, in every captive situation it would be advisable to monitor moisture loss to be able to adjust the incubator to its surroundings as

necessary. In the wild it is not possible to adjust the ambient relative humidity, making hatching success a hit and miss game. From this point of view artificial incubation would be a better option, especially considering recent irregularities in climatic conditions. The lowest percentage moisture loss recorded, (see Appendix 5), was 16% and the highest percentage moisture loss recorded was 27%. With the above results in mind, incubating at a relative humidity which will result in a moisture loss of 17 to 21% would be recommended. The above results regarding moisture loss compare very closely with those of Kear (1967) which were not in a wild situation, but were parent incubated eggs and ducklings. There is no wild data on this aspect to compare to.

3.11 HEALTH PROBLEMS IN CAPTIVITY

3.11.1 PNEUMONIA: Being essentially sub-tropical birds, captive African White-backed Ducks appear to be sensitive to cold and seem prone to pneumonia, especially young birds less than one year of age, and also weaker than average adult birds such as those which may have been subjected to stress. If they get too wet (prior to water-proofing) they can very quickly catch a chill and die within half an hour. At TWT, 80% of a batch of ducklings, ranging from two to four weeks of age, were lost when a violent thunderstorm caused a power failure in the brooder room. The ducks went without their warming lamps for approximately three hours in the night. The air had also been cooled because there was a lot of hail on the ground outside, causing a dramatic drop in ambient temperature, especially being night time. If they catch a light chill during normal swimming sessions, they may display symptoms such as sneezing and excess mucus exuding from the nostrils. In these cases, they can easily be treated with a general antibiotic with a penicillin active ingredient.

Treatment should be given twice daily for five days. They should be kept warm during this time and be introduced to water very slowly after recovery. An adult imported male was lost during a very harsh winter (1993) only 7 months after he arrived in the country. The bird had never really been accepted by the other three birds and had also not enough time to get over the stress of the travelling from Europe to South Africa. These two stressors weakened him to pneumonia.

These problems experienced with cold are only applicable to hand-reared birds. Wild ducklings would have the water-proofing oil from their brooding mother's feathers to coat their feathers which prevents them from getting wet and cold. Therefore, the captive situation increases the number of cases of pneumonia although there are ways of preventing it.

3.11.2 LEG PROBLEMS:

Splayed legs can happen mainly to hand-reared captive birds which start swimming from a later age than normal (three to four weeks of age instead of day one.) Due to the fact that caged birds spend so much time sitting still on the wire, the legs tend to grow in a position wider apart than normal, giving a splayed effect. It is essential that swimming sessions start from as young an age as possible, so as to prevent this. If the body weight is taken off the legs, by floating on water, correct bone growth is promoted. If the condition has already developed, but is not too serious yet, full recovery is possible if swimming therapy commences immediately. If the condition is chronic, then the prognosis is not good.

Slipped tendon can happen at any age and is also due to being in a cage, with regular catching and handling. The hock tendon is displaced from its normal position to one side or

the other. Once occurred, it is seldom possible to rectify. Even with surgical operations, the prognosis is not good.

Bumblefoot is not very common but can occur in African White-backed Ducks which grow up in wire cages. Ventral parts of the foot can get sore and cracked from rubbing on hard surfaces and these sores can get infected. To prevent this they must start swimming from a very young age and as soon as they are waterproof, they must progress to a pen with water. The water keeps the skin on the feet moist and supple. Such sores and cracks on their feet must be kept clean and disinfected regularly if they are to heal.

Occasionally a joint may become infected, swollen and hot. A course of injectable antibiotics is recommended, together with gentle massaging with an anti-inflammatory cream. This will usually remedy the situation.

All of the above leg problems apply to hand-reared young birds only, because when parent-raised, the ducklings spend most of their time on the water and then there is no undue pressure on the legs at all. Therefore, the captive situation is the main cause for the problem although the most recent rearing techniques are more successful in preventing these problems.

3.11.3 <u>EYE INFECTIONS</u>: Some young African White-backed Ducks may be prone to eye infections. This may be due to excess handling and contact with other birds in close quarters. Eye infections can be treated with any veterinary eye creams. This would be un-common in the wild and would only occur if a bird with an eye infection came into very close contact with an African White-backed Duck or if they are bitten by insects carrying a virus.

3.12 RELATIONSHIPS BETWEEN BIOLOGICAL PARAMETERS OF AFRICAN WHITE-BACKED DUCKS

Various relationships between parameters were investigated, using results obtained in this study to optimize captive breeding techniques and to predict hatching and rearing successes.

African White-backed Duck egg mass and hatching success: It can be seen from the frequency distribution in Figure 3.10 that a higher percentage hatch was obtained with the lightest and the heaviest eggs. This is contrary to what would be expected. However these results could be bias because at extreme egg masses (lightest and heaviest) (n) was very low compared to the middle range of egg mass and this can affect the accuracy when using a frequency distribution to illustrate rates. The frequency distribution was plotted again after removing the data of two clutches of unviable eggs (Figure 3.11). Similar results were obtained although the lightest eggs showed a slightly higher rate of hatching than before. Once again it must be cautioned that at the extreme egg masses, there were not enough numbers of eggs to compare hatch success rates to those found in the middle range of egg masses.

African White-backed Duckling mass *vs* survival rate: The relationship between the mass of African White-backed Ducklings and the percentage survival was determined and the result is shown in Figure 3.12. It is clear from Figure 3.12 and Figure 3.13 that the survival rate of ducklings increases with increase in duckling mass. Ducklings with a mass of below 46,24 g have very little chance of hatching. The largest duckling hatch mass was 61,38 g. A statistically significant difference between the initial mass of ducklings that survived and those that died at any age up to 6 weeks of age was determined: ($t = 3,997$; $P = 0,000$).

African White-backed Duck egg mass vs duckling mass: The relationship between fresh egg mass and the mass of all ducklings that hatched was then determined. This relationship is shown in Fig. 3.14. A highly significant linear relationship was calculated (r = 0,666; P = 0,000). This positive correlation emphasizes and reinforces the importance of egg mass on duck survival rate because it was previously determined that a higher duckling mass increases the chances of survival. A higher egg mass results in a higher duckling mass which in turn results in a higher survival rate.

Parameters of duckling mass: In an effort to find statistically significant parameters of duckling mass, the relationship between duckling mass and beak length (Figure 3.15), tarsus length (Figure 3.16) and wing length (Figure 3.17) was determined. Only tarsus length showed a significant positive linear relationship with duckling mass (r = 0,782; P = 0,000). Tarsus length is therefore a good indicator of duckling mass. If a higher tarsus length indicates duckling mass and duckling mass indicates survival rate, then tarsus length may be a good indicator for survival probability.

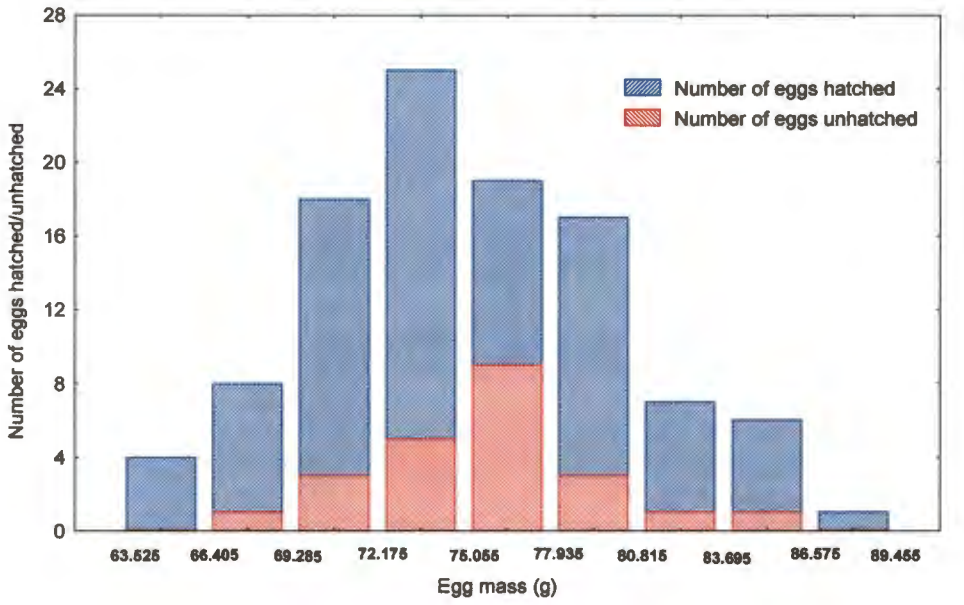

Figure 3.10: Frequency distribution of egg mass versus number of hatched/unhatched African White-backed Duck eggs.

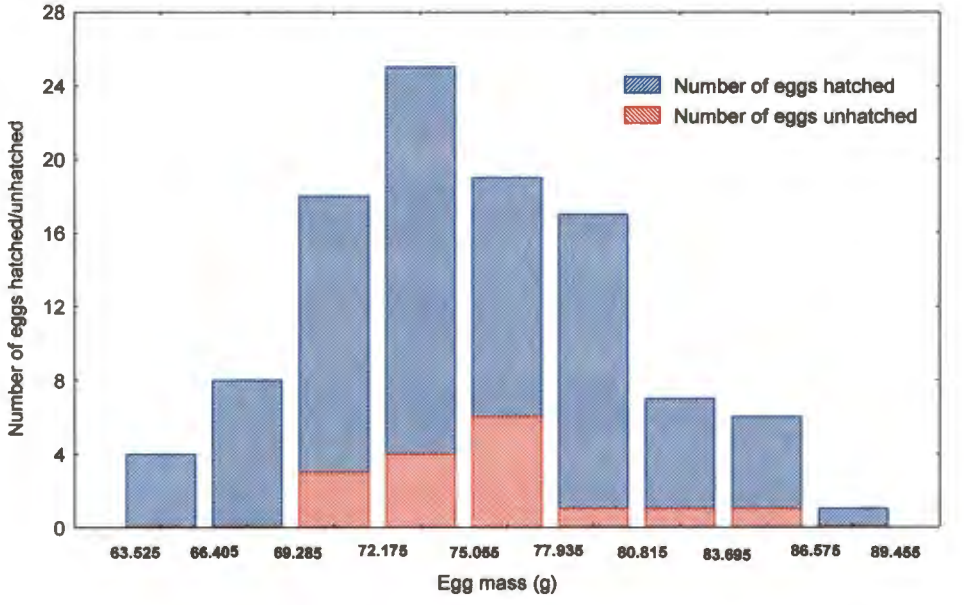

Figure 3.11: Frequency distribution of egg mass versus number of hatched/unhatched African White-backed Duck eggs, excluding two clutches of unviable eggs.

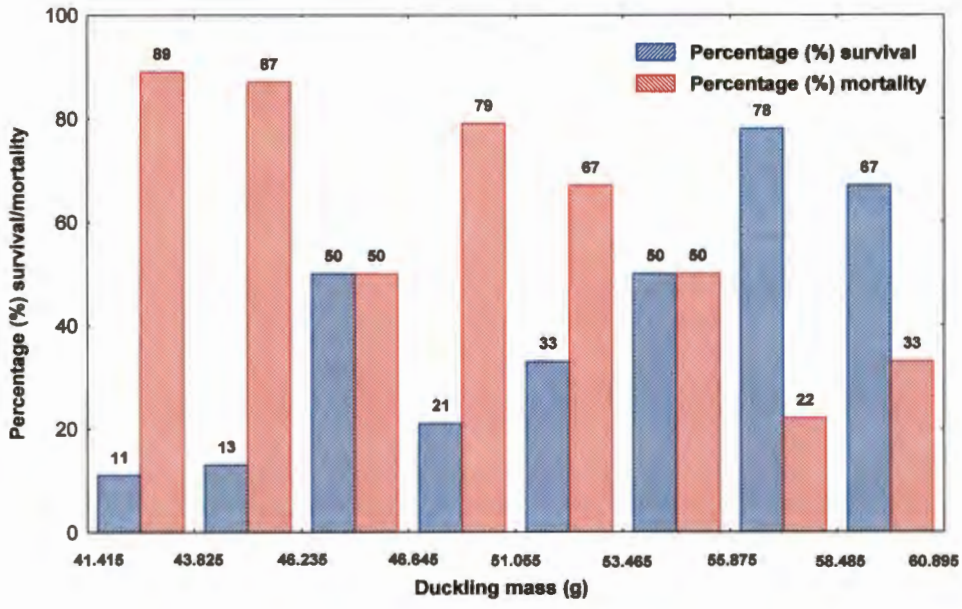

Figure 3.12: Frequency distribution of duckling mass (g) versus percentage survival of African White-backed Ducks.

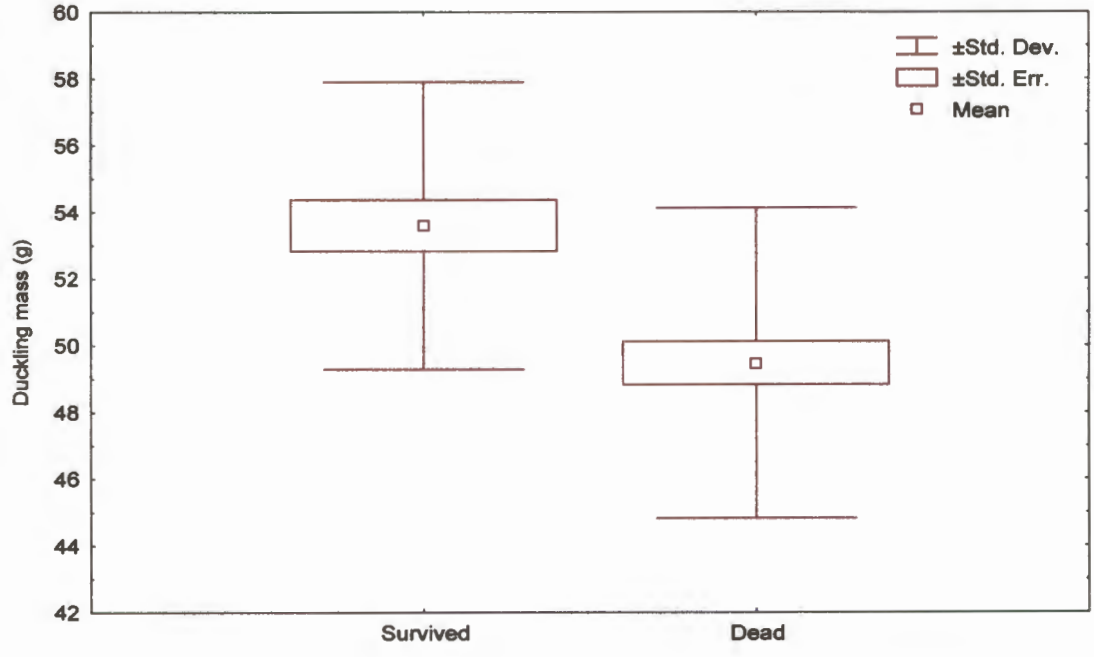

Figure 3.13: Comparison of mean duckling mass (g) of survived and dead African White-backed Duck ducklings (t = 3,997; P = 0,000)

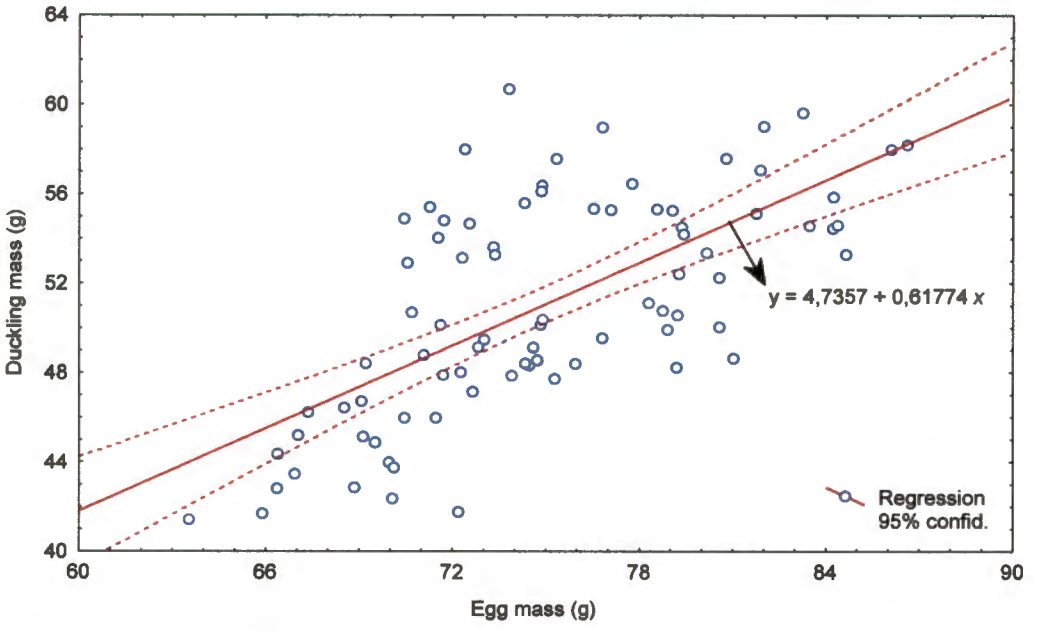

Figure 3.14: Correlation between duckling mass (g) and initial egg mass (g) [r = 0,666; P = 0,000]

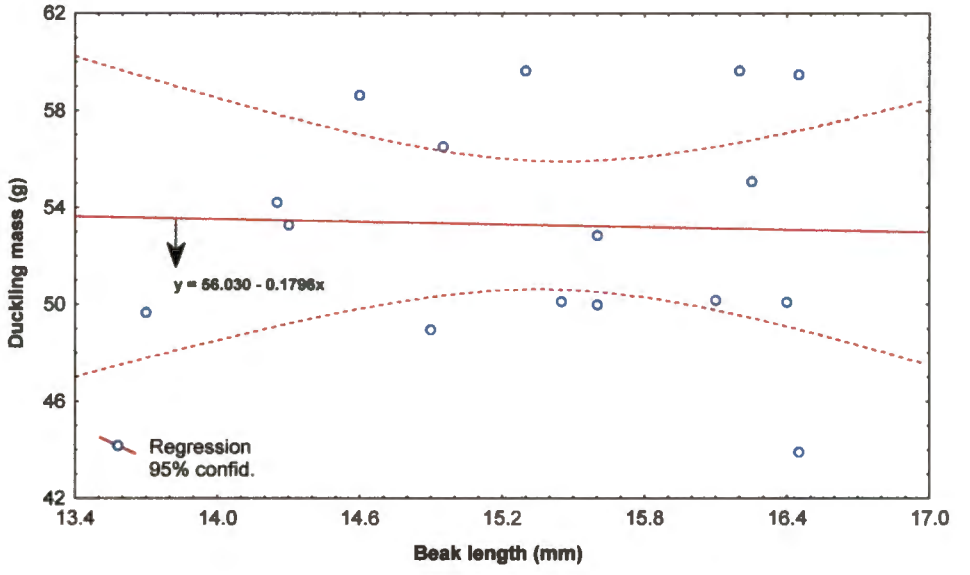

Figure 3.15: Correlation between duckling mass (g) and beak length (mm) [r = -0,034; P = 0,900]

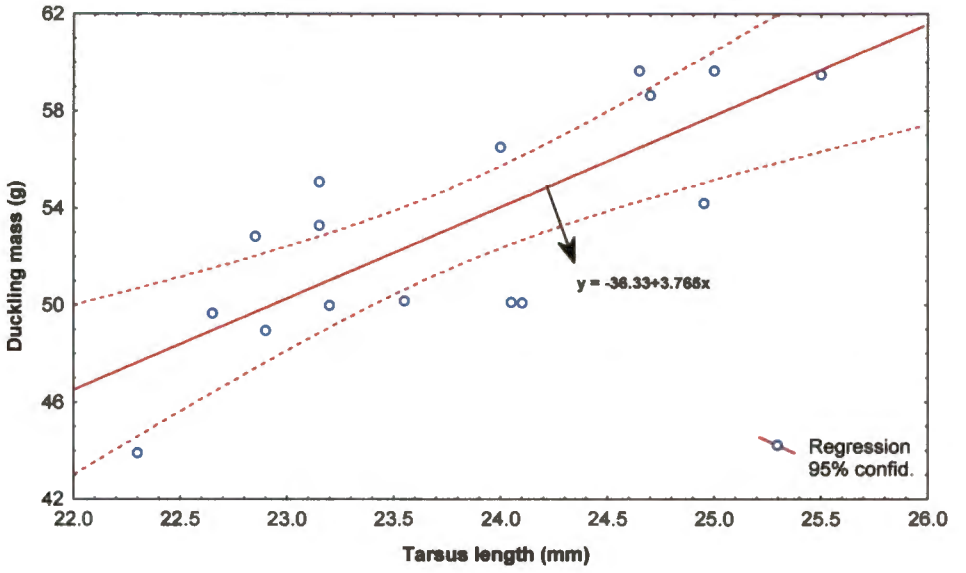

Figure 3.16: Correlation between duckling mass (g) and tarsus length (mm) [r = 0.782; P = 0,000]

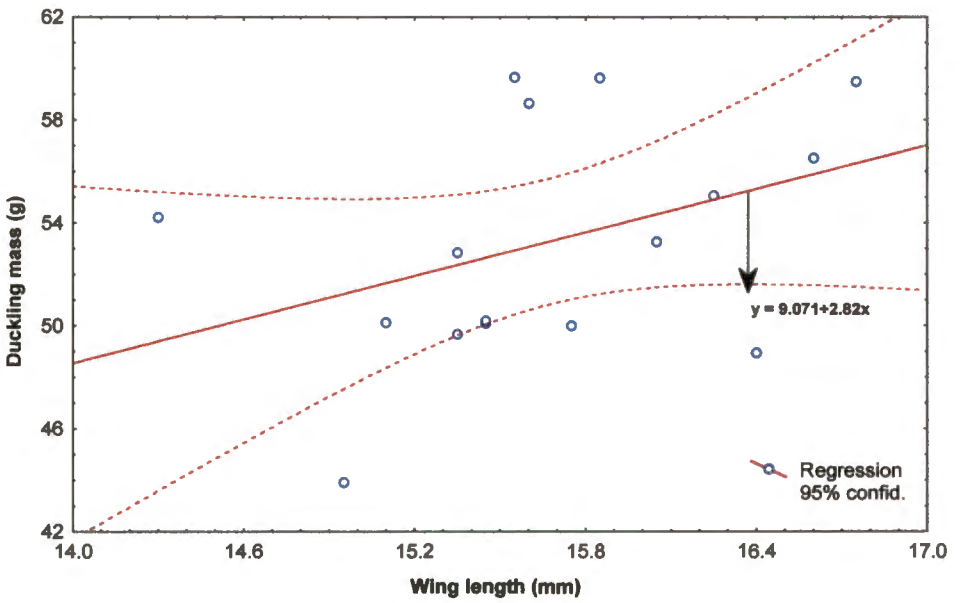

Figure 3.17: Correlation between duckling mass (g) and wing length (mm) [r = 0,388; P = 0,137]

3.13 BREEDING SEASON CONDITIONS vs BREEDING SUCCESSES

Two variables of breeding season conditions were recorded during the study period:

1) mean maximum daily temperature of December, January and February of that breeding season
2) total annual rainfall

Three variables of breeding season success are discussed:

1) the average number of eggs laid per sexually mature female that breeding season
2) percentage fertility of all the eggs laid that year
3) hatch rate of all the eggs laid that year

Table 3.7 shows summarised data of season and breeding success variables of each breeding season during the study period.

Table 3.7: Effects of rainfall and temperature on breeding successes of African White-backed Ducks in captivity

Season	Mean max. daily temp. Dec - Feb	Rainfall (annual)	No. of eggs per female	Percentage fertility	Percentage hatchability
1993/94	26,3 °C	663 mm	22,5	93%	69%
1994/95	30,1 °C	264 mm	11	95%	81%
1995/96	26,4 °C	874 mm	11,2	96%	87%
1996/97	28,1 °C	889 mm	8	88%	74%

From the above results it can not be concluded that rainfall and temperature had any significant effect on the breeding success of the African White-backed Duck in the

captive situation because not enough data for enough breeding seasons has been collected yet. Graphs were plotted for the above variables but no significant correlations were found. For example, rainfall plotted against the average number of eggs laid per female resulted in t = 0,836 and P = 0,871. Temperature plotted against the average number of eggs laid per female resulted in t = 0,859 and P = 0,480.

A more significant affect may be seen if the studies were to continue over a much longer period. The following tendencies could be expected with longer term studies: A more moderate summer temperature seems to favour a higher egg production. Once the summer temperature gets above 27°C, egg production shows a tendency to drop. Egg production also seems to be favoured by higher rainfall up to a point. There was a marked drop in egg production when rainfall was too high. The combination of temperature and rainfall is also very important to take into account. The hottest and driest season showed the lowest production of all. The hot, wettest season was the second worst season. Egg production is therefore generally favoured by moderate temperatures and high rainfall.

3.14 EGG FERTILITY

There is no data for wild eggs available on this subject. Results at TWT are shown in Table 3.7.

These egg fertility results are all within acceptable limits for any species, especially one such as the African White-backed Duck which can easily lay a clutch of 10 eggs. The larger the clutch of eggs, the more chance there is of an egg in that clutch being infertile. In a clutch of ten eggs, if only one egg is infertile, the fertility would be 90% and quite acceptable, so the fertility rates above are actually very good.

3.14.1 FACTORS WHICH HAVE BEEN OBSERVED TO AFFECT FERTILITY DURING THIS STUDY (pers. obs.):

The female is fertile from one year of age, as females have been observed laying at this age. The female must, however, be ready to accept a male for mating, to ensure fertile eggs. The males are only fertile from about 18 months of age when their phallus is fully developed. There will also be an upper limit to the fertile age of both males and females. There are no records of African White-backed Ducks being too old to produce eggs, but an average age at which eggs would no longer be produced, for a duck that size, would be from 12 to 15 years of age (pers. obs.).

Good quality food is essential to produce fertile, viable eggs. The volume of food is also important and African White-backed Ducks will only breed successfully when food is plentiful. High infertility can be expected when unbalanced diets are offered to the birds; for example a mixture of laying pellets, maize and mixed fowl food is a commonly used diet which is unbalanced and often leads to problems such as infertility.

Conditions such as climate and habitat need to be within a suitable range to produce fertile eggs. Both birds of a pair need to be unstressed by environmental and weather conditions. If a pinioned pair of African White-backed Ducks were kept in unsuitable conditions, for example in an excessively cold climate on a pond with no suitable nesting sites, and the female lays eggs, they may very well not be fertile because the birds are compromised and may not complete important courtship rituals. Good rainfall seems to be important in stimulating African White-backed ducks into

breeding, without which fertile eggs might not be produced.

The birds should not be ailing from anything at the time of breeding. What can sometimes happen is that a fertile female duck can get an infection in her reproductive system due to an egg laying complication, and this can render her infertile for the rest of her life. She then starts producing more male hormones and less female hormones and may attain partial male colouring, in sexually dimorphic species (pers. obs.). If either of the birds are not in good condition, fertile eggs are very unlikely.

A female biased sex ratio may result in one or more un-paired females laying unfertilized eggs, and incubating them. This is quite likely in African White-backed Ducks because they are monogamous. One male seldom takes more than one female except in a matter of forced mating.

Breeding birds which are inbred for more than a few generations could produce infertile eggs.

Unlike a lot of other smaller ducks, although the courtship display of the African White-backed Duck is not very extravagant, rituals such as mutual nest building and general participation of both partners does seem to be very important in this species to produce fertile eggs.

3.15 PREDICTING MORTALITY

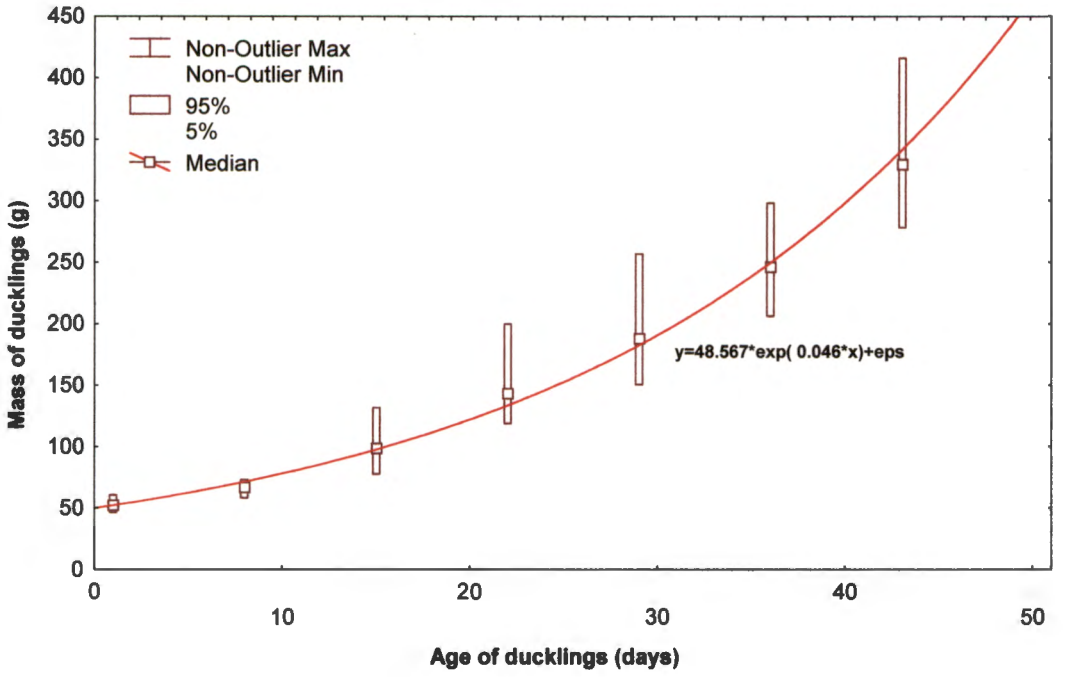

Figure 3.18: Box and whisker plot and exponentially fitted regression line showing growth rate of African White-backed ducklings

Growth rates were plotted for all the ducklings hatched in this study which survived to 6 weeks of age (Figure 3.18). The vertical bars represent the 95th percentile (95% of all the surviving ducklings fit into this curve). There were no whiskers (outlier values) in this data. This graph is only for the captive data from this study and the graph may change as more data is accumulated.

If a duckling's growth is plotted over this graph, it may be predicted whether or not the duckling should survive, barring unexpected accidents.

It was determined mathematically that a duckling must at least increase its mass at an average of 4,2 % per day if it is to survive.

3.16 REARING SUCCESSES OF DUCKLINGS ON DIFFERENT FEEDING REGIMES

A number of different rearing techniques were used in this study with vastly different success rates:

Method	**No. of survivors/No. hatched**
Parent-raising (Section 2.10.1)	2/6 = 33%
Dry-feeding (Section 2.10.2)	0/2 = 0%
Force-feeding (Section 2.10.2)	2/5 = 20%

The above three rearing systems had very small samples and it is therefore very difficult to draw conclusions about these systems. The problem was that, at the same time as trying to find the best way to rear these ducklings, it was not possible to sacrifice large numbers of ducklings, just to prove that a particular rearing system was no good. As soon as a rearing system was seen to produce very bad results, it was necessary to switch to another system. This obviously puts limitations on certain conclusions.

Method	**No. of survivors/No. hatched**
Wet-feeding – crumbles (Section 2.10.2)	11/33 = 33%
Wet-feeding - high protein (Section 2.10.2)	17/26 = 65%
Other systems (Section 2.10.2)	13/20 = 65%

3.16.1 Parent-raising:

This system has the potential to be very successful, but it is very slow. Results of the three clutches left with the adults are detailed below:

a) FIRST CLUTCH: Both parents were very attentive over the ducklings and at

night they were brooded on the nest in the reeds. During most of the day the family was in the water or on the bank near the water. Only the adults ate the floating pellets. The ducklings showed no interest in the floating pellets at all and spent their time repeatedly diving to the bottom of the pond. They stayed under the water for periods of up to 45 seconds and would then bob up to the surface. Their efforts at foraging seemed to be rewarded as they were sometimes still busy swallowing something when they surfaced. On the fourth day after hatching, at 07:00 hours, the four ducklings were found dead in the wheat bowl in which the adults' wheat was served. How the ducklings managed to climb into the high bowl is not known. They seemed to be trying to imitate their parents who regularly went to feed there and then could not get out of the deep, smooth-sided bowl and succumbed to pneumonia after becoming totally wet.

b) SECOND CLUTCH: Again the ducklings ignored the floating pellets and dived down to the mud on the bottom of the pond to feed. They often had bits of sticky mud on their beaks when they surfaced. This incessant diving dramatically decreased when the ducklings reached three weeks of age. At this age, the ducklings started consuming floating pellets, together with the adults. At two months of age, the two immature birds were capable of flight but they were reluctant to fly at this stage. By four months of age they were flying regularly but they did not fly high and occasionally got stranded on the wrong side of the fences and wall surrounding the property. One immature bird flew off never to be seen again and one has stayed.

c) THIRD CLUTCH: Although these ducklings hatched under the female duck, it was decided to hand-rear them. In retrospect it was not a good decision because the ducklings had already become bonded with their parents and had also become accustomed to diving for their food the natural way. They were very difficult to catch as they had already mastered the technique of diving, which added to their stress levels. They could not adapt to the confines of a wire cage and to eating from a bowl and/or drinker and all but one succumbed to undernutrition and stress in a matter of 10 days.

d) GENERAL OBSERVATIONS OF PARENT-RAISING: When the ducklings were left with the adult birds, both the male and female tended to the ducklings and protected them defiantly, becoming defensive towards potential intruders and danger. They were much more aggressive and confident than normal. If the young ducklings strayed too far, the adults, more often than not the female, would utter a call which soon brought all the ducklings back together again. When very young, the ducklings were brooded on the nest at night. If the ducklings had difficulty in climbing back onto the nest, the male would modify one of the built in ramps so as to facilitate entrance to the nest by ducklings. The ducklings then made good use of their sharp claws and 'wing-hooks' to climb up to the nest.

The ducklings were water-proof from their first day because their down was coated with oil from the female's feathers, which were always oiled by her own oil gland and preening. Although the ducklings did preen from their first day onwards, their own oil glands were not active until two to three weeks of age.

Parent-raising successes in captivity appears to be very similar to what would happen in the wild, taking into account predators and food availability problems which wild birds may encounter.

3.16.2 Hand-rearing:

a) DRY-FEEDING: This system is not at all successful because of the ducklings' instinctive habits of diving and filter-feeding. Compared to the wild and parent-raising, this system is of no use.

b) FORCE-FEEDING: The first clutch of ducklings were force-fed on various food types with limited success. The next batch of 10 ducklings were all force-fed with ground starter crumbles in warm water, until they were seen to be eating by themselves. One duckling hatched as a breech with much bleeding. This duckling died on its second day. The other nine ducklings were doing well in mass gain, but a power failure resulted in six of them dying from pneumonia. There was a hail storm as well, so the temperature dropped significantly in a very short time. It also meant that there were no heating lamps on for the ducklings, which was fatal.

Although this method of rearing does not compare favourably with wild ducks or parent-raising, it may be due to the unfortunate power failures that such bad results were obtained. However, it is also an impractical method to use as it is very time consuming.

c) WET-FEEDING – CRUMBLES: This system is very successful, but it is not practical to stand next to the ducklings all day topping up their food and this would be necessary for them to be totally successful. If one put too much food in the drinker, the food absorbed too much water and expanded to the extent of blocking the hole where the water comes in. This system rates equal to the wild or parent-raising systems, even though there were many casualties due to the food blocking up.

d) WET-FEEDING – HIGH PROTEIN: This filtering method of feeding suited the ducklings very well. This system seemed to produce strong ducklings quicker and easier than any other method to date. However, some ducklings experienced leg problems, caused by staying on the wire for too long instead of swimming from a younger age. Other ducklings suffered from a lack of water-proofing which resulted in difficulties in getting them to live outside. Results can be improved in future breeding seasons with improved swimming and water-proofing techniques. This system is almost twice as effective as the wild or parent-raising techniques and should be pursued and perfected until a success rate of 85% is achieved. This is the average maximum success rate for hand-rearing any other species of waterfowl as obtained by TWT in the last seven years. This would then be more successful than any wild situation.

3.17 AFRICAN WHITE-BACKED DUCKLINGS vs OTHER DUCKLINGS

According to other aviculturalists consulted, African White-backed ducks are said to be one of the most difficult species of duckling to hand-rear. Its adaptations for survival in the wild are undoubtedly the cause for this difficulty:

1) The fact that the parent-raised ducklings refrained from eating floating pellets on the surface of the water for their first three weeks, even though their parents were setting an example by eating them, means that they have some very strong instinct to dive down to the pond-bottom and eat from there.

2) The unusual bill design: very strong, with a hook on the end - with filtering mechanisms inside the beak. Their bills are totally unique in their order. Most other ducks have a flatish bill with filtering mechanisms on the edges. The hook on the tip one might think is for ripping plant material, but plants do not seem to play an important role in their diet. Possibly they use it to loosen clay/mud or plant roots on the pond-bottom so that they can get to what they are looking for. It is also very effective as a defence tool.

3) Their short stubby legs, designed for a life on water, makes sitting on a wire cage and moving around in it very difficult and uncomfortable. This leads to an array of leg problems from bumblefoot, dry skin, joint infections, splayed legs, hip displasure, muscle strains and slipped tendon. Their design for a totally aquatic life means that feeding on dry food from a bowl is totally unnatural, especially at this early age, making a wet-feeding system essential.

Chapter 4: Conclusions

4.1 CAPTIVE AFRICAN WHITE-BACKED DUCKS VS WILD ONES AND THEIR PROPAGATION

Descriptively the captive birds were very similar to wild birds recorded. The captive birds were, on average, somewhat lighter than wild birds measured. This could, however, be due to the fact that the captive birds were pinioned. Pinioning results in a lower mass due to the loss of part of one wing and also due to the loss of muscle tone on the breast because of the fact that the bird does not fly if pinioned. The beak length of the captive birds is shorter than that of wild birds. This could be due to slightly different measuring techniques. None of the previous literature stated the method of measuring the birds. The body length of captive birds is fractionally smaller than the wild birds measured. This could also be due to different measuring techniques. The tail length of the captive birds compares closely with those of wild birds as does tarsus length. In the captive birds, the males' measurements were all somewhat larger than the females' measurements. This makes visual sexing by size more feasible and accurate, however, it would be necessary to have at least one average sized female and one average sized male present to be able to compare birds of unknown sex. No differences between male and female wild birds have been recorded. When the African White-backed Ducks were taken from a small, cultivated garden pond to the large natural ponds with reeds all around, they immediately settled down and bred in the next breeding season. This shows that their preference in the wild for large ponds with reeds and water plants along the edge is also evident in captive birds. This appears to be a species trait regardless of whether they are in captivity or in the wild.

In captivity, the African White-backed Ducks became very 'domesticated' preferring food hand-outs rather than the active feeding regimes which their wild counterparts partake in. This results in tamer birds which is advantageous in the following ways: a) it keeps the birds tame and in close contact with keepers which helps keepers to detect any potential health problems or breeding behaviour, thereby aiding in management and b) if parent-rearing is envisaged at a later stage, it encourages the parents to bring the ducklings closer to people for nutritional supplements. This has, however, serious implications for future possibilities of reintroducing captive birds into the wild. Before release, the birds would have to be weaned off hand feeding and encouraged to feed naturally, so as to enable them to cope and find enough food in the wild.

In general behaviour, the captive birds appeared very similar to wild birds except in two aspects: a) their activity times were more regulated by the feeding times in captivity, whereas wild birds are strictly crepuscular. This does not have serious implications for birds destined for release because they should easily adapt to more natural hours of activity according to food availability. b) The captive birds were seen to be stronger on their legs than those observed in wild birds. This could indirectly be as a result of the pinioning. Due to the fact that the birds cannot fly from one dam to another, they have to walk, which may result in better muscle development in the legs over a period of time. In other duck species, however, pinioning has been seen to have a slight negative effect on birds in captivity. Owing to the fact that the pinioned ducks are spending more time walking and running on land than they would if they could fly, they tend to experience more frequent leg problems than would be the case if they could fly (pers. obs.)

In breeding behaviour, the captive birds were exactly the same as wild birds in most aspects. However, there was only one exception, again an adaptation to the feeding regimes, wherein one female used to leave her nest to feed on floating pellets on every feed which resulted in a much higher rate of cooling of the eggs on the nest than what would normally be found in the wild. It had no effect on the hatchability of the eggs and can, therefore, be considered an exception to the rule with little or no implications. Artificial incubation presented the opportunity to accurately measure the incubation period of African White-backed Duck eggs, giving a result of 32 days. This is in agreement with the findings of Wintle (1981). Incubation records for wild ducks are vague in this regard and tend to give a wide range of incubation periods. In colder climates, incubation periods are influenced by extreme ambient temperatures and are, therefore, seen to be quite variable. However, in warmer climates this is not the case (pers. obs.) The African White-backed Duck originates from a comparitively warm habitat in Africa and will, therefore, not exhibit much variation in its incubation period. It can, therefore, be concluded that the actual incubation period for African White-backed Ducks is 32 days.

Breeding seasons for the captive birds were similar to the season observed in the wild but, were slightly shorter. The captive birds were not sexually active during the very cold winter months, but this was to be expected since they are not normally expected to be in such a cold area as Vereeniging during the dry, cold winter months. They could not fly away during these months because they were pinioned.

It can be concluded that African White-backed Duck males in captivity are sexually mature at 18 months of age. This could not be compared to wild birds as there is no literature referring to this. However, sexual maturity is not simply an observation of when the birds first breed. The birds have to be physically capable of breeding and therefore it can be concluded that 18 months of age is the correct age for sexual maturity in males because of the complete development of the male phallus at this time. Females are sexually mature at one year of age as they have been observed laying eggs at this stage.

Egg-laying intervals in captive birds were shorter than those of wild birds. This could either be a trait specific to a particular individual or it could be directly related to the amount of food available to the laying bird. In the captive situation, there was always regular feeding and the female did not have to work hard to find that food. In the wild, the female would have to continue diving and searching for tiny fragments of food, during laying, and it may well take longer to accumulate enough protein and carbohydrates to lay the next egg. From this aspect a captive situation is favourable. Captive egg mass was similar to wild egg mass measured in the Vereeniging area, but the mass of the eggs produced in captivity were more consistent. This could again be a result of the consistent food supply in captivity. What was disturbing is the difference in mass between eggs measured in the last five years, in captivity and in the wild in Vereeniging, compared to eggs measured in 1967, 1978 and 1985 elsewhere in the wild. The recent eggs (in captivity and in the wild in Vereeniging) were much lighter which could indicate a long term effect of air pollution and deteriorating water quality associated with increasing industry. This is something which should be followed up further. The

possibility of altitude affecting egg mass should also be investigated. The differences in egg sizes were not as dramatic, but once again the captive eggs were more consistent in their size and had a smaller standard deviation.

Clutch size in captivity appeared to be slightly smaller than those recorded for wild ducks. This could be related to the slightly smaller mass of the females in captivity. In actual fact, as shown in Table 4.1, if the egg mass as a percentage of body mass for the captive birds (13,14%) is compared to records for wild birds (11,2%) then egg production per clutch size is larger in captivity.

Table 4.1: Comparison of wild and captive egg production in African White-backed Ducks

	Egg mass as % of body mass	X	Average clutch size	=	Percentage of female's body mass laid per clutch
Wild:	11,2%		6,28		70,34%
Captive:	13,14%		5,43		71,35%

This indicates that captive propagation may result in a higher egg production. This higher egg production is, however, counteracted by the lower egg mass. The lower egg mass tends to result in lower duckling mass. The lower duckling mass tends to result in a lower survival rate. So, although the captive egg production may be higher, it does not necessarily result in higher production of ducks in captivity.

The average moisture loss during incubation in captivity was less than the only other records for wild eggs. Although it may be inaccurate to compare to only one other record, it is all there is to compare to. The incubation conditions in captivity were easier to control and could be assumed (but not confirmed) as being ideal for the eggs. The wild

record of 25% moisture loss does, however, fit into the range recorded in captivity of 16 to 27%, but could not be termed an ideal moisture loss. The norm for most waterfowl species is 15%. The mean moisture loss in captivity of African White-backed Ducks was 18,79% which is much closer to the 15% norm than the 25% recorded by Kear (1967).

The medical problems experienced in the captive birds were all due to the fact that the birds were being hand-reared in captivity. This would indicate that, in captivity, one gets more medical problems, but this is not necessarily the case. There are no real records of duckling losses in the wild. It is possible that there are large losses due to other problems such as bacterial, fungal or viral infections, leg problems, etc.

Predator problems and duckling victimization from other adults or ducks could be high in the wild, but there were no predator problems nor victimization in the captive situation and, therefore, the captive situation has the potential to be more productive than the wild situation, even with its associated medical problems. Rearing methods can also be improved so as to avoid almost all of the medical problems experienced and this could push duckling rearing rates up to 85%.

From the breeding seasons during the study period and the prevailing climatic conditions during same, circumstantial evidence indicated that breeding was favoured by moderate temperatures and high rainfall. This was in a captive situation, but may also be applicable to the wild situation.

The factors affecting fertility are the same in a captive and wild situation, namely a) age at breeding, b) feeding of adult birds, c) climate and habitat, d) illnesses,

e) number of males, f) inbreeding, g) courtship rituals and nest building. In captivity, it is possible, to varying degrees, to control these six factors and, therefore, it should be also possible to increase fertility in captivity above that of fertility in the wild, where the birds are subjected to conditions which may not be ideal all the time.

In captivity it is also possible to control and optimise conditions which promote the viability, hatchability and survival rate of the eggs/embryos/ducklings which are: a) freshness of eggs at incubation commencement, b) fertility, c) incubation techniques, d) handling, e) infection control. In the wild it is not possible to affect or change these conditions and so the viability, hatchability and survival rates are more dependent on a combination of various conditions.

During the development of a hand-rearing system, the percentage survival increased from 0% in 1992 to 65% in the 1996/97 breeding season (Appendix 2). With further development it would be possible to increase it to 85% survival. Although difficult to compare with a wild situation because there are no records, the 65% success obtained so far is already much higher than the survival rate for other duck species in the wild which are averaging at about 20% success (pers. obs.)

Therefore, a captive rearing program can dramatically increase production if needed.

4.2 RECOMMENDED PROCEDURE FOR HAND-REARING DUCKLINGS (INCLUDING RECENT DEVELOPMENTS)

1) House the newly hatched African White-backed ducklings in a wire brooder cage 60cm x 60 cm and 30 cm high (see Figure 4.1). They should not be able to see out of the cage and this may be achieved by hooking up paper towel around the sides of the cages. This ensures that they do not become distracted from their most important task lying ahead, namely learning how to eat.
2) Ideally no less than two ducklings and no more than four ducklings should be in the above-mentioned cage at any time to avoid loneliness or overcrowding/trampling.
3) The cage should have an infra-rubin lamp above it at a height of 30 cm (just above the wire).
4) Two plastic drinkers (each of one litre capacity) of water should be provided. One should have 3 to 6 blocks (1 to 2 of each) of frozen *Daphnia*, bloodworms, and brine shrimp in the water (the amount given depends on the number of ducklings per cage. The other should have a light sprinkling of finely crushed duck floating pellets in the water. A bowl of starter crumbles should also be provided and a piece of paper towel with starter crumbles sprinkled on it.
5) The ducklings should have their beaks dipped into either of the two drinkers, alternately, as often as possible.
6) Ensure that the food is changed at least four times a day, initially, so that it does not go bad. Later it will be necessary to change it more often as it will be eaten very quickly.

Figure 4.1: African White-backed ducklings in a wire brooder cage

7) The above should continue for seven to ten days. Then the birds should be transferred to a fibreglass rearing tank (see Figure 4.2) half of which is wire surface with an infra-rubin lamp above it and half is water to swim in. The water is 15 cm deep, with a wire ramp leading out of the water onto the wire at a 30° angle.

8) The two drinkers with the frozen food and crushed floating pellets and the bowl of starter crumbles must all still be offered on the wire surface. Additionally there should be fresh whole-wheat bread and whole floating pellets offered in the swimming section, for when the birds start swimming.

9) The ducklings tend to be dependent on the crushed floating pellets in the drinkers for up to two months, and they also need the infra-rubin lamp until they are fully feathered or when the temperature drops below 25 °C.

10) Living in the water tank seems to prevent all the leg problems encountered in a dry-rearing system.

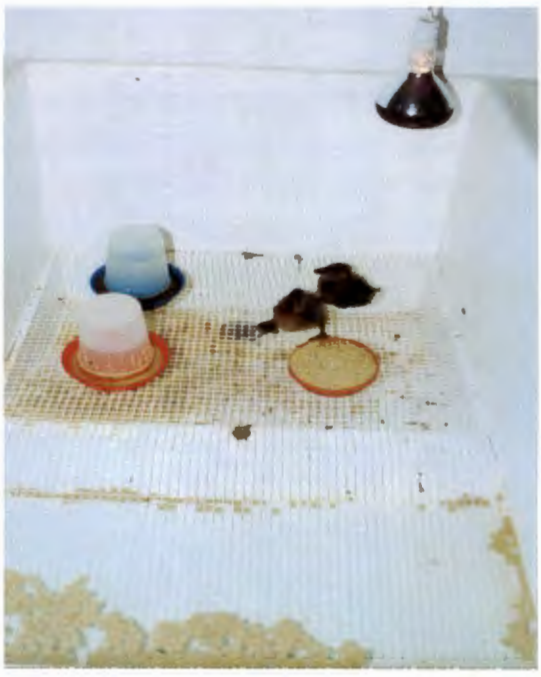

Figure 4.2: African White-backed ducklings in a fibreglass tank

11) From two months they can spend time, during the heat of the day, in a similar tank outside - weather permitting.

12) Once they are three months old they can be introduced to a normal pond situation, bearing in mind they will initially not be able to tolerate extreme temperature reductions.

4.3 CONSERVATION IMPLICATIONS AND RECOMMENDATIONS

A successful system for hand-rearing African White-backed Ducks means that the ground work for implementing a captive breeding program for the threatened Madagascar White-backed Duck has partially been done.

If eggs or even wild adult birds could be collected from Madagascar, a captive breeding program could be started, with guaranteed results, with a view to eventually releasing large numbers of birds back into suitable protected wetlands in Madagascar. Of course, it

would be necessary to do thorough status investigations first and also to determine if there are suitable release areas available. An education programme with the local people would have to be started and pursued so as to maintain an acceptable environment for the released birds.

As far as the African White-backed Duck is concerned, it is now becoming slightly easier for private people to keep indigenous ducks in captivity. It was previously a big taboo to even mention keeping South African ducks in captivity. Now, if one goes about applying for the necessary permits in the correct manner and one has a reputable supplier who also has those birds on permit and has bred and closed-rung them, the conservation authorities will first investigate the future holding pens of the birds. If satisfied that all is well, they will issue the permits.

Therefore, it is now very important to encourage as many people as possible to keep indigenous ducks so that more of them can be bred. Under the correct conditions, a much higher survival rate can be obtained in captivity than in the wild because predators can be controlled and food supply can be limitless. If more people start keeping and breeding South African ducks, enormous numbers of flighted birds can be produced, boosting the wild populations to original numbers. There are many reserve areas where waterfowl populations have diminished due to habitat mismanagement and hunting in the past, which are now ready for repopulating. There are also many other water-bodies such as mine water storage dams which could be transformed into suitable wetlands for waterfowl release. Previously mismanaged farmlands could also be transformed into duck friendly areas with a few minor habitat changes. If a program such as this is

successful, hunting as a sport could still continue with no impact on waterfowl populations.

It must be borne in mind that the three main requirements of waterfowl need to be met in a potential release habitat when searching for same, namely:

1) Constant food supply which, in the case of the African White-backed Duck, means constant water supply as well.
2) Security from predators and excess disturbance.
3) Breeding areas which, in the case of the African White-backed Duck entails, reed beds on the edge of the water.

4.4 GENERAL CONCLUSIONS

African White-backed Ducks are unique in many ways: in their uncertain classification, their unusual appearance and habits and most of all their ducklings with their unique morphology and feeding techniques.

When the ducklings hatch they are so well adapted to their very specific feeding techniques that it makes it nearly impossible for them to adapt to artificial feeding techniques which suit ducklings of other species.

Their widely placed legs, especially so for diving, make it very difficult for them to sit for two to three months on a wire cage. (Most other ducklings would not have to be indoors for this long, but the African White-backed Ducks' sensitivity to cold requires that they stay indoors for longer.) Their filter-feeding beaks, designed for sifting mud, make eating out of a bowl a difficult task. With these points in mind, it is obvious that the

best method for rearing African White-backed Ducks would be wet-rearing with high protein food to filter feed (section 4.2). This should result in an 85% success rate which is very good for any species.

Six weeks is the minimum time it takes for the African White-backed Ducks to become fledged. During this time they should reach a mass of between 300 and 400 g to have a good chance of becoming fully grown, vigorous, breeding ducks. This is a 500 to 700% mass increase in six weeks.

An African White-backed Duck's greatest enemy in its first year of life is COLD. If they get wet or if there is a rapid drop in ambient temperature, they are the first to feel it and, being so dependent on their respiratory system, even if only one lung is affected by pneumonia, the prognosis after diagnosis is very poor.

Another weak point which they have is their legs which can easily succumb to various problems. These problems can, however, be prevented with correct management and by wet-rearing from a young age.

The habitat requirements to breed these ducks could be summarised as follows: as natural a pond as possible, at least two to three m in diameter for one pair (although much more is preferable). By natural it is meant that the pond should be earth bottomed and should have reeds and water plants growing along the edges. An island in the pond would afford the birds some privacy. Alternatively, there could be a part of the pen where people do not go at all so that the ducks can breed there undisturbed. A sub-tropical to tropical climate is preferable.

It could be concluded from the results that hatchability in the African White-backed Duck is generally very high. A higher egg mass resulted in a higher duckling mass. A higher duckling mass resulted in a higher survival rate. Tarsus length proved to be a good parameter for duckling mass.

Further studies should be continued in captivity on this unique species, both on the breeding aspects and also in improving the rearing techniques of the ducklings.

5. REFERENCES

BENSON et al. 1971 Birds of Zambia. Collins, London.

BRICKELL, N. 1988 Ducks, geese and swans of Africa and its outlying islands. Frandsen Publishers, Johannesburg. 200 - 202

MADGE, S. & BURN, H. 1988 Wildfowl: An identification guide to the ducks, geese and swans of the world. Christopher Helm Publishers, London. 132 - 133

CLARK, A. 1979 The breeding of the White-backed Duck on the Witwatersrand. Ostrich 50: 59 – 60.

DEL HOYO, J., ELLIOT, A. & SARGATAL, J. 1992 Handbook of the birds of the world – Vol. 1. Lynx Edicions, Barcelona. 577

DELACOUR, J. 1959 The waterfowl of the world. Vol. 3. Country Life, London. 252 - 257

DOUTHWAITE, R.J. 1977 Filter feeding ducks of the Kafue Flats, Zambia. Ibis. 44 - 65

GINN, P. & McILLERON, G. 1982 Waterbirds of southern Africa. Chris van Rensburg Publications, Johannesburg. 83

HARVEY, R. 1990 Practical incubation. Payn Essex Printers Ltd., Suffolk. 18 - 19

IRWIN, M.P.S. 1981 The birds of Zimbabwe. Quest Publishers. Salisbury.

JOHNSGARD, P.A. 1967 Observations on the behaviour and relationships of the White-backed Duck and the stifftailed ducks. The Wildfowl Trust annual report 17: 10 - 13

JOHNSGARD, P.A. 1978 Ducks, geese and swans of the world. University of Nebraska Press, U.S.A. 24 - 26

JOHNSGARD, P.A. 1995 Ducks in the wild. Swan Hill Press, England. 45

KEAR, J. 1967 Notes on the eggs and downy young of *Thalassornis leuconotus*. Ostrich 38: 227 - 229

MACLEAN, G.L. 1985 Roberts birds of southern Africa. CTP Book Printers, Cape Town. 81 - 82

MACLEAN, G.L. 1997 Whitebacked Duck In: The atlas of southern African birds. Vol. 1: Non-passerines. Allan D.G., Brown C.J., Harrison J.A., Herremans, M., Parker V., Tree A.J., Underhill L.G. (eds). BirdLife South Africa, Johannesburg. 120 - 121

MILSTEIN, P. le S. 1977 A guide to the waterfowl of the Transvaal. Crown Publishing Company, Pretoria. 7

SOOTHILL, E. & WHITEHEAD, P. 1988 Waterfowl of the world. Blandford Press, London. 242

TODD, F.S. 1979 Waterfowl: ducks, geese and swans of the world. Sea World Press, San Diego. 307 - 309

TODD, F.S. 1996 Natural history of the waterfowl. Ibis Publishing Company, California. 88 - 91

WINTLE, C.C. 1981 Notes on the breeding behaviour of the White-backed Duck. Honeyguide 105: 13 - 19

ZALOUMIS, E.A. 1989 White-backed Duck In: Complete book of southern African birds. Ginn P.J., McIlleron W.G., Milstein P. le S. (eds). Struik Group, Cape Town. 104

APPENDIX 1

DATA SHOWING FRESH EGG MASS & SIZE, HATCH SUCCESS, DUCKLING MASS AND SURVIVAL OF AFRICAN WHITE-BACKED DUCKS IN CAPTIVITY (1993/94 SEASON to 1996/97 SEASON)

FRESH EGG MASS (g)	EGG SIZE (mm)	HATCH?	DUCKLING MASS (g)	SURVIVE?
73,91	62,16 X 48,61	yes	47,85	no
70,45	61,12 X 46,28	yes	54,89	no
78,56	64,96 X 49,12	yes	55,31	yes
79,05	63,38 X 50,10	yes	55,26	yes
74,83	61,66 X 49,68	yes	50,12	no
70,55	63,95 X 49,90	yes	52,89	no
72,38	63,25 X 50,10	yes	57,98	no
79,36	63,10 X 49,00	yes	54,52	yes
77,10	63,25 X 50,40	yes	55,29	no
71,26	63,15 X 49,80	yes	55,40	no
72,39	61,50 X 50,45	no		
76,53	62,60 X 49,30	yes	55,34	yes
74,63	62,45 X 49,85	no		
73,81	61,65 X 49,80	yes	60,68	yes
76,12	64,65 X 49,30	no		
75,81	64,95 X 48,25	no		
74,88	63,35 X 49,90	yes	56,38	no
72,31	63,50 X 48,95	yes	53,13	no
70,08	58,40 X 47,60	yes (breech)	42,36	no
73,32	61,45 X 48,50	no		
75,29	62,10 X 48,10	yes	47,72	yes
70,65	58,15 X 47,80	no		
72,20	61,70 X 47,90	yes	41,75	no
72,04	58,75 X 48,70	no		
71,47	56,00 X 48,80	yes	45,97	no
67,39	58,50 X 47,15	no		
77,64	63,40 X 48,60	no		
74,39	60,60 X 48,55	no		
79,65	63,35 X 49,30	no		
79,63	64,00 X 48,90	no		
76,33	61,30 X 48,30	no		
75,47	59,65 X 49,05	no		
70,68	64,65 X 48,50	yes	50,69	no
81,02	65,00 X 47,90	yes	48,64	yes

FRESH EGG MASS (g)	EGG SIZE (mm)	HATCH?	DUCKLING MASS (g)	SURVIVE?
82,00	66,80 X 49,25	yes	59,03	yes
80,79	65,00 X 49,05	yes	57,60	yes
76,81	64,50 X 50,00	yes	59,00	no
80,56	63,20 X 45,10	yes	52,24	yes
76,81	60,10 X 44,80	yes	49,56	yes
79,23	61,15 X 46,20	yes	50,56	no
81,89	65,80 X 48,60	yes	57,07	yes
69,97	60,25 X 42,60	yes	43,96	no
78,76	60,80 X 41,60	yes	50,76	yes
80,16	63,40 X 46,80	yes	53,35	no
79,28	62,40 X 47,60	yes	52,40	yes
67,03	63,30 X 40,45	yes	45,19	yes
66,39	63,55 X 45,10	yes (breech)	44,36	no
66,92	59,00 X 45,80	yes	43,46	no
66,37	60,40 X 45,95	yes	42,79	no
68,53	60,90 X 45,35	yes	46,41	yes
69,21	63,00 X 45,40	yes	48,41	yes
72,25	62,80 X 46,30	yes	48,00	yes
83,26	65,10 X 47,60	yes	59,63	yes
79,42	60,85 X 47,95	yes	54,18	yes
81,34	65,45 X 47,45	no		
84,18	64,00 X 48,65	no		
78,90	62,85 X 48,10	yes	49,94	no
83,46	66,00 X 49,05	yes	54,55	no
84,22	63,80 X 50,00	yes	54,46	no
84,36	64,05 X 50,20	yes	54,58	no
84,64	65,00 X 49,90	yes	53,31	no
74,47	61,20 X 46,90	yes	48,32	yes
70,44	59,65 X 46,65	yes	45,95	no
78,30	63,15 X 46,20	yes	51,10	no
74,33	60,15 X 46,15	yes	48,41	no
74,58	61,30 X 46,10	yes	49,13	no
65,90	58,80 X 44,90	yes	41,68	no
75,95	62,60 X 46,80	yes	48,40	no
74,73	61,75 X 45,55	yes	48,54	yes
80,57	63,15 X 48,05	yes	50,04	no

FRESH EGG MASS (g)	EGG SIZE (mm)	HATCH?	DUCKLING MASS (g)	SURVIVE?
71,61	59,50 X 46,45	yes	50,12	no
63,53	56,15 X 44,50	yes	41,42	no
73,32	59,10 X 47,15	yes	53,61	yes
67,35	56,85 X 45,85	yes	46,23	no
69,14	61,40 X 42,65	yes	45,12	no
70,12	62,20 X 44,90	yes	43,74	no
76,93	63,90 X 46,55	no		
84,23	66,90 X 49,80	yes	55,86	yes
79,19	64,25 X 50,00	yes	48,23	no
77,74	63,20 X 49,70	no		
73,54	60,50 X 48,30	no		
72,64	62,75 X 48,95	yes	47,41	no
75,10	62,25 X 45,45	no		
71,36	61,35 X 42,95	no		
72,83	63,30 X 44,10	yes	49,12	no
69,51	60,20 X 41,95	yes	44,86	no
71,08	62,95 X 44,55	yes	48,78	no
76,84	64,82 X 47,28	no		
74,90	63,20 X 44,20	yes	50,36	no
69,06	62,25 X 42,80	yes	46,71	no
78,48	64,80 X 47,55	no		
73,02	61,50 X 46,20	yes	49,48	no
68,84	60,20 X 42,60	yes	42,86	no
71,70	61,40 X 45,10	yes	47,89	no
73,36	62,55 X 47,80	yes	53,26	no
86,09	65,80 X 50,20	yes	57,98	yes
86,61	64,70 X 49,90	yes	58,19	yes
81,76	63,10 X 47,20	yes	55,12	yes
74,84	62,65 X 56,15	yes	56,11	yes
71,55	63,10 X 49,05	yes	54,02	no
72,53	62,55 X 48,70	yes	54,64	no
71,71	60,50 X 49,65	yes	54,80	no
74,32	64,60 X 48,90	yes	55,57	yes
77,76	63,65 X 48,80	yes	56,45	yes
75,32	65,75 X 49,15	yes	57,60	yes

APPENDIX 2

DATA SHOWING CLUTCH SIZE, FERTILITY, HATCHABILITY AND SURVIVAL RATE OF AFRICAN WHITE-BACKED DUCKS IN CAPTIVITY

DATE	NO. EGGS	INFERTILE	BAD	HATCH	SURVIVE	COMMENT
1993/94 BREEDING SEASON						
18 Dec	4	1	1	2	0	
15 Jan	5	-	-	5	2	
08 Feb	5	-	-	5	1	
10 "	3	-	2	1	1	
13 "	6	-	2	4 (B=1)	1	
27 "	6	1	2	3	1	
29 "	3	1	2	0	0	
06 Mar	4	-	4	0	0	
11 "	6	-	-	6	1	2/6 in APP#1
28 May	3	-	-	3	2	
1994/95 BREEDING SEASON						
17 Oct	4	-	-	4	3	
06 Dec	7	1	2	4	2	
18 "	4	-	2	2	2	not in APP#1
01 Mar	7	-	-	7 (B=1)	4	
1995/96 BREEDING SEASON						
25 Oct	4	-	2	2	2	
26 "	7	-	-	7	1	
27 "	6	-	-	6	1	
29 "	1	-	-	1	0	
18 Nov	4	-	-	4	1	
06 Dec	8	-	3	5	1	
06 "	10	2	2	6	0	
06 Feb	10	-	-	10	1	not in APP#1
09 "	6	-	-	6	3	
1996/97 BREEDING SEASON						
01 Nov	3	-	1	2	2	not in APP#1
14 "	5	1	1	3	2	not in APP#1
25 "	7	-	-	7	4	
09 Dec	8	2	3	3	3	not in APP#1
01 Jan	6	-	-	6	4	not in APP#1
16 "	4	1	-	3	2	not in APP#1
28 "	7	1	4	2 (B=1)	0	not in APP#1

APPENDIX 3

DATA SHOWING AFRICAN WHITE-BACKED DUCKLING BODY MEASUREMENTS IN CAPTIVITY RECORDED DURING THIS STUDY

BEAK LENGTH (mm)	TARSUS LENGTH (mm)	WINGTIP LENGTH (mm)	SHELL MASS (g)	SHELL AS % OF EGG MASS (g)	DUCKLING MASS (g)
14,30	23,15	16,05	6,77	11%	53,27
16,45	25,50	16,75	7,91	12%	59,49
16,20	25,00	15,55	7,65	11%	59,65
15,30	24,65	15,85	9,71	14%	59,63
14,60	24,70	15,60	9,05	13%	58,64
13,70	22,65	15,35	6,37	11%	49,68
14,90	22,90	16,40	8,35	15%	48,95
15,60	22,85	15,35	8,80	14%	52,85
16,40	24,10	15,45	8,47	14%	50,08
15,60	23,20	15,75	6,66	12%	49,99
16,45	22,30	14,95	6,77	13%	43,92
15,45	24,05	15,10	6,96	12%	50,12
16,10	23,55	15,45	8,26	14%	50,18
			8,02	15%	47,41
			7,28	12%	50,48
			8,81	14%	54,64
			6,43	12%	52,86
			8,04	16%	48,08
			7,26	12%	52,18
			8,77	13%	50,58
			7,31	11%	57,41
			8,18	12%	55,81
			8,23	13%	51,63
14,95	24,00	16,60	9,17	14%	56,50
14,25	24,95	14,30	9,20	15%	54,20
16,25	23,15	16,25	7,55	12%	55,07
			7,54	11%	55,33
			6,74	11%	52,65
			6,98	11%	53,95
			6,10	10%	53,42
			7,62	12%	53,32
			9,76	14%	55,56
			6,47	10%	56,05
			7,95	12%	57,43
			7,94	12%	56,42
			9,36	15%	54,56
			5,95	12%	55,10
			8,07	12%	59,80
			7,43	12%	56,35
			10,23	14%	61,38
			10,11	15%	59,29

APPENDIX 4

DATA SHOWING WILD AFRICAN WHITE-BACKED DUCK EGGS MEASURED DURING 1997/98 SEASON AT A WASTE WATER DAM IN THE VEREENIGING INDUSTRIAL AREA

MASS (g)	WIDTH X LENGTH (mm)
79,57	49,35 X 61,55
75,77	49,1 X 59,8
67,54	47,8 X 62,45
76,36	46,55 X 58,5
55,09	45,8 X 56,9
65,43	49,35 X 60,45
66,82	49,6 X 59,75
71,33	50,1 X 59,6
64,82	49 X 59,9
65,99	49,3 X 61,3
67,51	49,5 X 61,6
85,76	50 X 65
84,15	50,25 X 63,9
74,40	48 X 63,1
64,54	45,3 X 58,95
72,18	67,8 X 62,15
76,29	48 X 63,3
79,57	49,4 X 62,45
79,50	48,3 X 64,85
67,38	47,4 X 55,55
73,23	47,95 X 61,2
91,70	50,75 X 65,85
77,64	48,45 X 62,15
85,02	50,1 X 63,6
80,99	48,3 X 65,05
77,05	50 X 60,05
86,58	49,6 X 66,45
82,01	49,2 X 63,1
77,59	49,1 X 61,5
80,03	49 X 60,35
82,70	46,85 X 68,7
87,34	50,35 X 67,15
73,62	47,6 X 61,25
80,68	48,55 X 61,6
69,68	47,2 X 60,45
74,42	48,7 X 68,25

	SHELL MASS (g)	EGG MASS (g)	SHELL AS % OF EGG MASS	DUCKLING MASS (g)	LOSS IN MASS (g)	LOSS IN MASS AS %
	7,95	88,33	9	57,43	22,95	26
	7,94	88,22	9	56,42	23,86	27
	9,36	85,09	11	54,56	21,17	25
	6,95	77,22	9	55,10	15,17	20
	8,07	80,70	10	59,80	12,83	16
	7,43	82,56	9	56,35	18,78	23
	10,23	85,25	12	61,38	13,64	16
	10,11	84,25	12	59,29	14,85	18
MEAN	7,74	75,82	10	52,71	15,38	18,79