

Warthog

(*Phacochoerus africanus*)

Husbandry Guidelines



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1 Natural history

1.1 Physical description

The warthog is a nearly hairless swine with a large, flattened head. A long, thin mane of coarse hair extends from the nape to the middle of the back, where it is broken by a bare space, and then continues on the rump. The remainder of the body is covered with bristles. The colour of both the skin and the hair varies from greyish to dark brown and blackish. A long, ridge like fold on the cheek bares white hairs. The tail hangs limply, but when the animal runs or gets excited it carries its tail in an upright position with the tufted tip hanging over. Adult males have prominent tusks and facial warts. The warts are skin growths and have no bony support or core; a larger pair is located below the eyes (up to 15 cm), a smaller pair close to the tusks. Upper tusks can measure up to 60 cm in males, lower tusks up to 13 cm. Tusks are smaller and warts much less developed in females. Warthogs are 65 to 84 cm in height and their weight varies from 68 to 100 kilograms in males and 45 to 71 kilograms in females.

1.2 Range and habitat

Common warthogs (*Phacochoerus africanus*) inhabit open and wooded savannas, grass-steppe and semi-deserts in almost all sub-Saharan countries from Mauritania and Ethiopia in the north to Namibia and Natal in the south. They occur over a wide range of habitats from sea level in The Gambia up to 3000m on the Ethiopian plateaus. Its distribution is limited by the availability of suitable forage and cover and, increasingly, by human pressure. Warthogs occur on treeless open plains and lightly wooded savannas, but avoid densely wooded vegetation without grazing. There are no desert warthogs (*Phacochoerus aethiopicus*) in captivity.

1.3 Diet

Warthogs are predominantly grazers, which is why they will avoid forest and dense undergrowth. In the wet season they graze, though they will also consume sedges and fallen fruits. In the dry season the warthog may also specialize on the underground rhizomes of perennial grasses and sedges, as well as bulbs and tubers, which it unearths with its tough snout. Unlike other pigs, it grazes and roots while resting and walking on its padded wrists. Although drinking daily when water is available, it may be able to subsist without drinking water during periods of drought by rooting for succulent rhizomes and bulbs, which makes it less dependant on the continuous availability of surface water.

1.4 Social structure and behaviour

Warthogs are largely diurnal and sleep at night in burrows, often using aardvark holes. While their body temperatures can evidently vary within a certain tolerance range, warthogs usually cope with high temperatures by behavioural strategies, such as wallowing. Warthogs have early-morning and especially late-afternoon feeding peaks, but also graze between irregular resting/sleeping periods.

Warthogs are known to have a good sense of smell and hearing and are extremely vocal, using different sounds to communicate.

Warthogs usually live in small family units, which generally comprise one to three adult females and their young. Sounders may include up to 16 animals but typically number 5 or less. One or two mature daughters may continue to associate with their mother over several mating and farrowing cycles. Males generally leave their natal group before the age of two years. Subadult males often associate in bachelor groups after leaving the natal group. Adult males either live solitarily or in small bachelor groups. Boars only accompany female groups briefly for mating.

Warthogs are not known to be territorial, but adult males do contest mating priority. Both males and females tend to remain in the natal home range. Home ranges vary from 64 to 374 ha; they may overlap and are often shared by sounders, male bachelor groups and solitary males. Home ranges and population densities are dependant on the available recourses.

1.5 Reproduction

Warthogs breed throughout the year in equatorial regions, but under seasonal climatic conditions warthogs are seasonal breeders (see figure 1). Rutting and farrowing are cyclical, with rutting occurring at the end of the rains or early in the dry season and farrowing occurring at the end of the dry season or near the beginning of the rains. Oestrous lasts about 72 hours and occurs at intervals of 5 weeks (35 days). The gestation period is about 155 days; the average litter size is 3 with a range of 1 to 7. The piglets return to the burrow for 6 to 7 weeks except for brief excursions or to change burrows. They begin to accompany their mother at about 50 days on longer forays and are completely weaned at about 21 weeks. Males separate from their mother at 15 months; females usually stay longer, perhaps in permanent association to their natal group. Both sexes reach puberty at approximately 18-20 months, although males generally do not mate until they reach physical maturity at approximately 4 years (see figure 2). The average lifespan is 12 to 15 years.

Interbreeding with other suids has not been reported, even if several species live in the same region and use the same waterholes.

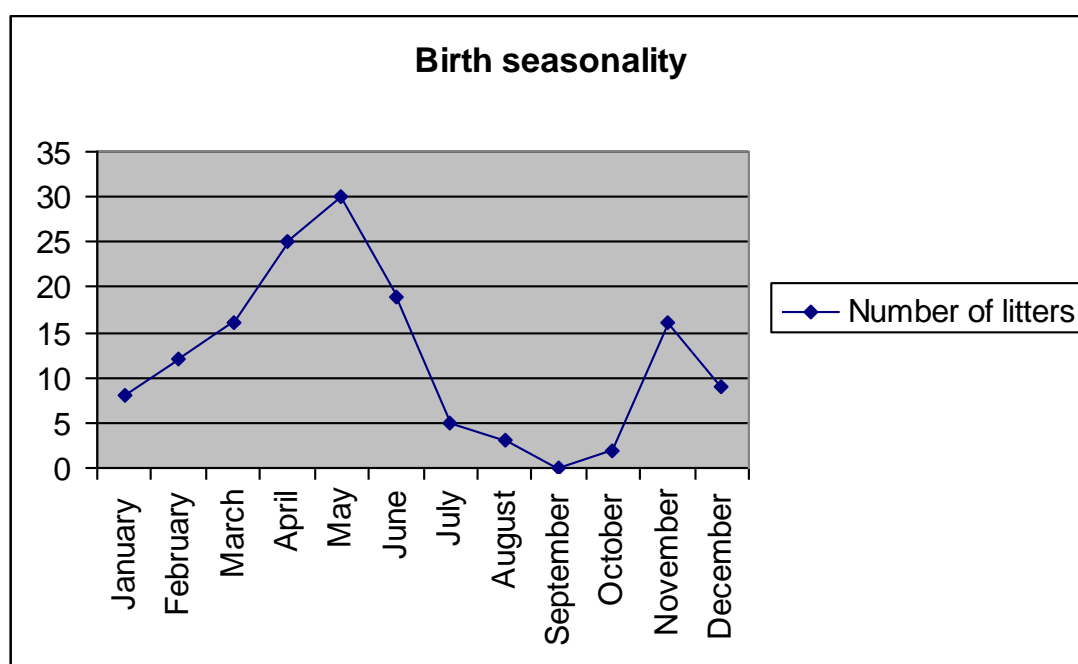


Fig 1: Birth seasonality in the European captive warthog population

Warthogs (wild and captive) are seasonal breeders.

A clear birth peak in the European warthog studbook population occurs around May; this can be explained by European climate conditions. A smaller birth peak can be seen in November, which can not be related to climate conditions in Europe. This peak may occur because a significant number of specimens in the European studbook population were born in Africa, where birth peaks in warthogs occur around November, about one month before the rains.

Females*	
Average age at first reproduction	3 years, 6 months, 0 days
Median age at first reproduction	2 years, 10 months, 16 days
Youngest dam at first reproduction	1 year, 4 months, 12 days
Oldest dam at first reproduction	~ 12 years, 4 months
Average age at reproduction	4 years, 9 months, 27 days
Median age at reproduction	4 years, 6 months, 22 days
Oldest dam to reproduce	~ 12 years, 4 months
Males*	
Average age at first reproduction	2 years, 11 months, 30 days
Median age at first reproduction	~ 2 years
Youngest sire at first reproduction	0 years, 11 months, 14 days
Oldest sire at first reproduction	6 years, 7 months, 13 days
Average age at reproduction	4 years, 8 months, 21 days
Median age at reproduction	~ 4 years, 3 months
Oldest sire to reproduce	13 years, 9 months, 7 days
* Note that age of reproduction in females is the age on which the dam gave birth; age of reproduction in males is the male's age when the dam conceived (gestation period is set to 155 days).	

Fig. 2: Reproductive demographic information for the European studbook population

Male warthogs tend to breed at earlier age in captivity because of the lack of potential competitors. Males as well as females are able to breed at older age in captivity because of more suitable environmental conditions, which often lead to a better physical condition.

1.6 Threats and status in the wild

The common warthog (*Phacochoerus africanus*) is widespread and locally abundant in most of its historical ranges. Given the very low levels of international trade in live warthogs and warthog products at the present time, this species is not included on any of the CITES Appendices.

The principal causes of mortality among free-living warthog populations are climatic extremes (including low temperatures, excessive rainfall or extreme drought) and predation. Human persecution in reprisal for crop-raiding and excessive hunting for its meat outside protected areas are probably the most important threats. Hunting is forbidden in all national parks and wildlife sanctuaries, but the actual enforcement of these regulations may vary from country to country. Outside these areas, hunting is permitted (during fixed seasons and/or on restricted permits) and farmers are free to control warthog numbers. Religion plays an important role in the survival of this species: warthogs are widespread in many Islamic countries where they are not hunted for their meat. A small scale trade in warthog tusks, and the animal's susceptibility to various diseases - which may seriously affect local warthog populations as well as making them important targets for disease control programs - form additional smaller threats. Owing to their preference for open savannas warthogs may benefit from deforestation, though desertification has undoubtedly contributed to the species' decline.

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2 Enclosure

2.1 Indoor enclosure

Although warthogs can go outdoors every day throughout the year, in winter time they do need a heated indoor environment. The animals should have free access to their indoor enclosure throughout the day. Warthogs can cope with many different weather conditions, as long as their environment is not both wet and cold at the same time.

It must be possible to separate the indoor enclosure into different areas, since warthogs may live in several different social systems. In the wild, females live in small family units with their offspring. One or two mature daughters may continue to associate with their mother over several mating and farrowing cycles; males generally leave their natal group before the age of two years. Adult males usually live solitarily or temporarily accompany one or more females and their offspring. Subadult males often associate in small bachelor groups. In captivity, group composition depends on several different parameters, such as individual preferences, age and sex, and is not predictable beforehand.

2.1.1 Size

If the animals have access to an outdoor enclosure on a daily basis, an indoor enclosure measuring 4.5 square meters per animal would be sufficient. However, if the animals have to stay indoors for several days or longer (for example because of unsuitable weather conditions during winter time), the inside enclosure should measure a minimum of 10 square meters per animal. Because warthogs can jump up to 1.80m, the indoor enclosure (and the separation walls) should be at least 2m in height.

2.1.2 Structure

Since a group of warthogs in captivity may not necessarily form a socially compatible group (see above - 2.1), it must be possible to divide the enclosure into several separate boxes at all times. Although it might be possible to keep several animals or even a group of animals together in one enclosure, for management and/or safety reasons it must be possible to keep the animals apart. Preferably, there should be one box for each animal so that animals can be separated for birth, introduction, medication or behavioural problems. The enclosure should have separate feeding places and separate sleeping quarters for each animal or each group of animals (mother with piglets, mother/daughter). The number of boxes required within the enclosure depends on the number of animals and group composition.

There should be at least two animal doors in the indoor enclosure. With introductions or other risky situations, the possibility to use two doors decreases the risk of animals being cornered. (For additional guidelines regarding introductions, see 3.2 - Introduction) For safety and practical reasons, non-barred sliding doors are recommended. Handling the doors must be possible without placing the keeper at risk.

Special care must be taken to avoid potential hazards such as large gaps and open spaces between bars, around doors, between walls, in ventilation openings etc. as animals can get hurt and/or get stuck with their tusks. Blind corners or places where cycling females or other individuals could be trapped by aggressive, exhibiting mates should be avoided.

Warthogs prevent their skin from dehydrating by wallowing in mud. In winter time it is generally not possible for the animals to wallow on a daily basis because of decreasing temperatures. In this case additional skin care should be provided. One

way to realise this is to hose the animals down with heated water on a regular basis. Showers could be included in the indoor enclosure for this purpose. Care must be taken not to allow wet animals to go outside in freezing conditions. Another option is the use of baby oil which can be applied with a spray bottle or brush.

2.1.3 Substrate

Floors and walls are usually solid concrete. Rubber mats or other anti-slip floors and bedding material can be used to prevent the floor from becoming slippery. An anti-slip floor is essential since warthogs are very susceptible to leg injuries and piglets regularly die from splay legs. Bedding material, such as straw, hay and/or wood shavings, helps the animal to keep up its body temperature and is especially important if the floor is not heated. It is also used by the animals to create nests in which they burrow at night. The availability of sufficient bedding material is particularly important for females prior to and after giving birth. The female creates a nest in which she gives birth. The piglets return to this nest for several weeks. Piglets are extremely susceptible to loss of body heat and pneumonia, so a warm nest (in combination with a heated indoor environment) is very important.



Fig. 3: Sufficient bedding material is necessary

2.1.4 Temperature

Warthogs can handle hot temperature extremes in summer relatively well. They need a heated indoor environment in winter time. Although warthogs can usually go outdoors on a daily basis throughout the year, in winter time free access to the heated indoor enclosure must be provided throughout the day. By using plastic or rubber 'pet doors' the animals can go in and out while the plastic or rubber flaps keeps the heat inside. Piglets should not be allowed outdoors as long as weather conditions are relatively cold and/or wet, since they are particularly prone to pneumonia.

A heated indoor environment can be created by using underground incorporated heating pads (also used in commercial pig breeding), coils or warm water pipes in the concrete floor. Overhead heating can also be used, but great care is required with wiring-construction, as this can be very dangerous; warthogs can jump up to 1.80m. It is recommended to keep the indoor enclosure at a temperature of least 18°C at all times. If the exhibit is heated by overhead heating, floor temperatures should also be monitored in winter time. It is important to prevent overheating of the floor as this causes skin problems: the skin becomes too dry and flaky.

Piglets are especially dependant on extra heat; they need an indoor environment of 33°C. They are born naked with very little body fat, which is why they can not keep up their body temperature themselves.

2.1.5 Ventilation

Although warthogs are relatively heat tolerant, proper ventilation in indoor areas is essential since pig species are particularly prone to respiratory difficulties. Indoor ventilation systems should be able to provide fresh air to meet the respiratory needs of the animals, control moisture build-up within the enclosure, move enough air to dilute airborne disease organisms produced within the enclosure and to control or moderate extreme temperatures.

Piglets are very susceptible to pneumonia, so be careful with air circulation. Extra care must also be taken to make sure that the animals can not get any body parts, such as their tusks, stuck in the ventilation openings.

2.1.6 Watering

Because of the increased susceptibility to heat stroke and respiratory difficulties in pig species, providing fresh water at all times is essential. Automatic drinking nipples/pressure pads or other kinds of hog waterers are a very good and effective way of providing controlled continuous access to fresh water in the indoor enclosure. These should be placed as close as possible to a drain so that spillage of water during drinking does not wet the rest of the stable and the bedding. Large tubs of water might work as well, but must be cleaned on a daily basis and are often tipped over by the animals. The animals may also try to climb into the tubs for bathing. An additional reason to prefer automatic drinking nipples/pressure pads over tubs is to prevent soiling of the drinking water.

2.1.7 Lighting

Since natural lighting might not be sufficient on overcast or winter days, artificial lighting needs to be provided in each area of the inside enclosure. Be careful with hanging lamps since warthogs can jump up to 1.80m! Additional natural lighting is not necessary, but indeed preferable.

2.1.8 Keeper safety

Caretakers should never share the same physical space with the animals without the benefit of some type of barrier; keepers have been killed by warthogs in the past. The lower tusks are razor sharp and are used for slashing at the opponent's body. In the case of human victims it is usually the region of the femoral artery that is slashed with fatal consequences.

As with other species, it is important to know your animals, be aware of any relevant special circumstances and of your surroundings, and to always have an escape route in mind if put into a dangerous situation. Extra care must be taken when working around females with piglets.

2.2 Outdoor enclosure

An outdoor enclosure should be available to the animals, at least on a rotating basis. Warthogs are heat tolerant, and can handle hot temperature extremes relatively well. Although there are many variables such as rain, snow, sleet and wind chill when deciding what minimum temperatures warthogs can tolerate, adult warthogs have little problem with temperatures above freezing, as long as it is not wet and windy at the same time. In zoos in Western Europe, warthogs can go outdoors on a daily basis throughout the year, as long as they have free access to a heated indoor environment throughout the day.

2.2.1 Size

The outdoor enclosure should be as spacious as possible. A spacious outdoor enclosure is essential in order to enable the animals to express natural behaviour, to avoid stereotypic behaviour, stress and aggression among animals and to decrease risks when introducing new animals. If it is not possible for the animals to go outdoors on a daily basis (for example because of unsuitable weather conditions in winter time), the size of the inside enclosure should be adjusted.

2.2.2 Structure

The outdoor enclosure must not be placed on a slope, because the warthogs' digging will cause the soil to come down and accumulate at the lower part of the exhibit. If enough soil is heaped up, the warthogs will be able to jump over the fences.

Since the establishment of a social group is never guaranteed and group composition is not predictable on beforehand, it must be possible to divide the outdoor enclosure



Fig. 4: Female and piglets snoozing in the shade.

into several smaller areas. These separate areas can be connected to each other whenever a social group is established.

Although warthogs are relatively heat tolerant, the outdoor enclosure should provide a sufficient amount of shade to the animals. A mud pool for wallowing is essential: warthogs will wallow in the mud on warm days to keep cool. The mud pool must be closed off in winter time, because warthogs are very susceptible to pneumonia and can not cope well with cold and wet

environmental conditions. This is why in winter time the animals should also have free access to a heated indoor environment throughout the day. Another reason for warthogs to wallow is to prevent their skin from getting dehydrated. If the mud pool is closed, additional skin care must be provided. This can be realised by hosing the animals down with heated water or rubbing the animals' skin with for example baby oil on a daily basis. If the animals use scratch brooms, the oil can be put onto the bristles of the brooms. This way the animals will rub the oil onto themselves.

Vegetable oil must not be used; the animals will lick it off, which may cause diarrhoea. For safety reasons, there must always be some kind of barrier between the animal and the caretaker when handling the animals. The animals can be trained to go into some form of a box in order to be showered or get their skin oiled.

When designing an outdoor enclosure, try to create several places where the animals can withdraw, but which prevents them from hiding completely out of the public's sight. Feeding places and places where the animals can find shade and shelter should be placed within the sight of the visitors, because we do not want to display an empty enclosure.

A variety of barriers can be used to keep the animals in their outdoor enclosure. Water/dry moats, rocks, chain link fencing, wooden fencing and solid walls have proved to be effective in keeping warthogs inside their enclosure. Neonates cannot be allowed in an outdoor enclosure with open weave fencing until they are large enough not to pass through the fencing anymore. Extra care must also be taken when considering open spaces in for example, chain link fencing, because the tusks of the animals might get stuck. For the very same reason one must be extremely careful with electric fencing, as warthogs have been killed by electrocution in the past after getting their tusks trapped in electrical fencing. If electrical fencing is being used, it should always serve as a secondary, not a primary barrier. If rocks are being used as a barrier, care must be taken that the rocks are large enough to prevent the animals from climbing them. This is not only to prevent the risk of animals escaping, but also because warthogs are very susceptible to leg injuries. The rocks should be placed on some kind of a foundation, which prevents the animals from digging underneath them. In the past warthogs have been killed when excavated rocks fell upon them (fig 5). Although water/dry moats are very functional and attractive



Fig. 5: Warthog piglet killed by rock

barriers, they must be at least 2.5m broad to prevent the warthogs from jumping over them. When using water moats, there should be a secondary barrier on the public's side of the moat to prevent the warthogs from climbing out of it. During introduction the fence should be at least 1.80m high including overhang, afterwards this can be reduced to 1.25m without overhang. The fencing should go at least 0.5m into the ground. Attached to this underground fencing should be another 0.5m

horizontally placed square welded (10x10 cm, or 15x15 cm) concrete re-enforcement mesh in order to prevent the warthogs from digging themselves out.

2.2.3 Substrate

The substrate in the outdoor enclosure must consist of sand and/or soil. Concrete is not suitable considering the warthog's digging nature. It is no use to plant grass or any other vegetation in smaller enclosures, since warthogs will dig it out immediately. If vegetation is preferred in order to make the enclosure look more attractive, some kind of barrier should be placed around the plantings. Be careful with electric fencing, since warthogs can get stuck with their tusks and get electrocuted.

Make allowance for heavy equipment (tractor, loader and shovel) to enter the enclosure for the annual change of substrate.

2.2.4 In general

It is recommended to monitor the enclosure on a daily basis. This way potential hazards and/or escape attempts will be noticed in time. The animals should be locked inside every night to prevent them from digging too deep and making shelters for themselves, in which they can hide from the keepers and the public. Continuous access to fresh water must be available in the outdoor enclosure (see 2.1.6 - watering). Keepers must never enter the exhibit while the animals are inside; keepers have been killed by warthogs in the past (see 2.1.8 - keeper safety).

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3 Social structure

3.1 Social structure within the species

In the wild, female warthogs usually live in small family units. Sounders generally consist of one to three adult females (often mother and one or two daughters) and their young. These sounders do not include adult males; males generally leave their natal group before the age of two years. After leaving their natal group, subadult males often associate in bachelor groups. Adult boars generally live solitarily, and sometimes in small bachelor groups. They only accompany females briefly for mating.

When accommodating warthogs in captivity, their social structure in the wild must always be kept in mind. Many different forms of group composition have proved to be successful in captivity, but just as many have failed. What works at one institution or in one group, may fail at another. Which way of group composition will work out best can not be predicted beforehand, as this depends on many different factors; for example the number of animals, their sex, age, husbandry, available space, individual preferences and characteristics etc. It should be noted that even if a stable social group is established, this is no guarantee for the future. Group composition may change instantly, and for many different and sometimes unknown reasons. This is why it must always be possible to keep the animals apart. It would be best if there was one box for each animal so that animals can be separated for birth, introduction, medication, behavioural problems etc. If a social group is established, the enclosure can be shared by the animals. However it is still recommended to provide separate sleeping quarters and feeding places. Social groups in captivity held warthogs may vary from one adult male with one or several adult females (and their offspring) to non-breeding groups, such as all female or male bachelor groups. Warthogs can also be kept solitarily (mostly males). It may be necessary to temporarily separate a female with piglets from the male and/or the rest of the group. Male offspring can usually stay with its parents for one or two years (until it reaches puberty). It is at this age that the adult male generally starts to behave aggressively towards the young male(s). Females may be able to stay with their natal group longer, and sometimes even continue to associate with their mother permanently. If it is decided to keep female offspring in its natal group, care must be taken not to let the young female mate with her father. In this case, it may be necessary to find a new breeding male. Note that females choose their mating partners, and it is possible that a certain male will never be accepted by a female. All male groups usually consist of subadult animals, since adult boars only rarely accept other adult males. All male groups and very large social groups are usually relatively stressful and are seldom successful.



Fig. 6: Family warthog group

3.2 Introduction

Extra care must be taken when introducing animals to a new enclosure and/or new exhibit mates. Introductions are usually very stressful and have led to many stress-related deaths in the past. This is why the use of long acting tranquilizers (such as perphenazine enanthate) is recommended, for the new animal as well as its exhibit mates.

When introducing an animal to a new facility, it is preferable to keep the new individual apart from its new exhibit mates for the first few days. During this period, the new animal can adjust to its new surroundings, food items, daily routine and keeper staff. When the new animal seems comfortable in its new surroundings, there should be a period that allows the new individual to familiarize itself with its exhibit mates via preliminary introductions that include olfactory, visual and limited tactile contact (through some kind of a barrier). If you see the animals interact without any signs of aggression, they may be introduced to each other. When actually introducing the animals to each other, make sure the space is adequate for animals to get away from one another. Reduce the risk of animals being cornered as much as possible; this means avoiding blind corners and other places in the enclosure where animals could be trapped by aggressive exhibit mates. Also make sure that the space offers shifting opportunities (doors/gates) in case the animals need to be separated from one another.

3.3 Mixed species exhibits

In the wild - and this is in contrast to the Red River hogs and Bushpigs (*Potamochoerus sp.*) - warthogs are not known to hunt and kill prey. Several smaller mammal and bird species are known to share the habitat and even the burrows with warthogs. Large African ungulates grazing close to warthogs are a familiar sight on the African savannahs. Ground Hornbills (*Bucorvus leadbeateri*) have recently been reported to act as 'giant oxpeckers' on friendly warthogs in South Africa. However, until quite recently most zoos were very reluctant to introduce warthogs to other species in their enclosures.

A mixed species exhibit often offers a very attractive display to the public. Several zoos in Europe and North-America have started to experiment with mixed species exhibits including warthogs. Their experiences and recommendations are listed below, and may be taken into account by institutions that are planning to create a mixed species exhibit with warthogs in the future.

3.3.1 Plains zebra & white rhino

One zoo in the past had a mixed species exhibit containing warthogs, plains zebra's and white rhino's. This was not a success; aggressive behaviour between the different animal species (especially between the warthogs and the zebra's) occurred on a regular basis. This is why this type of mixed species exhibit is not recommended by the zoo. Everybody who is familiar with zebra's in a mixed species exhibit can probably confirm this type of problem. Zebra's are known to chase every new animal in their enclosure, from new born wildebeest to stray deer, which is the main reason most collections are reluctant to introduce new born giraffe in a mixed species exhibit if zebra's are around. It takes a long time for the zebra's to lose interest in the new arrivals. In many cases it is not possible to allow for rapid intervention of the keepers by car if you are working in a normal zoo environment. Safari parks are more suitable for this type of co-habitation. However here too they often have problems with exhibits that are too large, which enable the warthogs to disappear from sight and thereby refuse to return inside at night.

3.3.2 African elephant

In another institution, a male warthog shares a 1500m² outdoor exhibit with 1.2 African elephants. Next to this large outdoor exhibit is a smaller outdoor enclosure, in which the warthog can be separated from the elephants if needed. The elephants cannot enter the smaller exhibit, because the fencing contains only a low entrance which is only just high enough for the warthog to go through. The warthog has a separate indoor enclosure, which it can reach through the smaller outdoor enclosure. When the warthog first arrived it was housed in the indoor enclosure and the smaller outdoor enclosure, where the animals could see and smell, but not touch each other. When the big outdoor enclosure was made warthog-proof (to prevent the warthog from digging himself out etc.), the warthog was introduced to the elephants. A lot of interaction between the elephants and the warthog was seen during the introduction. The elephants would sometimes chase the warthog, but no aggressive behaviour



Fig. 7: Warthog with African elephants

or accidents occurred. Later the animals became very calm together. The animals no longer show aggressive behaviour towards each other and physical contact has been seen several times, especially between the warthog and one of the female elephants. The warthog calmly walks between the elephants and sometimes even underneath them. The female elephant rubs the warthog with her trunk and her front legs. Up until now, no intervention by the keepers was needed since no aggressive behaviour occurred. If the

elephants are excited or when the male is in musth, the warthog keeps his distance. It must be noted that the elephants were already used to sharing their exhibit with other species before the warthog arrived, as they were housed together with different antelope species in the past. The mixed species exhibit with a warthog and African elephants provides a very attractive display for the visitors; it is very interesting for them to see the different species interact. Thus, based on its own experiences, the zoo can give positive advice regarding this type of exhibit. The zoo hopes to expand this experiment by adding a female warthog to the exhibit in the near future (and eventually maybe breed with the warthogs).

3.3.3 Porcupine & meerkat

In this example, warthogs lived together with porcupines & meerkats. The animals shared an outdoor exhibit, but each species had a separate indoor enclosure. This was realized by adjusting the entrances to the different enclosures to the species' size. The entrance to the meerkats' indoor enclosure was small enough to prevent porcupine or warthog from getting through. The entrance to the porcupine's enclosure was too small for a warthog to pass through. A disadvantage of this system was that the meerkats could enter all indoor enclosures, and that the porcupines were able to enter the warthog enclosure. It would be best to lock all animals in their own indoor enclosure at night in order to prevent accidents and to keep an eye on the nutritional intake of the individuals.

The zoo adjusted the outdoor enclosure to prevent the animals from digging themselves out (warthogs, porcupine and meerkat all dig). A combination of large

square welded concrete re-enforcement mesh (for warthog and porcupine) and ½ inch square welded mesh (for meerkat) was placed underground. The square mesh was placed on top of the ½ inch square welded mesh in order to protect this more refined material from digging warthogs. The rocks in the enclosure were attached to the square mesh foundations with cement. This prevented the rocks from falling upon the animals when they would dig underneath them. The zoo also made sure that enough places where the animals could find shelter were provided so that the animals were able to withdraw from their exhibit mates if they wanted to.



Fig. 8: Warthog with meerkats



Fig. 9: Warthog with porcupine

The introduction went very well. The meerkats interacted a lot with the warthogs; they would often sit on top of the warthogs and use them as an observation post. The warthogs did not show any aggressive behaviour towards the meerkats. This mixed species exhibit with warthogs and meerkats was a very attractive and popular display, considering the association with the well known and very popular movie 'The Lion King'. Unfortunately, it was very difficult to lock the meerkats in their separate indoor

enclosure during the night, so meerkats and warthogs would often sleep together. This was when most accidents occurred; several meerkats were squeezed to death when sleeping together with the warthogs. There was not much interaction between the porcupine and the other species. The porcupine sometimes showed some aggressive behaviour towards the warthogs; if a warthog would come too close, it would sometimes end up with a quill in its nose.

In this case the zoo did not give a positive recommendation regarding this type of exhibit because it lost several meerkats. The advice would be positive if a practical way could be found to keep the species apart during the night.



Fig 10: Unfortunate encounter of warthog and porcupine

3.3.4 Hippo

In the past, one collection had warthogs on the land area of their Nile hippo enclosure. There was no problem with the two species in the enclosure during the day time but it became a whole different story at night. It proved to be practically impossible to separate the warthogs from the hippos and all animals would enter the night enclosures of the hippos together. The hippos received their evening meal, the

warthogs joined them and everybody slept together afterwards. Several warthogs got squashed when a hippo rolled over and one warthog was bitten and had to be euthanized, probably after a food dispute. Here once again, the limiting factor proved to be the night enclosure. It became impossible to separate the species.

3.3.5 Other African savannah species

In addition, several other institutions have experimented with mixed species exhibits including warthogs. In these exhibits, warthogs live/have lived together with zebra's, ostriches and various antelopes, bat-eared foxes, black face impala's, gnu's and Cape buffalo's. Unfortunately we were not able to make contact with these institutions for their comments and to hear about their experiences.



Fig 11 : Warthogs with Sable antelope and Grant's Gazelle

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4 Enrichment

Enrichment can be defined as a way of improving the animals' environment to encourage the expression of more natural behaviour.

4.1 Exhibit design

The enclosures should be designed in a way that stimulates the warthogs to express natural behaviour -such as digging, rooting, wallowing and burrowing- and avoids boredom and stereotypic behaviour. The substrate in the enclosures is a very important factor in this. Bedding material is a good way to stimulate natural behaviour in the indoor enclosure, since the animals can use this to create nests in which they sleep at night. The outdoor enclosure must at least contain sand/soil and a mud pool, since digging/rooting and wallowing are essential elements of the warthog's natural behaviour.

4.2 Feeding

Changing feeding routine and food presentation on a regular basis can be a very functional way of behavioural enrichment, as it may decrease boredom and stimulate natural behaviour. Rather than offering the warthog's daily allowance of food at one feeding, it can be offered at several times throughout the day (see 5.1 - Feeding schedule and food presentation).

The food can also be presented to the animals in different places within the enclosure. For example, by spreading the food throughout the enclosure and/or hiding the food in different places within the exhibit, the animals will have to search for their food, just like they would have to do in the wild. This way they are stimulated to express natural behaviour and to be more active during the day.

Food items can also be presented in a way that encourages the animal to be more active, for example in a 'boomer ball'. This is a ball with holes which can be filled with, for example, grain, peanuts, cereal, raisins etc. If additional food items are offered as a way of enrichment, the rations at regular feedings should be reduced so that the daily recommended intake remains consistent.

4.3 Other

There are many other ways of behavioural enrichment. Some examples are scratch brooms and different kinds of toys, like balls and hanging buckets. It is necessary to rotate these toys very often to keep them effective, since warthogs (as well as many other species) rapidly lose their interest in new things. Single held warthogs will enjoy the temporary company of a domestic pig as both will understand the other's 'language'. (see Fig 12)

4.4 Conclusion

Since warthogs are highly intelligent, they constantly need to be stimulated and challenged in order to show activity and natural behaviour.

The major problem with enrichment is that the animals get used to new things and lose their interest in them quite fast. This makes it a challenge for the keepers to continue coming up with new and effective ways of enrichment for the animals.

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5 Nutrition

5.1 Feeding schedule and food presentation

A foraging warthog typically walks around (often on its padded wrists) with its nose to the ground grazing, rooting and probing through the leaf litter while slowly, bit by bit, picking up food items that it comes across and unearthing underground rhizomes of perennial grasses and sedges, as well as bulbs and tubers. Foraging is therefore likely to occupy a significant proportion of the wild warthog's day. To duplicate this level of activity, feeding in captivity should be spread throughout the day. For example, animals could be fed about 30% of the diet in the morning, 20% (scatter feeding and browse) throughout the day and 50% in the afternoon. Feeding not too much in the morning will hopefully result in animals still willing to forage for scatter food rather than to snooze.

Changing food presentation may also increase activity levels in foraging captive warthogs. Spreading the food throughout the exhibit, hiding the food, using toys like boomer balls (see 4.2 - Feeding) stimulates activity and natural behaviour in captive warthogs. If additional food items are offered as a way of enrichment, the normal rations given at regular feeding times should be reduced so that the daily recommended intake remains consistent.

It is important to have sufficient control over the intake of individual animals. Males tend to monopolise the food when fed in the company of females. Therefore food items requiring more precise dosage such as vitamin and mineral supplements and nutrient-rich items such as commercial pellets, starchy fruit and vegetables, larger quantities of nuts and seeds etc., should be offered individually, for example during the morning and/or evening meals.

Ground surfaces as well as troughs can be used for feeding the main portion of the diet as long as they are cleaned thoroughly and regularly. When using food troughs, these should be placed at ground level.

In order to prevent soiling of the drinking water it is recommended to have automatic drink nipples / pressure pads in the enclosures. These should be placed as close as possible to a drain so that spillage of water during drinking does not wet the rest of the stable and the bedding.

5.2 Diet

The structure of the stomach and the intestinal tract is largely the same for warthogs and domestic pigs, so the domestic pig can be considered the dietary model for the warthog in captivity. However, the slower growth rate, longer pregnancy and smaller litter size of warthogs must be taken into account. Nutritional requirements for the domestic pig can be found in Zootrition (Saint Louis Zoo, 2005).

Warthog diets in zoos may consist of fruit, vegetables, grass, hay, alfalfa, leaves, branches, pellets, animal products and vitamin and/or mineral supplements. Most zoos feed a combination of fruit, vegetables, grass/hay/branches and pellets. Animal products are added to the diet in some institutions, but generally not on a daily basis. Vitamin and/or mineral supplements for adult animals are generally not necessary if the nutritional values of the diet are sufficient.

When compiling a warthog diet, it must be noted that captive warthogs are prone to obesity. Feeding considerable amounts of (commercial) pig meal / pellets or other highly nutritional items is therefore not recommended. It is advised to feed lactating sows to appetite and to achieve the required intake of nutrients, a greater quantity of food items with lower nutrient density is needed.

The considerable differences in body size and weight between males and females should be taken into account when compiling their diets, as well as the physiological and reproductive stage (in females) of the animal.

An example for a captive warthog diet (maintenance) is included here.

<i>Amount</i>	<i>Item</i>	<i>Frequency</i>
850 grams	alfalfa hay	daily
1300 grams	ADF-#25* herbivore pellet	daily
1 piece	romaine lettuce	daily
7 pieces	carrots or raw yams	daily

(* ADF-#25: Mazuri Foods, herbivore pellet with 25% ADF)

Note that the diet above is just an example; there is a very wide range of warthog diet varieties in zoos, lots of them being sufficient.

Young wild boar and other wild suids are known to have higher iron requirements than usually provided. Farmers with domestic pigs used to provide compost or mud from a nearby river to sows with piglets. It was suggested to provide iron injections to growing warthog piglets, certainly if they have limited access to natural soil. Mineral lick stone's as used for domestic herbivores can be offered to warthogs as well.

5.3 Handrearing

<i>Composition of warthog milk</i>	
Total solids	19-20%
Fat	7.3%
Protein	7%
Sugar	3.4%

The composition of warthog milk is not very different from that of domestic pig milk. It is recommended to use the commercially available milk replacers for domestic pigs in cases where you have to handrear a warthog. Brands will be different from country to country but are generally widely available within Europe. An American supplier is Pet-Ag Inc. this company makes a wide range of milk replacers used in zoological collections all over the world.

Warthog piglets are known to drink from females other than their own mother in some cases.

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6 Transportation

Warthogs must be transported individually, either in separate compartments of a large container or in single smaller containers. However, sibling piglets can be transported together.

High mortality rates in warthogs during or immediately after transportation are mainly caused by stress-related injuries (broken legs, broken back, etc). In the period from January 1st 1995 until July 1st 2006, 123 deaths were witnessed in the ESB for warthogs. Among these deaths 60 animals (49%) were younger than 30 days, including youngsters that disappeared immediately after birth. From the remaining 63 deaths, 20 cases (= **32%**) can be attributed to deaths during or immediately after transport or introduction to a new enclosure and/or to a new partner. This figure is unacceptable and must be improved.

This is why proper crate training and the use of long acting tranquilizers is highly recommended. Since pig species are particularly prone to heat stroke and respiratory difficulties, extra care must be taken considering proper ventilation and a continuous access to drinking water.

6.1 Container requirements

The shipping crate must be constructed out of wood, metal or other similar strong materials. The frame must be made from solid wood or metal bolted or screwed together and it must have additional metal re-enforcing braces. The sides and door must be made of solid wood, or similar material, constructed inside the framework. It must be close boarded to a height of 30 cm to prevent excreta escaping, and it must be slatted (or containing ventilation holes) above the closed boarding to provide a smooth and strong interior, free of any potential hazards to the animal. The slats must be spaced in such a way that prevents the animal from getting any body parts through the openings between the slats, but wide enough so that air can circulate freely. Extra care should be taken to make sure the tusks of the animal can not get stuck. The non-slip floor can either be close boarded to form a solid base and covered by sufficient absorbent material in order to prevent excreta escaping. Alternatively it should be made of peg board or slats over a leak-proof droppings tray in such a manner that all the excreta falls onto the tray. The roof must be slatted for maximum ventilation at a distance that does not allow the tusks to protrude. A sliding or hinged door must be provided at the rear of the container, with a secure means of fastening that cannot be opened accidentally.

Warthog crates must allow the animal to stand erect and lie down comfortably, but not wide enough to encourage the animal to turn around. A minimum height of 15 cm over the highest part of the back is required. An adult warthog is approximately 65cm in height, so this means a minimum height of $65+15 = 80\text{cm}$ for the crate. If the animal is bigger (note that males are subsequently bigger than females), logically the crate should be higher.

6.2 Ventilation

Pig species are particularly prone to heat stroke and respiratory difficulties. Extra care must be taken to keep them as cool as practicable and well ventilated.

Ventilation openings must be provided and distributed equally over all four sides of the crate. Pig species need more ventilation than other species; the openings must be equivalent to not less than **40%** of the floor area. When holes and slots are used for ventilation purposes, attention must be paid to allow noxious gases such as CO₂ to be able to escape from the container which must therefore be provided with openings in the lower half as well as higher in all four walls. Ventilation openings

must be spaced so that no parts of the animal (nose/legs) can protrude, and the animal cannot get stuck with its tusks.

Transport of warthogs in either hot or cold temperature extremes is not recommended. Either extreme poses a severe animal welfare risk, since warthogs are extremely prone to respiratory difficulties as well as pneumonia. It must be noted that even if ambient temperatures are not considered extreme, the temperature inside a trailer or crate can be considerably higher.

6.3 Feeding and watering

The warthog's welfare is enhanced by the provision of continual access to drinking water during transportation; preferably by the use of drinking nipples, but if not available, other means of continual or frequent access to water must be provided within the container.

Feed normal ration before transport. *Do not overfeed.* Additional feeding is not required during the 24 hours following the time of dispatch. If feeding is required due to an unforeseen delay, greens or hay (no pig meal) must be provided but care must be taken not to overfeed.

6.4 Crate training

Many warthogs have died in the past when being crated, during or shortly after transport. This is why proper crate training prior to shipment is essential. Crate training involves several weeks or months of giving the animal access to the transportation crate. The shipping institution must receive the shipping crate at least four weeks in advance. The animal can be crate trained by offering food inside the crate. Animals should not be shipped unless they are completely acclimated to the crate. Young animals should be completely separated from their dam well before shipping.

6.5 Veterinary care

Warthogs are known to be stressed very easily, especially during transportation. The extensive high death rate in warthog transports and introductions is mainly caused by stress or stress-related injuries (broken back, broken legs). This is why the use of long acting tranquilizers is highly recommended.

Immobilon remains the traditional choice for total immobilisation of warthogs but depending on the restlessness of the animal and the required procedure the combination of medetomidine and ketamine is an alternative.

For short time sedation the use of azaperone is recommended while for long time sedation (for transport and introduction for instance) perphenazine enanthate is the best choice and we recommend to use this for every warthog transfer within the ESB.

Sedating the animal should always be done in the presence of an experienced veterinarian who is familiar with the drugs and the dosages and effects on warthogs.

6.6 Conclusion

Do not:

- Place more than one warthog in a crate (except for piglet siblings)
- Transport warthogs when the ambient temperature is high
- Expose warthogs to wet, cold and/or windy conditions during transportation
- Transport warthogs without proper crate training
- Transport warthogs without using a suitable tranquilizer

Always:

- Provide a continuous access to fresh water during transportation
- Make sure that the transport crate is properly ventilated

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Fig 12: Solitary held warthog with domestic companion.

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- We would like to thank the following colleagues who searched their memories in order to find the wanted information for us. Without their help, we could not have finished this project: Rob van Glabbeek, Kristin Leus, An Pas, Marc Damen, Christophe Grossiord, Jacques Kaandorp, Achim Winkler, Jason Jacobs, Bruno van Puijenbroeck, Ellen Dierenfeld, Tom de Jongh, Alastair Macdonald, Doug Richardson, Jeff Holland and Curby Simerson*

8 Appendix: The Abuko Conservation project

The ABUKO project in the Gambia and the formation of a ABUKO Conservation Fund by members from the European Federation of Zoos and Aquaria (EAZA)

In 1992 a close co-operation was initiated between the Department of Parks and Wildlife Management in The Gambia and a group of 4 European zoos. In return for animals from The Gambia, the European zoos agreed to set up a conservation fund on behalf of the Department of Parks and Wildlife Management. The animals were problem animals from species that caused excessive agricultural damage or that were a potential risk for the people of The Gambia. Some animals were confiscated by the Wildlife Department during a law-enforcement campaign or were born in the animal orphanage in the Abuko National Park, close to Banjul.

Up to November 2000, 12 warthogs (*Phacochoerus africanus africanus*) and 6 spotted hyenas (*Crocuta crocuta*) were transferred from The Gambia to Europe. All these animals and their offspring are on loan from the Wildlife Department of The Gambia. All these animals are managed in a European Studbook (ESB). Every zoo that participates in the programme pays a nominal fee of 1000 Euro for every animal it receives from the programme. After recommendation from the IUCN Pigs and Peccaries Specialist Group and endorsed by the Pigs and Peccaries TAG from EAZA, the warthogs are to be managed in a similar way as an EEP in order to keep track of the offspring and to prevent unwanted mixing with the warthogs that were already in Europe. This means that offspring from the imported animals can only be transferred with the agreement of the studbook keeper and go to institutions that signs the same type of contract and pays the same amount of money. If a replacement animal is needed for the members of the consortium, no new participation fee is required. Up till now -July 2006- 20 zoos have participated. The 1000 Euro does not include any other arrangements by the zoos concerned regarding transport costs or permit costs. Because of the high risk involved in transport and handling warthogs it is essential that only experienced staff from the exporting institution conduct this operation and travel with the animals if necessary.

In the beginning, the managing of the funds depended on every individual zoo itself and it became increasingly difficult for the Gambian Management Authority to keep track of all the transactions. Therefore it was decided to set up a proper conservation fund on behalf of the Department of Parks and Wildlife Management. All the money, also from past transactions was collected in a special account of the conservation fund from the Dutch Foundation Zoos Help (Stichting Dierentuinen Helpen). This account is independently kept and an annual report by a neutral party can be provided. Wim Verberkmoes from Gaiapark Kerkrade Zoo is the treasurer of the fund for the foundation.

A management committee for this account is formed by the studbook keeper for the hyenas, the studbook keeper for the warthogs, a conservation biologist with experience in population management, a representative from the Department of Parks and Wildlife Management from The Gambia and a representative from the European or Dutch Zoo Federation as an observer. Money from this account is to be used by the Department of Parks and Wildlife Management from The Gambia after unanimous agreement by all the committee members.

During the past 10 years, money that was made available for the project through different zoos was used in various ways:

- To buy a slide projector and projection screen for the education centre in Abuko.

- To pay for the travel and accommodation for one keeper who spent 1 month training at the Institute for Tropical Medicine (ITG) and at the Antwerp Zoo in Antwerp.
- To pay for the travel and accommodation for the same keeper to follow a specialist training course in Munich - Germany.
- To buy and ship a blowpipe and veterinary medicines for the chimpanzee orphanage and rehabilitation project from the Goodall Institute on Baboon Island in the Gambia river.
- To buy and ship two blowpipes and a dart gun with protective case for use by the Department of Parks and Wildlife Management from The Gambia.
- To buy and ship all the necessary equipment that must be used with this darting equipment: two boxes, darts, needles, syringes etc.
- To pay the transport costs for the release of confiscated animals (baboons, parrots) by the Department of Parks and Wildlife Management.
- To pay for the genetic and parasitic testing of some animals which were offered for transport to Europe from Abuko.
- To buy and ship anti-parasite treatment for the animals currently held at the animal orphanage at Abuko National Park.
- To buy and ship additional material and replacements to be used with the darting equipment.
- To pay for the flight and boarding cost of a staff member from the Department of Parks and Wildlife Management, to participate in a year training course in a Wildlife College in South Africa.
- To pay for the flight and boarding cost of another staff member from the Department of Parks and Wildlife Management, to participate in a month training course in a Wildlife College in South Africa.

We feel that in future our contribution should continue with these kinds of projects. Before any new project can started we would like to learn from the Department of Parks and Wildlife Management what the long term goals are for Abuko and the animal orphanage.

We from the European zoo community are of the opinion that improving the educational and conservation value of the animal orphanage in Abuko should be our highest priority and that support to the services of the Department of Parks and Wildlife Management in general is a second point of interest.

Support for reintroduction projects is only possible if these meet the requirements stipulated in the IUCN Reintroduction Guidelines.

Within the zoo community a vast knowledge exists on educational matters. If Abuko needs new signs, species identification plates, educational newsletters, a guidebook, posters, teaching programmes etc., these materials can be developed in Europe according to the priorities from The Gambia. All zoos have education departments who can take this on together with their own programmes and this will have minimal financial influences on the projects funds. The printing and framing must be done in The Gambia, with local materials and local enterprises. The invoices can then be sent to Europe. We will find a reliable and cheap way to transfer this money from Europe to The Gambia without paying excessive transfer costs to the banks.

Improvement of the present facilities is also a possibility. We first need to obtain from Abuko a priority list and an estimated budget. There is not enough money to build a completely new zoo but gradually improving and reorganising the existing infrastructure is possible. Once again, there is a massive amount of know-how about this within the European zoo community; we can check the ideas and proposals on safety, animal husbandry, nutrition etc. All actual constructing work and building materials must be bought and executed by local craftsmen. We will not ship materials from Europe because of the budget restrictions. Also, local experience for future

repair and maintenance is essential. Involvement of local workforce is also beneficial to the relations between the parks with its neighbours.

Building and improving of the visitor facilities can also be done according to these guidelines. We strongly encourage the development of visitor facilities, guidebooks and teaching materials that aim for the local Gambian visitors and not principally for the tourists. We support the development of a separate way of generating a financial benefit from the tourists by offering guided tours and/or a guidebook on condition that this money can be used immediately by the park itself and will not have to be transferred to the state budget first as is the case with the entrance fees.

Political changes in the whole country and the resulting changes in the management authority of the National Parks in Gambia mean that our involvement in the Abuko project is faced with an uncertain future. The loss of key staff members resulted in a lack of communication during the past 2 years. We will continue to keep the collected funds aside until we have established new and reliable ways of contributing to the project.

A sample of the standard participating contract is attached. Please send it along with the animals to the new institution and ask it to be signed and sent back to the studbook keeper.

Bank account of the conservation fund from the Dutch Foundation Zoos Help (Stichting Dierentuinen Helpen):
Rabobank Amsterdam 31 35 80 022
IBAN NL53 RABO 0313 5800 22

Memorandum of Participation

ABUKO Conservation Fund in The Gambia

Zoo (name)..... in (country).....
represented by its director (name)..... hereby
declares that it will, in return for (number)..... (species).....
(scientific name).....
received from..... on (date)..... make a single
donation of Euro 1000 per animal to the ABUKO Conservation Fund of the National
Park of ABUKO in The Gambia.

This contribution will be made to the bank of the Dutch Foundation Zoos Help
(Stichting Dierentuinen Helpen), based in Amsterdam, the Netherlands.

Any other institution that receives offspring produced by this/these animal(s),
originally imported from The Gambia (or by one of their descendants) will also
contribute the sum of 1000 Euro to the ABUKO Fund. Holders of this species agree,
by participating in this project, to include their animals in the relevant European
Studbook or Breeding Programme.

The Dutch Foundation Zoos Help (Stichting Dierentuinen Helpen), represented by its
director, Mr. Harry Schram, will take responsibility for managing this bank account.
The distribution of the funds from this account will be done after agreement from the
Management committee members:

- Raymond van der Meer, ESB co-ordinator Hyenas, Amersfoort Zoo
- ESB co-ordinator Warthogs - to be appointed
- Dr. Kristin Leus, Conservation Biologist, CBSG Europe
- Representative from The Gambia - to be appointed

SIGNATURES

Date