EAZA BEST PRACTICE GUIDELINES

White-winged duck *(Asarcornis scutulata)*

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Waterfowl TAG
Authors: Alexandre PETRY, Laure DAVOIGNEAU
Contributors : Nutrition (Julien BENSALEM & Flore VIALLARD from Nutrioo), Veterinary (Michelle O'BRIEN from WWT Slimbridge)

TAG chair: Johnpaul HOUSTON, Calviac
EEP Coordinator: Alexandre PETRY, Parc de Branféré

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Preamble

Right from the very beginning it has been the concern of EAZA and the EEPs to encourage and promote the highest possible standards for husbandry of zoo and aquarium animals. For this reason, quite early on, EAZA developed the “Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria”. These standards lay down general principles of animal keeping, to which the members of EAZA feel themselves committed. Above and beyond this, some countries have defined regulatory minimum standards for the keeping of individual species regarding the size and furnishings of enclosures etc., which, according to the opinion of authors, should definitely be fulfilled before allowing such animals to be kept within the area of the jurisdiction of those countries. These minimum standards are intended to determine the borderline of acceptable animal welfare. It is not permitted to fall short of these standards. How difficult it is to determine the standards, however, can be seen in the fact that minimum standards vary from country to country.

Above and beyond this, specialists of the EEPs and TAGs have undertaken the considerable task of laying down guidelines for keeping individual animal species. Whilst some aspects of husbandry reported in the guidelines will define minimum standards, in general, these guidelines are not to be understood as minimum requirements; they represent best practice. As such the EAZA Best Practice Guidelines for keeping animals intend rather to describe the desirable design of enclosures and prerequisites for animal keeping that are, according to the present state of knowledge, considered as being optimal for each species. They intend above all to indicate how enclosures should be designed and what conditions should be fulfilled for the optimal care of individual species.

Summary

These Best Practice Guidelines are an update of the original guidelines “The captive breeding of White-winged duck C*airina scutulata,* White-winged duck Conservation project_WWF Project 406” (Ounsted, 1985). The information in this document has come from several sources; other literature, personal experiences of holders and exchanges between institutions. As part of the guideline development process, a questionnaire comprising 55 questions divided into broad categories was sent out to all White-winged duck holders (26 at the time of the survey). The information in the guideline was supplemented by responses from 21 institutions (bibliographic source indicated: Best Practice Guidelines Questionnaire).

This Guideline has been reviewed and approved by Waterfowl and Pelecaniformes TAG members and White-winged duck species committee.

The white-winged duck (*Asarcornis scutulata*) is one of the most endangered birds in the world and has largely disappeared during the latter half of the century. They are listed as “Endangered” under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species and likely to be reclassified as "critically endangered" category in the light of the latest field surveys. This duck is the subject of an EAZA Ex-situ Programme (EEP) but is suffering from a lack of popularity and is rare in captivity. The species is known for its marked territorial behaviour, particularly during the breeding season, but little systematic data has been collected and few behavioural studies have been carried out. In addition, the white-winged duck is extremely vulnerable to *Mycobacterium avium* (avian tuberculosis), which leads to high mortality in captivity. Today, it seems that those mycobacterial infections and inbreeding are the most important factors limiting the ex-situ recovery of this species.

The EAZA Waterfowl TAG (Taxon Advisory Group) and white-winged duck EEP have set the goal to actively take part in the ongoing conservation actions for this species. Some aspects of breeding are still in progress, and new studies need to be carried out in captive populations (interspecific interactions, reproductive behaviour, health issues, genetic diversity), with a view to improving its management and developing its presence in captivity. An increase in the number of institutions will help to create new breeding pairs and a better genetic mix, which is already impoverished.

Acknowledgements

Laure and I would like to extend our sincere thanks to all the contributors who made this Best Practice Guidelines possible.

In particular, we would like to express our deep gratitude to **William Van Lint** and **Jan Harteman,** whose expertise and dedication laid the groundwork for this project. Their initial draft not only served as the foundation for this new document but also reflected a wealth of experience in the species management.

Secondly, we want to thank our contributors who wrote complete chapters of the Best Practices Guidelines. **Julien Bensalem** and **Flore Viallard** worked brilliantly on the Nutrition Chapter when Dr **Michelle O'Brien** brought all of her experiences in the Veterinary Chapter.

In addition, we are deeply grateful to the 21 institutions that responded to the management practices survey. Their valuable input, representing the majority of institutions housing the species, has been essential to the document's relevance and comprehensiveness.

This collaborative effort highlights the importance of such guidelines in continuously improving our best practices and contributing to the One-plan approach strategy of this species.

William Van Lint, Manager of Animal Programmes and Conservation for EAZA, has played a pivotal role in the development of the Best Practices Guidelines. His extensive experience, particularly as the long-time coordinator of the White-winged Duck EEP, has been invaluable.

Jan Harteman, a private breeder of birds (www.harteman.nl) and teacher of Husbandry and Zootechnics at Aeres MBO Barneveld, is the only private breeder to house this species within the EEP. His extensive contributions to the first version of the guidelines have been instrumental in shaping their development. Jan has achieved significant success with this species.

Flore Viallard is a nutritionist and the founder of a consultancy specializing in animal nutrition for zoological parks : Nutrioo (www.nutrioozoonutrition.fr). Known for her excellent communication skills and strong work ethic, Flore's impressive ambition drives her to continuously improve dietary practices for various species.

Julien Bensalem, PhD in Nutrition, has a rich background in avian care, having worked extensively in Australia before joining Nutrioo, a consultancy specializing in nutrition for zoological parks. His expertise in animal nutrition is complemented by a genuine passion for birds, making him a good contributor for the Nutrition Chapter.

Michelle O'Brien is a veterinarian who serves as a veterinary advisor for the White-winged Duck EEP. Since 2006, she has worked with the WWT group centres, which have demonstrated their expertise in the care and breeding of White-winged Ducks. Her invaluable assistance in reviewing the guidelines and writing an entire chapter was essential to ensuring the document's accuracy and relevance, reflecting her deep commitment to the conservation of this species.

Contents

Section 1: Biology and Field data

A. Biology

1.1. Taxonomy

Table: Taxonomy of the white-winged duck according to Del Hoyo et al. (2014).

Kingdom	Animalia	Comment
Phylum	**Chordata**	
Class	**Aves**	
Order	**Anseriformes**	
Family	**Anatidae**	Family of ducks, geese and swans
Subfamily	**Anatinae**	
Tribe	**Aythyini**	Commonly called "diving ducks"
Genus	***Asarcornis***	Was previously placed in the genus *Cairina* with the Muscovy duck (*Cairina moschata*, Johnson & Sorenson, 1999)[1]
Species	***Asarcornis scutulata***	*Scutulata* for diamond or checker-shaped, in reference to plumage marks (Green et al., 2005)
Sub-species	-	The duck is a monotypic species and does not have any sub-species (Del Hoyo et.al., 1992)[2]
Common names	**White-winged Duck / White-winged wood duck**	French: Canard à ailes blanches / Nette à ailes blanches German: Weißflügel-Moschusente / Malaienente Nederland: Witvleugelboseend Spanish: Pato de jungle / Pato Almizclero Aliblanco
		Etymology: Its voice is distinctive and ghostly and accounts for the Assamese name "Deo Hans" or "Spirit duck". In Burma, it is called "Mandali", and in Indonesia "Itik Hutan", or "Forest Duck" (Mackenzie & Kear, 1976).

[1] The white-winged duck was originally placed in the genus *Cairina* and allied with the dabbling ducks. However, mtDNA cytochrome b and NADH dehydrogenase subunit 2 sequence analysis and the biogeographical pattern of distribution indicate that the anatomical similarity to the Muscovy Duck is deceiving. Thus, this species might more appropriately be placed in a monotypic genus, as *Asarcornis scutulata*, which appears to be unrelated to the Muscovy Duck but closer to the diving ducks (Johnson & Sorenson, 1999). Before DNA analysis, they were classified in the tribe *Cairinini* or "perching duck", based on the amount of time they spend in trees.

[2] Indonesian individuals have a different coloration and morphotype from continental populations, and were previously considered a subspecies of the white-winged duck (see chapter below).

Fig: Asarcornis scutulata © Henrik Grönvold
(from "The Game-birds of India, Burma, and Ceylon", Baker, 1921)

The case of the Indonesian population

In historical reviews, the name *Asarcornis leucoptera* has periodically been favored to designate continental populations of white-winged ducks, in contrast to the Indonesian subspecies *Asarcornis scutulata* (BirdLife international, 2001; Green et al., 2005). Indeed, Indonesian individuals show a greater but inconsistent amount of white in the plumage – some Sumatran males are almost entirely white with black flight feathers. Around less than 20% of Sumatran individuals are similar to the continental population, and the extent of white on the bodies of birds from the same island appears to be highly variable (Green et al., 2005).

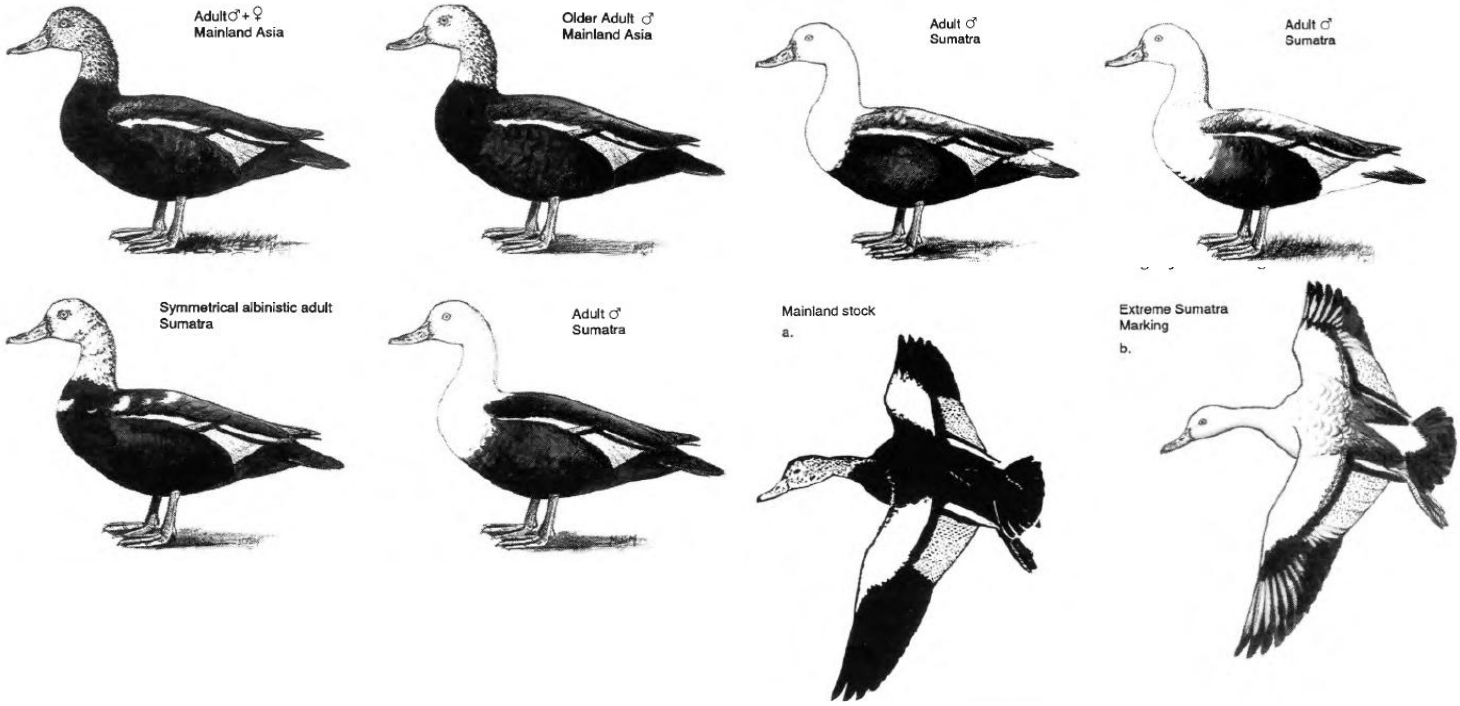


Fig: Adults showing progressive albinism (Mackenzie, 1990)

Fig: White-winged ducks in Taman Nasional Way Kambas, Lampung, Sumatra, Indonesia
© Lars Petersson – My World of Birds Photography

Sumatran birds also appear to have morphological differences, with a more rounded head, longer neck, smaller body and shorter, more curved bill than typical "leucoptera", with perhaps redder bare parts (Green et al., 2005). This results in more upright posture while sitting or standing. Structural and postural differences between Indonesian and continental birds suggest racial differentiation according to the authors; further morphological and molecular studies are required. However, extensive albinism in Indonesian birds was attributed to hybridization or inbreeding, rather than racial differences, because of variety of plumage types observed (Mackenzie, 1990). This remains up for debate because the populations of Indonesia were, until recently, too large for inbreeding to be more extensive than in the mainland (Mackenzie, 1990).

1.2. Morphology

A dark-coloured forest duck with a white head and upper neck, spotted with black to varying degrees (often thickly spotted on crown, nape and hind neck). Chest, back, rump, mantle and the upper tail coverts are black with a metallic green iridescence. Upper wing coverts are white and median coverts are grey tipped greenish black, forming a band. Secondaries are bluish grey and primaries and primary coverts are black. Outer tertiaries are white with black margin. Tail is dark brown. Lower neck is glossy greenish black, merging into chestnut brown lower parts. Bill is orange mottled black; legs are orange-yellow; iris is orange-red-yellow (Green et al., 2005; Kolbe, 1990; Mackenzie & Kear, 1976). In flight, white wing-coverts contrast with the rest of the wings (Birdlife International, 2017).

It is one of the largest duck species (Green, 1993a), with a length between 66 and 81 cm (Del Hoyo et al., 1992). More detailed measurements are available in "Ducks, geese and swans – Volume 2" (Green et al., 2005).

Male

Contrary to females, there is a considerable variation of head speckling between males, with a tendency for the black speckling to disappear from the cheeks and area above the bill leaving the neck and nape speckled. Another area that may show more white is the front of the throat, just above the breast (Mackenzie, 1990). In the same way, Indonesian males show a greater but inconsistent amount of white in the plumage (Green et al., 2005). In breeding season, base of male bill swollen (Green et al., 2005).

In captivity (continental individuals from Assam), adult males weigh around 2.4-3.1 kg (Green et al., 2005; Mackenzie & Kear, 1976; Species360, 2024). In literature, some wild animals collected are heavier (up to 4 kg, Green et al., 2005).

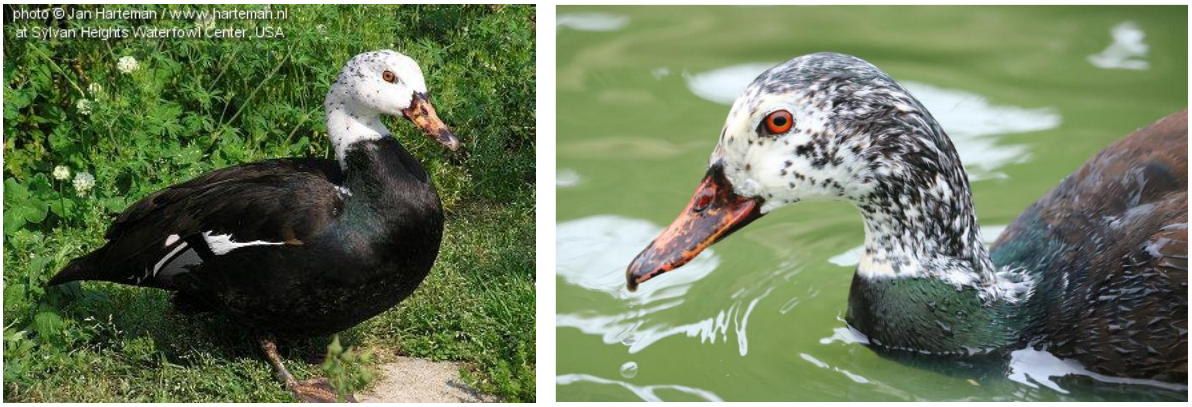


Fig: Adult males (3 years old), © Harteman, 2021

Adult male (8 years old), © Branféré, 2024

Female

There is a slight dimorphism. Females are smaller and usually have more densely mottled head and upper neck (Green, 1993b; Green et al., 2005; Mackenzie & Kear, 1976). The colour of the iris seems to differ between male and female. According to the literature, males have orange-yellow eyes whereas females have a brownish iris, more orange/dark brown (Del Hoyo et al., 1992; Kolbe, 1990). Mackenzie & Kear (1976) refers to orange and red eyes. Indeed, males can have red irises, depending on ambient lighting. It seems that female has less gloss on the plumage (Das & Deori, 2011). There is no swelling at base of bill during breeding season (Green et al., 2005).

Fig: Adult female (4 years old) in breeding condition at left,
sub-adult female (non-breeding condition) at right, © Harteman, 2021

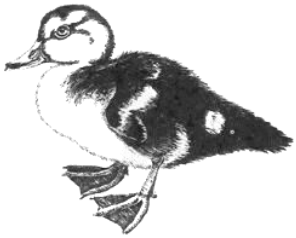
Fig: Adult female (12 years old) in breeding condition at left,
sub-adult female (1 year old) at right, © Branféré, 2024

In captivity (continental individuals from Assam), adult females weight from 1.8 to 2.1 kg (Green et al., 2005; Mackenzie & Kear, 1976; Species360, 2024). In literature, some wild animals collected are heavier (up to 3.5 kg, Green et al., 2005).

Egg

Eggs are white with faint green tinge. Dimensions: 60-70 x 45-50 cm in average / Weight: 80-90 g (Green et al., 2005).

Duckling



Back and wings are brown with face, foreneck, chest, and anterior underparts buff yellow. Highly distinctive orbital brown stripe divides anteriorly, with upper line running to nape and lower forming crescent on cheek (Green et al., 2005). At 24h female weighed 48.7 g, and male weighed: 48.4 g (Mackenzie & Kear, 1976).

Fig: Pictures of ducklings (above: 1 day old, © Branféré, 2023;
below left: a few days old, right: one month old, © Cologne Zoo, Thomas Breuer, 2017)

Juvenile

Continental juvenile is similar to adult, but duller and browner with less extensive white on head and neck (Green et al., 2005; Mackenzie & Kear, 1976). Indonesian immature has more black spots on head than adult, and breast and back (often white in adult) are always brown. Unlike Muscovy, has white wing patches in immature plumage.


Fig: Pictures of juveniles (left: 50 days old, right: 6 month old)
© Cologne Zoo, Thomas Breuer (2017)

Old age

Age is most readily indicated visually on the species by the staining on the beak and dark colour splotches on the legs and feet (pers.com. WWT Slimbridge). In white-winged ducks, there is variation in the colour of the underparts, at least in mainland populations, from chestnut-brown with black collar to all black, and in the amount of iridescence on the neck and mantle, which is suggested to be age-related (Wells et al., 1999). Old Sumatran white-winged ducks usually has whiter colour, and gradually loses the black (Way Kambas National Park's white winged duck monitoring team, Indonesia, 2020).

1.3. Physiology

The annual moult normally takes place in September-October, and during this time, individuals are rendered flightless for around a fortnight (Green et al., 2005; Mackenzie & Kear, 1976). Locals reported that individuals move to impenetrable forest swamps for the moult, only emerging when they are once more able to fly (BirdLife International, 2001). In captivity and in temperate climates, wing moult occurs during summer (July), following the breeding period (Mackenzie & Kear, 1976). During this period, captive individuals are less active and they hide more.

Further information is currently not available; more research is required.

1.4. Longevity

Further information for the wild is currently not available; more research is required.

In captivity birds can get on average 10-12 years old and often 15 (Best Practice Guidelines Questionnaire; Green et al., 2005; Ounsted, 1985). Some records of birds living up to 21 years (Best Practice Guidelines Questionnaire ; ZIMS for studbooks, 2024).

B. Field data

1.1 Conservation status/Zoogeography/Ecology

1.1.1. Distribution

The bird has been common in Southeast Asia since the species was discovered in 1840 (Muller, 1842) and at the beginning of this century, with an initial total population size probably of between 50,000 and 500,000 individuals (Green, 1993a). The species was historically widely distributed from north-eastern India and Bangladesh, through South-East Asia to Java and Sumatra, Indonesia (Green, 1993a). Its original range is shown on the map below.

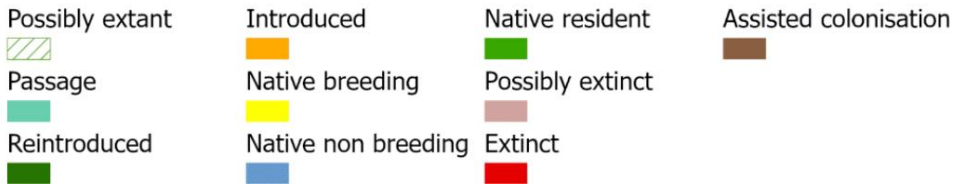


Fig: Species range map (Birdlife International exchange forum, 2024)

It has undergone a dramatic decline for the past 100 years to perhaps less than 5% of its original population size (Green et al., 2005; Johnsgard, 2010; Mackenzie & Kear, 1976). Nowadays in many of these range states, white-winged ducks are now probably extinct or nearly so. The total estimation is rounded to 150-450 mature individuals, but noting that a population size at the lowest end of this estimate is now probably the most likely (Birdlife International exchange forum, 2024). The current population trend is: Decreasing (Birdlife International, 2017).

Fragmented populations still occur in India (Assam and Arunachal Pradesh), in northern Myanmar, in western Thaïland, in Cambodia and in Indonesia (Sumatra) (Birdlife International exchange forum, 2024). It is probably now extinct in Bangladesh and was likely only ever a marginal visitor to Bhutan (Choudhury, 2007). The species is likely now extinct in Malaysia, Lao PDR and Viet Nam (Timminns et al., in press) or any population that does persist is almost certainly so small that it is probably not viable. The population in Java is assumed extinct (no records for over 50 years, BirdLife International, 2001).

India : Population was previously estimated to number 300-400 individuals based on surveys in the early 1990s but the species has lost a significant part of its habitat in the last 25 years (Ahmed et al., 2023). The precise number may be uncertain, but the maximum population in India is unlikely to exceed 150 adults. Most possibly, the Indian population now falls within a band of 50-150 mature individuals.

Myanmar : It is probably now a stronghold for the species (Tordoff et al. 2007). The total population is precautionarily estimated at 40-100 mature individuals, accounting for observations of rapid habitat loss and degradation on natural landscapes wich is likely to have (potentially significantly) reduced numbers since many of these surveys were carried out.

Thailand : Very few birds remain. In the exception, a reintroduced population (which is not yet known to be self-sustaining) is at Phu Khieo Wildlife Sanctuary (eBird, 2023). The duck is almost certainly extinct in the rest of Thailand.

Cambodia : Likely now comprises (potentially far) fewer than 50 mature individuals, with no recent records away from Preah Vihear (Birdlife International exchange forum, 2024).

Indonesia : There are few localities where the species could still persist; the Sumatran population is estimated here to number 30-60 mature individuals, with the lower estimate of this probably being more acurate (Birdlife International exchange forum, 2024).

1.1.2. Habitat

As the previous name suggest, the white-winged wood duck is a tropical forest species. It inhabits natural and artificial wetlands, preferably stagnant or slow-flowing, that is close to or inside (swampy) dense forest, on which it depends for roosting and nesting (Birdlife International, 2017; Del Hoyo et al., 1992; Jelil et al., 2020). This is a shade-loving bird that lives in a variety of relatively small, shallow, sluggish or stagnant wetlands (pools, swamps, sluggish streams and rivers or nearby lakes) in forest areas (Das & Deori, 2011; Green, 1993a). The duck has been recorded from a variety of tropical moist forest types (tropical moist evergreen forests, tropical semi-evergreen forests, temperate moist montane forests and tropical moist deciduous forests), but avoids the drier formations (Green, 1992). There is no evidence to suggest that it is present in deciduous forest types (Green 1993a, Evans et al. 1996).

With the extension of man's impact on forest areas, *Asarcornis scutulata* has probably increased its use of artificial wetlands such as rice fields (Green, 1993a). During the dry season, they may frequent larger open marshes, close to suitable patches of forest where they roost during the day (Mackenzie & Kear, 1976). Its range is more extensive during the rainy season (for example, it visits pools that disappear during the dry season) and it can be found closer to villages at this time (Evans et al., 1996). In Sumatra, they seem to tolerate much more open and disturbed forests (small patches of forest amongst grasslands and agricultural areas). Sometimes ducks use fairly open forests with little shade, but it is likely that suitable large trees must always be present (Green, 1993a; Holmes, 1977).

The majority of white-winged duck records have come from lowland areas of less than 200 m altitude, but the species has also often been observed at average altitudes of 200 to 500 m and up to 1,500 m above sea level (Green, 1993a). Thus altitude does not appear to be a limiting factor in itself, but the terrain needs to provide optimum habitat. As habitat destruction has mainly occurred at lower altitudes, the duck is now largely restricted to higher altitudes in some parts of its range (Green, 1993a).

Fig: Wild white-winged ducks habitats in Namdapha National Park (left) and Pakke Tiger Reserve (right) in India. © Aftab Ahmed – Wildlife Trust India

1.1.3. Threats and Conservation status

Threats

There are many causes for this decline. Threats to the entire range include: destruction, degradation, pollution and disturbance of wetland habitats in forests, outright deforestation outside protected areas, hunting and egg collection, off-farm hunting and, perhaps increasingly, stochastic pressures on highly fragmented and generally tiny sub-populations.

The major cause of the decline is deforestation including the inappropriate management of forests (Green, 1993a). Until recently, management practices in reserve forests involved the removal of old and dead wood that could have provided nesting sites for the species, as well as the drainage and planting of marshes and swamps. Besides, deliberate burning of forests by local people during the dry season (during the suspected breeding season of the species) is a problem affecting large areas of Thailand and elsewhere, leading to the gradual conversion of dense evergreen forests to drier, open deciduous forests, which are less suitable for white-winged duck. One of the consequences of the deforestation is that the forest patches that remain are disconnected from each other and lead to isolated animal populations. These isolated populations are more vulnerable for an epidemic or other disaster, and might not be genetically viable enough to recolonize (Green, 1993a). A study carried out in the Dehing Patkai sanctuary in India shows that the occupancy rate of the white-winged duck was low and that increasing the richness of the trees and decreasing the altitude increased the occupancy rate of the species (Jelil et al., 2020). A long-term ecological research to better understand the present and future population trends of the species is recommended.

Swamps, marshes, and other wetlands have been extensively drained throughout the species' range, primarily for agricultural use, reducing crucial areas of dry-season foraging habitat. Hydro-power development and pollution are other more localized threats. The fragmentation of forests causes a rise in hunting and egg collection pressure. As the species has been recorded in rice fields and close to villages, human activities can harm it by disturbing it and preventing it from feeding or reproducing effectively. In addition, ducks can suffer from pesticides used in Asian rice fields and water pollution from tea plantations and timber mills (Green, 1993a; Selvan et al., 2013; Sharma et al., 2015). From year to year, the intensity of illegal fishing continues increasing on the white-winged duck's primary habitat (Way Kambas National Park's white winged duck monitoring team, 2020).

In Assam, northern India, the main causes of habitat loss are expected to be changes in temperature and rainfall due to climate change (as this species requires an average annual rainfall of around 1,000 to 1,200 mm). Due to climate change, 436.61 km^2 of habitat of the species would be lost by 2070 (Goswami, 2022). In Indonesia, the long dry season has also been recognized as a new threat due to the reduction in the ducks' feeding area (Way Kambas National Park's white winged duck monitoring team, 2020). Another threat identified is the increase in the crocodile population (native and introduced) in Indonesia, in many areas of the white-winged duck 's main habitat.

Conservation history

The white-winged duck has been protected in India since 1937. In 1951, the bird was declared to be one of the most threatened species of duck in North-Eastern India, and was placed under a Special Protected List since 1952 by the Indian Wild Life Board (Das & Deori, 2011).

The World Wildlife Fund's Project 406 was launched in 1968 with clear objectives: collect young ducks to establish captive flocks in India, England, and USA; study and breed the species; create a sanctuary in Assam's primary rainforest for reintroduction or in a country previously inhabited by the species such as Thailand or Malaysia (Mackenzie & Kear, 1976). Major ex-situ breeding programs were conducted following this project during the 1970s and the 1980s, especially at Wildfowl & Wetlands Trust (WWT) Slimbridge Center (United Kingdom). The entire captive population, particularly those within the EEP, originates from this initiative.

In 1975, the Endangered Waterfowl Group was created by the International Waterfowl Research Bureau, the Wildfowl Trust, the International Council for Bird Preservation (now BirdLife International), and the International Union for Conservation of Nature (IUCN). The Endangered Waterfowl Group selected the white-winged duck to be the first threatened waterfowl species to have its status reviewed (Green, 1992; Mackenzie & Kear, 1976). In 1993, 21 protected areas were thought to support populations of the species (Green, 1993a). A recovery project was initiated by Wildlife Trust of India in 2018 and the white-winged duck was declared as the State Bird of Assam in 2003 (Goswami, 2022).

Conservation status

The white-winged duck is one of the most endangered birds in the world (Das & Deori, 2011) and has largely disappeared during the latter half of the century. As mentioned above, the population of the white-winged duck is declining (Birdlife International, 2017). The species is currently listed in Appendix I of CITES under the scientific name *Asarcornis scutulata*, protecting the animal from wildlife trading (CITES, 2013). The species is listed in Annexe A of the Council Regulation (EC) No 338/97 of 9 December 1996 .,

The IUCN re-classified the species as "Critically Endangered" (Birdlife International, 2024) because its population is very small and fragmented and is declining very rapidly and continuously due to hunting but also the loss and disturbance of river habitats.

Indeed, in the light of latest records (as seen above in the chapter 1.5.1), the BirdLife Red List Team has proposed category "critically endangered" under several IUCN Red List Criteria (Birdlife International exchange forum, 2024). The justification is that "there is a strong likelihood that the global population has not only fallen below 250 mature individuals but also has declined by possibly > 80 % over the past three generations. The species now exists in isolated, fragmentary populations, the majority of which may not be viable given their small size, and almost all are still declining in response to pollution, habitat loss and stochastic events. It is possible that no population contains more than 50 mature individuals (and also similarly possible that only northern Myanmar comes close to that)" (Birdlife International exchange forum, 2024).

The species is legally protected from hunting and collection in seven countries: Bangladesh, India, Myanmar, Thailand, Indonesia, Cambodia and Laos (Evans et al., 1996; Green, 1993a). A large proportion of the white-winged duck's wild population is found in protected areas, wildlife sanctuaries, and national parks, although these areas are the focus of more research and birding than private or unprotected areas (Foote, 2023). Rural education and ecotourism have been shown to be important in combating illegal hunting (Sharma et al., 2015). The duck also appears to benefit indirectly from the protection of several umbrella species such as the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and the Indian elephant (*Elephas maximus indicus*) (Foote, 2023). Captive breeding programs have also been set up at WWT Slimbridge (UK), in Assam and Arunachal Pradesh (India), but the eggs and chicks developed tuberculosis and no reintroduction has taken place. Intensive surveys were conducted since 2018 in Assam and Arunachal Pradesh by Wildlife Trust of India (Goswami, 2022).

In June 2024, the white-winged duck Ex-situ Program had 86 animals in 26 institutions (Species360, 2024).

Conservation Actions Proposed

In the past, most white-winged duck populations remained outside protected areas, and site protections were insufficient to halt the declines (Green, 1992). Today the situation is better and the creation of more artificial or modified freshwater ponds within protected areas could help to maintain populations there (Way Kambas National Park's white winged duck monitoring team, 2020). Areas with high potential must be protected to save the metapopulation, and systematic studies are needed to determine the current population (Goswami, 2022). A conservation strategy is actually ongoing in Assam, India (Ahmed et al. 2023). Recommendations are also to introduce regular monitoring of certain key populations, promote strict enforcement of hunting regulations and minimize encroachment, disturbance and habitat degradation in all protected areas supporting populations, promote more widespread conservation awareness campaigns in and around key protected areas, ensure that captive breeding centres maintain healthy populations of this species, and ensure that diseased individuals are not able to escape and thus potentially spread disease in wild populations (Yahya 1994a,b).

1.2. Diet and feeding behaviour

The white-winged duck varies its diet on the seasonal availability but is largely omnivorous (Green et al., 2005; Mackenzie & Kear, 1976). The food consists of aquatic plants, seeds of wild and cultivated plants, aquatic insects, spiders, worms, crustaceans, molluscs, frogs, small reptiles such as snakes, and small fishes (Green, 1993b; Mackenzie & Kear, 1976). The duck feeds mostly at night, where it dabbles in shallow water and bill-dips for small water snails and other small water insects, but sometimes dives under water for fish (Green, 1993b). The species has been observed feeding in wet grass areas and shallow pools, shallow, stagnant or slow-flowing streams, ponds, swamps or rice fields even in populated areas (Green, 1993a; Green et al., 2005; Holmes, 1977).

Further information on duckling diet is required. According to the available literature, the ducklings swim and dive to gather crustaceans, small invertebrates and aquatic grass seeds (Way Kambas

National Park's white winged duck monitoring team, 2020). They seem to start feeding entirely on small animals, progressively expanding their diet to include insects, worms, small snails and fishes (Mackenzie & Kear, 1976).

1.3. Reproduction and life cycle

Breeding season

According to Green (1993b), the breeding in India, Thailand and Myanmar is timed so that the hatching takes place at the beginning of the wet season when floods are more common meaning there are more available areas for feeding (see chapter 1.6 "Diet and feeding behaviour" for more information). Thus breeding season may vary across its range: egg-laying possibly between March and July (Bangladesh, India, and Thailand), and between December and June (southern Sumatra) (Green 1993b; Green et al., 2005; Mackenzie & Kear, 1976).

In captivity, the breeding season is quite similar to that of Assam, globally lasting from March to June, with an egg-laying period extending from April to July, and peaking in May (Mackenzie & Kear, 1976; WWD Studbook, 2024). Captive populations in Europe seem to spontaneously cease to breed in the late spring while day-lengths should still be stimulatory. The species appears to develop the refractory period that is characteristic of most temperate-zone birds, unlike its tropical relatives. The implication of this pattern of photo-response is unexpected and could suggest that this species has evolved in temperate latitudes and has invaded the tropics secondarily (Mackenzie & Kear, 1976).

Age of sexual maturity

Captive females and males are generally mature at the age of two or three years (Best Practice Guidelines Questionnaire 2024; Mackenzie & Kear, 1976; Ounsted, 1985, Zims for Studbooks, 2024), but females frequently lay fertile eggs at 1-year-old (pers.com. Harteman). They are much more productive in their fifth year (Tomlinson et al., 1991). Further information for the wild is currently not available.

Nesting behaviour

Nesting usually takes places in tree holes, forks, hollows and natural cavities, generally observed between 1 to 10 m but which can be up to 23 m off the ground, and is usually lined with leaves, grass, straw etc. (Birdlife International, 2001; Green, 1993b; Green et al., 2005; Mackenzie & Kear, 1976). However, nests were also observed on the ground (under fallen tree-trunk or roughly on masses of branches, or in scrub-jungle and grass at the edge of pieces of water). The tree species used are likely to vary with availability (Green, 1993a). According to field surveys, each pair of white-winged ducks needs approximately 250 acres of habitat in order to breed (Das & Deori, 2011).

In captivity, ducks laid in boxes at height (about 1 m from the ground) or occasionally under a big poll of grass or somewhere else hidden away (See the next section 2 "Management in captivity").

The female is the only one who incubates, but the male is usually close by and escorts the female on feeding trips at dawn (Birdlife International, 2001). When the male returns to the nest with the female (i.e. late morning and dusk) he perches in the nest tree for a while or flies about nearby until she is settled, a behaviour which helps in the detection of nests. It has been interpreted as mate-guarding behaviour during the fertile period, but in the wild, the male continues accompanying her after all the eggs are laid.

Clutch and brood size

The incubation period in captivity lasts between 30-35 days with a mean of 33 days (Del Hoyo et al., 1992; Mackenzie & Kear, 1976). Clutch size can vary a lot but in captivity is usually between 6 to 13 eggs (sometimes only 4 to 6 eggs) with a mode of 10 (Best Practice Guidelines Questionnaire; Green, 1993a; Green et al., 2005; Johnsgard, 2010; Mackenzie and Kear, 1976; ZIMS for Studbooks, 2024).

In the wild, clutch size is between 2 to 12 with a mode of 4 (up to 15-20 eggs recorded in India and Cambodia, Birdlife International, 2001). A second clutch can follow the removal of the first one (Mackenzie & Kear, 1976). The brood size can vary from 2 to 7 ducks, with a mean of 4 and a standard deviation of 1.8 (Green, 1993b).

Rearing period

In the wild, broods are often seen with two adults suggesting that males may help guarding ducklings, however they are more usually accompanied by a single parent, presumably the female (Birdlife International, 2001; Green, 1993b). Juveniles take 14 weeks to fledge and many remain with their parents afterwards (Mackenzie & Kear, 1976). The observation of more than two birds with ducklings might indicate either post-fledging brood-merging in the species, multiple clutches laid in single nest cavities (which seems possible given the large brood sizes recorded) or that helpers assist the breeding pair (Birdlife International, 2001).

During the brood-rearing period, the mother molts and temporarily loses her ability to fly. She raises her juveniles by walking from pond to pond to shallow marshes and rivers (Way Kambas National Park's white winged duck monitoring team, 2020).

1.4. Behaviour

1.4.1. Daily activity patterns

Activity peaks at dawn and dusk, when it is most frequently observed (BirdLife international, 2001). The white-winged duck has a nocturnal activity of feeding, and they can be seen in flight between open feeding sites (swamps, ponds, paddy fields) and roost sites just before dusk or dawn (Green et al., 2005; Holmes, 1977; Mackenzie & Kear, 1976). They almost invariably call in flight and thus readily reveal their presence. They may fly four kilometers or more between their roost and feeding grounds (Holmes, 1977). They often go back to the forest to rest during the day (Green et al., 2005; Johnsgard, 2010; Way Kambas

National Park's white winged duck monitoring team, 2020). When suitable feeding is available within the forest, or they have young, they may remain on shaded waters all day (Mackenzie & Kear, 1976).

However, the daily activity patterns of the species appear to vary with levels of disturbance, hunting pressure, food availability etc. (BirdLife international, 2001). Local records show very less activity during the day (BirdLife international, 2001; Evans et al., 1996; Holmes, 1977). This information suggests that the species has become more strictly nocturnal in recent times, perhaps in response to disturbance and hunting pressure at feeding sites. In some areas, diurnal feeding is thought to be more intensive in the morning than in the afternoon.

In captivity, resting behaviour is the dominant activity (almost 60% of the observation time), followed by feather maintenance behaviour behaviour (20%) – called "confort behaviour" in the paper - and feeding activity (10%) (Green et al., 1992). As in the wild, birds seem to have a crepuscular rhythm, with a feeding peak in the early morning and evening and a resting peak in the middle of the day. However, it is unclear whether or not this rhythm is linked to routine feeding by zoo staff or to the disturbance of visitors in the middle of the day. Further observations in captivity of behaviour at night in relation to the availability of light would be worthwhile to obtain a clearer overall picture of rhythms and time budgets (Green et al., 1992). Besides, it is important to note that in this study, birds were pinioned and observations took place outside the breeding season. In another study, budget time varies from period to period and from individual to individual (Davoigneau, accessible on request, Branféré, 2024). Resting behaviour remains the dominant activity (around 50%) in each period. This behaviour is followed by comfort behaviour (around 20%) and locomotion/foraging (between 10 and 15%) outside the breeding period and with an old breeding pair. Resting is followed by foraging (around 20%) and comfort (around 15%) during the breeding period, and with a pair composed by the same old male (8 years old) and a new young and immature female (1-year-old). Females, especially the young one, are more active and spend more time foraging. In this study, ducks had clipped wings, with potential consequences to their time budget (Davoigneau, accessible on request, Branféré, 2024). According to Rose et al. (2022), resting, maintenance and locomotion behaviours were most commonly observed in captive ducks, and time spent in feeding increases in early spring.

1.4.2. Movements

The white-winged duck is not known to migrate, although short movements in response to dry weather and water conditions are frequently recorded (BirdLife international, 2001; Del Hoyo et al., 1992; Johnsgard, 2010). The White-winged Duck is primarily sedentary, exhibiting local movements between feeding and roosting sites within forested wetlands. It performs locomotory movements such as slow swimming in calm waters, short flights between ponds, and occasional walking or perching on low branches (Mackenzie & Kear, 1976). These movements are typically short-distance, suited to its forested, aquatic habitat. While not migratory, the species may engage in seasonal dispersals in response to water level changes (BirdLife International, 2024).

1.4.3. Social behaviour

The white-winged duck usually does not live in flocks. They are mostly found in pairs or trios – 1 male / 2 females (Green, 1993b; Mackenzie & Kear, 1976). Outside the breeding season they can be seen in small groups up to 6 birds (Evans et al., 1996; Johnsgard, 2010; Mackenzie & Kear, 1976). It is thought that these groups are families that have not yet split up. During the dry season, flocks of up to 16 adults were also seen, where the adults arrived or left in pairs. These groups may be unrelated to each other and formed because of necessity due to food shortage (Das & Deori, 2011; Evans et al., 1996; Green, 1993b).

1.4.4. Sexual behaviour

The white-winged duck has a monogamous mating system possibly with long term pair bond (Green et al., 2005; Johnsgard, 2010). The inciting behaviour can be mutual head-bobbing accompanied by honking. The display is generally initiated by the male who performs elliptical head-nodding, often responded by females with the same behaviour (Green et al., 2005). Males always performed more. Also, zigzag swimming with arching head movements has been seen. The precopulatory display was described as silent vertical head-pumping by both sexes, more obvious in males. After copulation, the male gives a loud kick and may swim quickly in random directions while female bathes (Green et al., 2005).

During aquatic mating, the male grabs the female at the base of the neck to hold her underwater. The female remains inert, with her wings partially extended underwater. After copulation, the pair performs mutual head-bobbing, they bath and start a grooming session (pers. obs. Branféré).

In captivity, territorial display is a regularly observed behaviour that can be provoked by playback (Green et al., 1992). Mutual head-bobbing is also triggered by negative intra- or interspecific interactions, whether the white-winged duck are the initiators or receivers of these interactions (pers. obs. Branféré).

1.4.5. Vocalization

Its voice is distinctive and ghostly and accounts for the Assamese name ‘Deo Hans’ or Spirit duck (Das and Deori, 2011; Mackenzie & Kear, 1976). A flight call can be heard during the evening and is used between a pair. It is series of vibrant honks, often ending with a nasal whistle (Birdlife International, 2017; Mackenzie & Kear, 1976). The usual call of the male is a trumpet-like ‘cronk,’ while the call of the female in flight is a whistle (Das & Deori, 2011). When disturbed, a shorter harsh honk is used.

1.5. Predation

Pythons have shown to be a predator in Sumatra (Green et al., 2005). There have been historical sightings of raptor attacks. An adult was observed being killed by an otter (BirdLife international, 2001). During brood rearing period, ducks moult and are more likely to be predated by terrestrial and aquatic predators. The growing crocodile population in many of the white-winged duck primary habitats could wipe out most of the Indonesian population, but there is no documentation of crocodile attacks yet (Way Kambas National Park’s white winged duck monitoring team, 2020).

It is unlikely that natural predators are a factor in the decline of this species, although disturbance and discarded fishing equipment may increase their vulnerability to predation (BirdLife international, 2001). A decreasing white-winged duck sighting on several habitats might perhaps indicate the threat of crocodile invasion (Way Kambas National Park's white winged duck monitoring team, 2020). Targeted hunting by rural populations (Green, 1993a) and collection of eggs could also be a factor.

When threatening, the birds hiss, holding the head low and, on occasion, lifting the wings to display the speculum and white patches in threat (Mackenzie & Kear, 1976). This posture can also be seen during stretching (pers. obs. Branféré).

Fig: White-winged duck threatening an Assam Cobra (Mackenzie & Kear, 1976)

Section 2: Management in Zoos and Aquariums

2.1 Enclosure

Historically, white-winged ducks have generally been held in (single species) aviaries or open ponds during the summer period and were kept inside for the winter period. More recently there is a trend towards holding them in larger immersive exhibits, tropical houses or public walkthrough exhibits mixed with multiple species. Reproductively they tend to do better in the more traditional aviaries (Ounsted, 1985) but breeding success is being achieved in the larger exhibits, however due to disturbance from exhibit mates, their attempts are less successful.

2.1.1 Boundary

The aviary for the white-winged duck can be of a wired fence, covered with wire or polyethylene netting (mesh size 2.5 cm, max 5 cm) (Ounsted, 1985). In order to prevent access by wild birds and mammals (like small predators) small mesh size would be recommended. Under floor wiring will also help prevent any potential rodent problems. An electric fence or electric wires at successive heights can be added around the aviary. The figures below illustrate the different types and fences of current aviaries.

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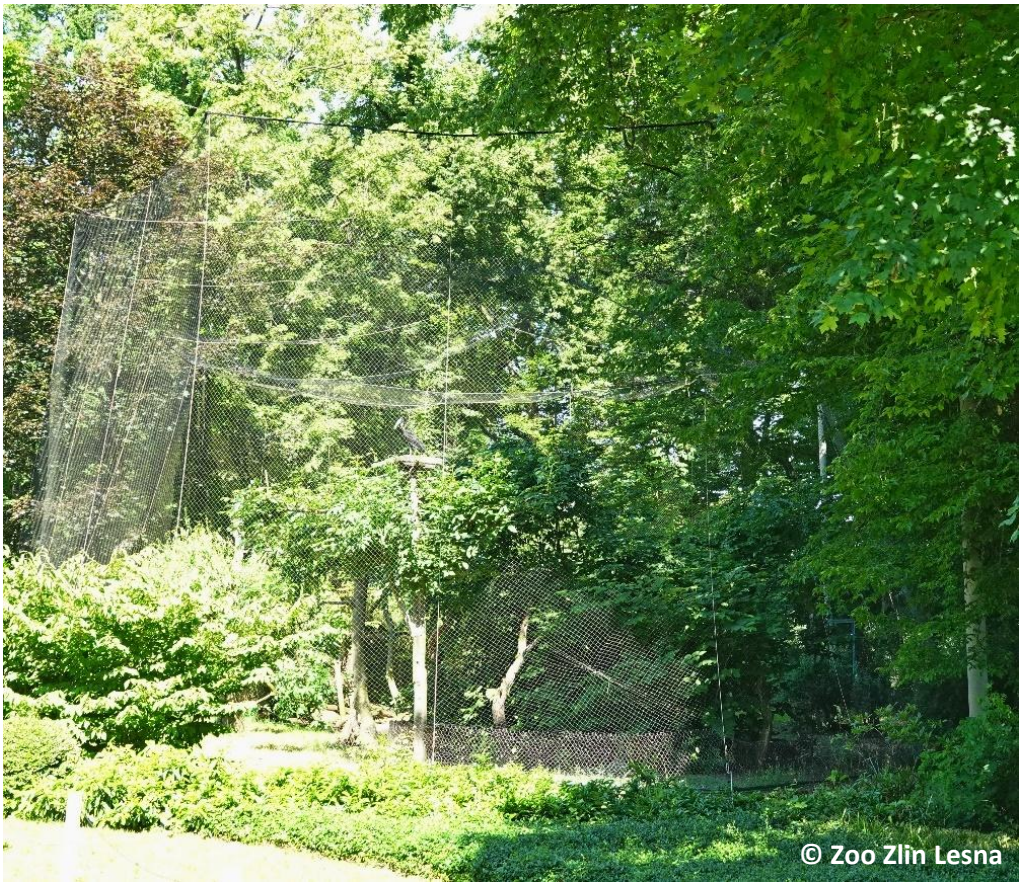

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Nowadays almost the entire EAZA WWD captive population is managed in aviaries in order to preserve their flight capacity (see chapter 2.7.1 about flight restriction).

2.1.2 Dimensions

Birds are mostly kept in pairs (see chapter 2.3 below). Keeping them in trios (1 male and 2 females) can also be successful. For optimal breeding success, the ideal enclosure size is 5 x 10 x 3 meters (150 m3)

according to literature in a monospecific enclosure (Foote, 2023; Ounsted, 1985). Best breeding results will be obtained with small enclosures; however small enclosures require a high standard of hygiene. However, the difficulty of small enclosures is parent rearing the ducklings, as males tend to get aggressive and even drown ducklings (pers. com. Harteman, 2018; pers.com. Van Lint, former EEP coordinator, 2024 ; Best Practice Guidelines Questionnaire). Therefore, males can be temporarily moved to another enclosure when females are incubating steadily. The female will rear the ducklings without problems (see chapter 2.4 below). The configuration of the enclosure must allow for the separation of individuals if necessary, particularly if the male has to be separated during the breeding season (see chapters 2.3 and 2.4 below).

In mixed aviary or group management (with several WWD individuals or several breeding pairs), the size of the aviary needs to be larger. In today's institutions, aviary dimensions are highly variable, depending on the number of species and individuals in the enclosure. The surface area of the aviaries varies between 25 m^2 and 14 000 m^2 (with more than half in the range 400 – 1500 m^2, Best Practice Guidelines Questionnaire). Considering outdoor facilities, half of the participants had aviaries between 4 and 8 m high, while the other half had heights of between 8 and 12 m, and even over 12 m for some institutions. We recommend a minimum height of 5 m for the main aviary (Best Practice Guidelines Questionnaire 2024).

2.1.3 Substrate

A concrete floor should be avoided, because the feet of the white-winged duck are soft (Ounsted, 1985) and sensitive to lesions. Preferably (short) grass, which is easy to maintain and attracts insects, which stimulate natural behaviour of catching insects during the morning and evening/night (pers.com. Harteman Wildfowl Aviaries). Though white-winged ducks need water to drink, bathe in and mate in, they will spend most of their time on the land to rest or graze (Green et al., 1992; Ounsted, 1985). A soft natural substrate like bark, sand, mud or soil is also preferred (both indoors and outdoors) and will stimulate foraging behaviour.

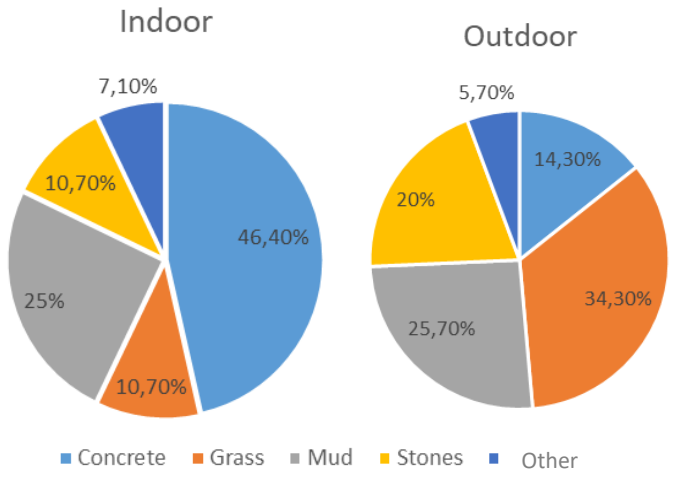

Fig: Substrate composition in aviaries at EAZA institutions (Best Practice Guidelines Questionnaire)

2.1.4 Furnishings

In the wild, white-winged ducks spend most of their time during the day roosting in trees (see previous section 1). High hiding places and substantial perches descending to the ground and water are recommended (Ounsted, 1985). This bird likes shady areas, living in dense forest in the wild. Part of the water area should be shaded and the aviary should be heavily planted to provide other shaded areas where the white-winged ducks likes to hide (Ounsted, 1985). A planted aviary is also recommended to limit mycobacterium exposure, in particular avian tuberculosis issue (strategy based on their tree-nesting ecology as perching ducks normally have less contact with the ground, see chapter 2.8 below). Today, 55% of institutions consider their aviaries to be poorly shaded (Best Practice Guidelines Questionnaire).

Fig: Captive individuals flying or roosting in their aviary (© Harteman, 2021)

At least a water pond should be available in the enclosure, preferably with a water flow. The water must flow at a sufficient rate to prevent stagnation and avoid the concentration of Daphnia (water fleas), which are the secondary hosts of the Acuaria intestinal worm, to which ducks are sensitive (Mackenzie & Kear, 1976).According to the literature, the water surface should be sufficiently large (a third of the enclosure surface is recommended), and its depth should not be too great over at least part of the pond (advantage of shallow ponds = more food, Ounsted, 1985). In the case of large ponds, the sections can of course be deeper (advantage = more volume = cleaner for longer) (pers.com. Harteman Wildfowl Aviaries). In EAZA institutions, pond depths vary from 0.2 to 1.5 m (up to 3 m deep, Best Practice Guidelines Questionnaire). There is a wide variety of ponds, both in number and dimensions (between 2 and 85 m^2), depending on the size and furnishings of the aviary. Half of all institutions have several ponds (up to 4 or 9, Best Practice Guidelines Questionnaire).

A concrete water boundary should be avoided, due to the fact that the feet of the white-winged duck are soft (Ounsted, 1985). The edges should slope gently to allow easy access and good dabbling areas. Ponds could have irregular shapes for better landscape integration. Slow-flowing streams could be added to recreate natural living conditions (see chapter 2.6. Behavioural enrichment).

The figures below illustrate the vegetation cover and layout of the current aviaries.


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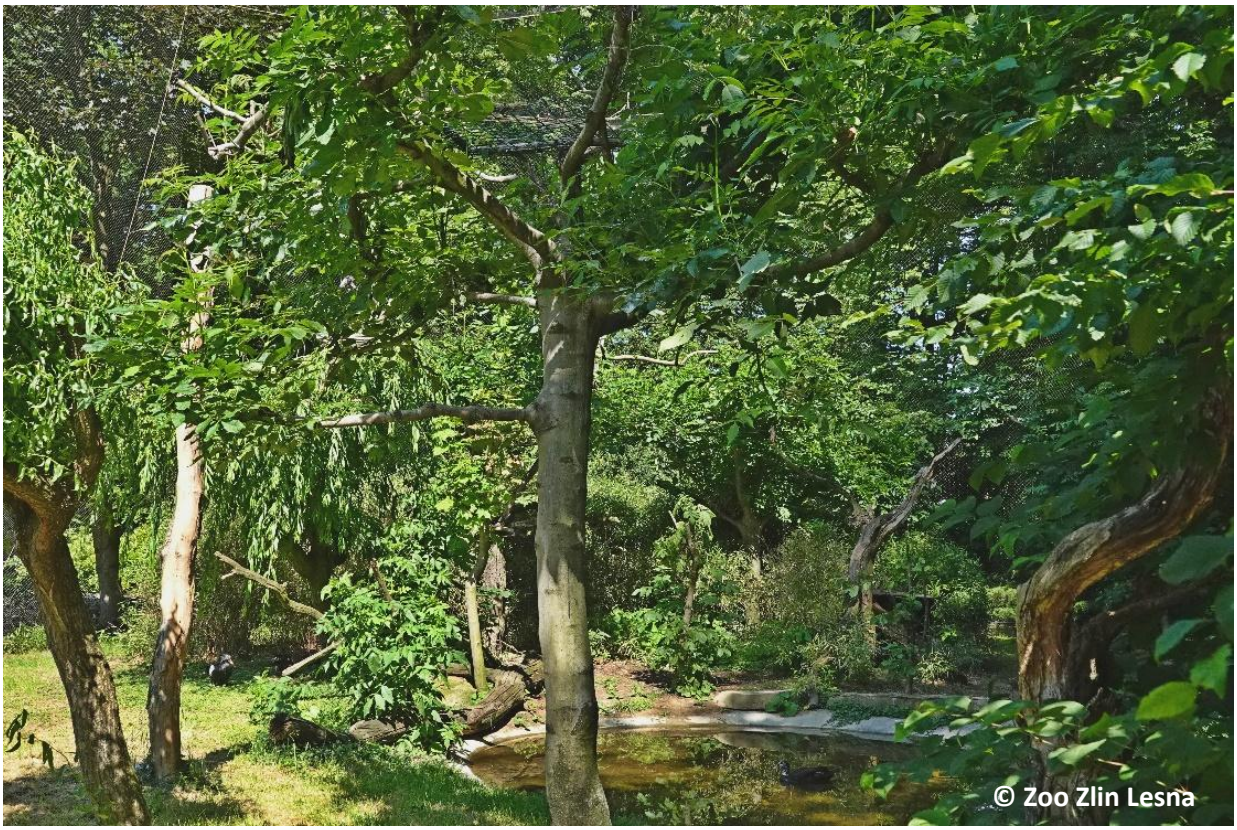
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2.1.5 Maintenance

The frequency with which the ponds are cleaned depends on their configuration. If there is no water circuit, ponds must be cleaned at least once a week. It is preferable to have running water with slow-flowing streams for instance. The best configuration is a natural or automatic filtration system. In this case, we recommend cleaning the ponds twice a year (at least once a year), or more if the ponds are small and stagnant.

Indoor enclosures must be cleaned every day (as is the case for 70% of survey respondents). Outdoors, the frequency of cleaning depends on the size of the aviary and the substrates present, as well as on the birds' behaviour (whether they are stressed or not, for example). Almost half of all institutions clean their exteriors on a weekly basis (Best Practice Guidelines Questionnaire). If the substrate is sand, it's best to use coarse sand for better drainage, and to change it regularly.

White-winged duck are untidy eaters and feeding stations need to be cleaned regularly (Ounsted, 1985).

2.1.6 Environment and indoor enclosure

EAZA institutions offer a wide range of aviary designs, from outdoor enclosures with or without indoor boxes to greenhouses (see figure below).

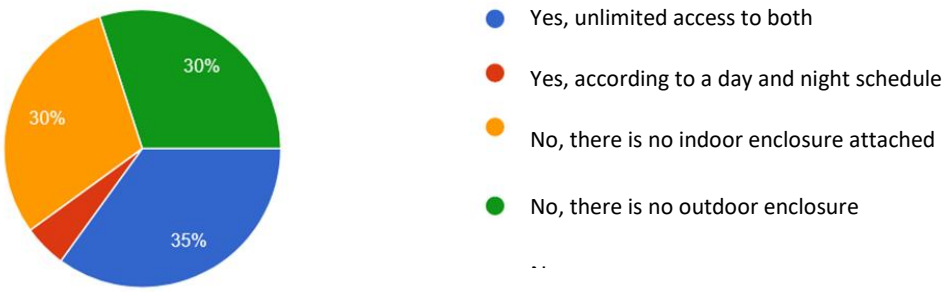


Fig: Access to an indoor and/or outdoor space (Best Practice Guidelines Questionnaire)

The situations regarding free access between indoor and outdoor areas for White-winged Ducks can vary; however, it is recommended to provide them with the choice of both environments. (Good Practice Guidelines questionnaire 2024). In some institutions, in winter, they spend only a few hours outdoors (depending on the weather) or are kept indoors only. In temperate climates, it is advisable to have an indoor enclosure since the birds are susceptible to frost bite on the feet (in the wild in Assam the temperature does not drop below 5°C). But the birds seem to be much more cold hardy than was first thought (Ounsted, 1985).

Decision-making criteria vary according to institutions, depending on geographic region and how ducks are kept. It seems that as long as there is open water (advantage of a slow water flow) and an access to a frost-free area, the birds do well. The cover provided by the natural environment of the aviary could mitigate winter weather conditions. When the ground is snow-covered or frozen, ducks must have access to a dry, heated indoor area. If temperatures repeatedly fall below -5 or -10°C for several days, the animals must be brought in.

In temperate climates, it's advisable to heat the indoor enclosure to around 15-18°C (so as not to have too great a difference with outside temperatures in winter when the birds have free access to an outdoor aviary). When birds are kept in tropical greenhouses, temperatures are often higher. It is also recommended to have ventilation in indoor enclosures (to limit Aspergillosis risk) in the absence of a hatch giving free access to the outside.

Fig: White-winged ducks in winter (© Cologne Zoo, winter 2013)

If you need to isolate an animal, the minimum dimensions of the indoor enclosure must be 3x2x2 m with a water point.

2.1.7 Safety measures against predators

As described above, we recommend using small mesh sizes and burying the net/wiring at the base to prevent any potential predator problems. An electric fence or electric wires at successive heights can be added around the aviary. Traps and rodent poison can be used with care inside the enclosure. Zookeepers are responsible for security checks around the perimeter.

2.2 Feeding

Chapter written by Julien BENSALEM and Flore VIALALRD, Nutrioo Zoo Nutrition (www.nutrioozoonutrition.fr).

2.2.1 Basic Diet

The white-winged duck is an omnivorous species with a diet that varies seasonally based on availability. Their diet in the wild includes aquatic plants, seeds of both wild and cultivated plants, aquatic insects, spiders, worms, crustaceans, molluscs, frogs, small reptiles such as snakes, and small fishes (Green, 1993c; Mackenzie & Kear, 1976). They typically feed at night by dabbling in shallow water, bill-dipping for small water snails and other small water insects, and occasionally diving underwater for fish (Holmes, 1977).

In captivity, their dietary needs can be met with a standard waterfowl maintenance diet. This diet should include aquatic plants and algae, such as duckweed and water lilies, which are rich in vitamins and minerals (Green, 1993c). Seeds and grains like millet, barley, and sunflower seeds provide essential carbohydrates and fiber (Holmes, 1977). Invertebrates, including earthworms, mealworms, and snails, are crucial for their high protein content. Small fish and amphibians, like minnows and small frogs, offer

additional protein and fatty acids (Green et al., 2005). Fruits and berries, such as blueberries, strawberries, and chopped apples, serve as excellent sources of vitamins and antioxidants (Green et al., 2005).

An adult white-winged duck typically consumes around 200-250 grams of food daily, with portions adjusted based on individual health and activity levels (Green, 1993c). Providing access to natural browse, such as leafy greens like lettuce and spinach, and safe foraging areas with aquatic plants is beneficial (Holmes, 1977). Calcium, vital for bone health and eggshell formation, can be provided through crushed oyster shells or calcium supplements. Vitamin A, important for vision and immune function, can be supplied via cod liver oil or specific vitamin A supplements. Vitamin D, crucial for calcium absorption, can be obtained from exposure to sunlight or supplements (Green, 1993c; Green et al., 2005).

To stimulate natural foraging behaviours, offer a variety of food textures and presentation methods. This can include scattering grains and seeds on the ground, providing live insects, and floating aquatic plants in water. Ducks particularly enjoy mealworms and blueberries, which can also be used to administer medication if needed (Green, 1993c; Mackenzie & Kear, 1976).

Alternatively, commercially available pellets formulated for duck maintenance can be used to cover the nutritional needs of white-winged ducks. These pellets are designed to provide a balanced diet and can be supplemented with fresh vegetables, fruits, and protein sources to enrich the diet and stimulate natural foraging behaviours.

2.2.2 Special Dietary Requirements

The captive dietary needs are standard waterfowl maintenance diet, which varies according to the life stage and specific needs of the ducks (Cornell University College of Veterinary Medicine; Metzer Farms; Fouad et al., 2018; Green, 1993c; Green et al., 2005; Way Kambas National Park's white-winged duck monitoring team, 2020; Mackenzie & Kear, 1976):

Protein: 16-20% depending on the life stage
Lipids: 4-5% of the diet
Carbohydrates: Should form the bulk of the diet, primarily from grains and seeds
Calcium: 1% for growing ducks, up to 3% for laying ducks
Phosphorus: 0.4-0.5% available phosphorus
Vitamin A: 10,000 IU/kg of diet
Vitamin D: 2000 IU/kg of diet
Vitamin E: 50 IU/kg of diet

Ducklings (up to 2 weeks) require a higher protein intake, which can be met with a starter diet with 18-20% protein to support rapid growth. They need approximately 100-150 grams of food per day, with an energy requirement of around 2900-3000 kcal/kg of diet. Ducklings initially feed on small animals like crustaceans and small invertebrates and progressively include insects, worms, small snails, and fishes in their diet (Mackenzie & Kear, 1976).

Growing ducks (3 weeks to maturity) need a diet containing 17.5-19% protein to support continued development. They typically consume 150-200 grams of food per day, with an energy requirement of approximately 2800-2900 kcal/kg of diet

Breeding and laying ducks require increased calcium (up to 3%) and protein (around 17.5%) to support egg production and overall health. This can be supplemented with additional oyster shells and mealworms (Green, 1993c). They consume about 200-250 grams of food daily, with an energy requirement of around 2700-2800 kcal/kg of diet.

Adult maintenance diet typically consists of a balanced diet with about 16-18% protein, ensuring all necessary nutrients for day-to-day health. Adults generally consume 200-250 grams of food daily, with an energy requirement of approximately 2600-2700 kcal/kg of diet.

Old or convalescent ducks should be provided with easily digestible foods and additional vitamins to support their health and recovery. This may include a lower protein diet with more fruits and finely chopped greens, with a daily intake adjusted to 200-250 grams and an energy requirement of around 2600 kcal/kg of diet

Certain foods and products can be toxic to white-winged ducks and should be avoided. Foods that are generally harmful to ducks include avocados, chocolate, onions, garlic, and caffeine. Mouldy or spoiled food can also be toxic and should never be provided. Additionally, care should be taken to avoid feeding ducks foods that are high in salt or sugar, as these can lead to health issues.

Food-related diseases can pose a significant risk to white-winged ducks. One of the primary concerns is the potential for bacterial infections, such as botulism, which can occur if ducks consume contaminated food or water. Ensuring that food is fresh and water sources are clean can help mitigate this risk. Aspergillosis, a fungal infection, can also be a concern if ducks are exposed to mouldy feed or bedding. Regular cleaning and proper storage of feed can prevent mould growth. Lastly, monitoring for signs of illness and maintaining good hygiene practices are essential to minimize the risk of disease.

2.2.3 Method of Feeding

In the great majority of institutions, food is presented in ground dishes (see figure below), but is also dispersed directly on the ground both indoor or outdoor. In many aviaries, food is also scattered in the ponds (representing the “other” category in the figure below), providing good enrichment for the ducks (floating pellets, greens, insects, water plants, corn, food bowl…). Ducks are usually fed once or twice a day and often have unlimited access to food. In naturalized aviaries, they can also spend a lot of time foraging in ponds or in the ground (behavioural enrichment).

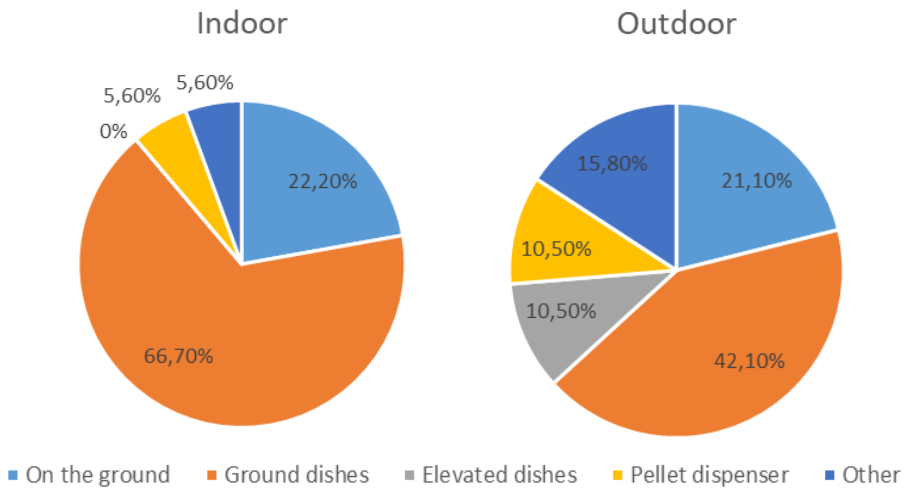


Fig: Feeding method in aviaries (indoor and outdoor enclosures) at EAZA institutions (Best Practice Guidelines Questionnaire)

Based on observations in feeding ecology, we recommend providing as many meals as possible per day, allowing ducks to forage throughout the day. Ducks have a rapid digestive transit, and an empty digestive system for too long can cause discomfort. We encourage the use of automated distribution systems if necessary. Providing food both indoors and outdoors encourages natural behaviours. The white-winged duck typically feeds at night by dabbling in shallow water and bill-dipping for small water snails and other insects, occasionally diving underwater for fish (Holmes, 1977). A mix of feeding methods should be used, including scattering food on the ground, placing it in shallow water trays, and using hanging feeders for enrichment. Enrichment devices can include floating platforms for aquatic plants and puzzle feeders for seeds and grains (Green et al., 2005).

Fig: Food provided in "pigeon tower" (Harteman, 2024)

2.2.4 Water

It is essential to ensure constant access to clean, fresh water in both indoor and outdoor enclosures. Large, shallow dishes should be cleaned and refilled daily (Green et al., 2005). Providing a pond or water feature where ducks can swim and forage naturally is also crucial. Water quality should be maintained through regular cleaning and filtration (Green, 1993c).

Water should be clean. Water can be contaminated by tuberculosis, which can infect the birds using it. The mycobacterium which causes tuberculosis in white-winged ducks can survive in longer period outside the host, for example in feces or water (Milton & Roffe, 1999). More information will be given in paragraph 2.8 “Veterinary: Considerations for health and welfare”.

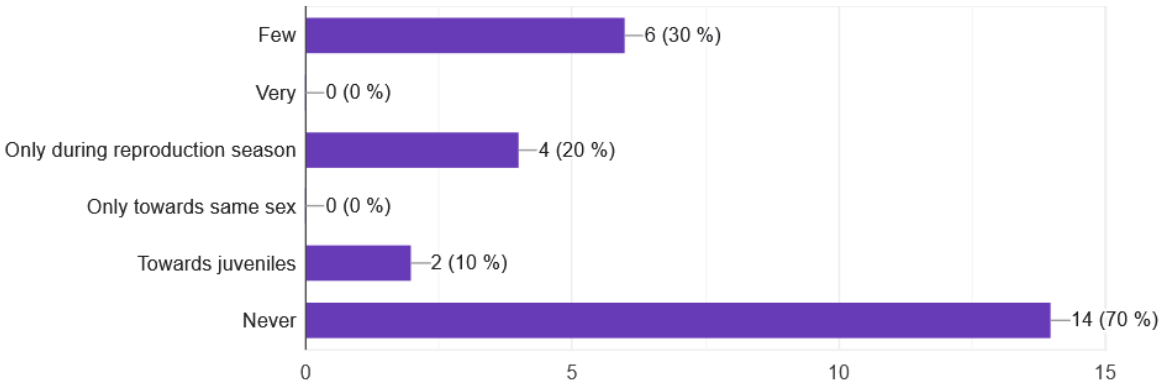
2.3 Social structure

2.3.1 Basic Social Structure

The white-winged duck is mostly kept in breeding pairs in captivity. The birds can also be kept in imbalanced sex trios, meaning 1 male and 2 females (Ounsted, 1985). The literature indicates that one of the females at the end is prioritized, and that it is best to remove the second female. Small groups of several couples have also succeeded in reproducing and living together in large space (Best Practice Guidelines Questionnaire; Mackenzie & Kear, 1976). The welfare of each individual must be closely monitored, especially regarding access to important resources (food, shelter, pond). Depending on institutions, juveniles are kept with parents until the next breeding season or are isolated. Siblings can stay together for one year or more. In some institutions we can also find groups of females (related or not), groups of young males or brothers, and groups of siblings (Best Practice Guidelines Questionnaire).

It seems that they can be very aggressive towards each other (Johnsgard, 2010) especially during breeding season. This information is also reflected in the responses from institutions, where the majority of agonistic behaviours are carried out during the breeding period and towards juveniles (see table below). But the great majority of respondents don’t observe any aggressive behaviour. Maybe when you have a spacious aviary where ducks can (temporarily) escape this might not be a problem. The literature says that it is very unwise to keep 2 mature males together in one enclosure (Ounsted, 1985) but this situation exists in several institutions. Further research is needed over the next few years, as aviary space and complexity play a key role in the level and frequency of aggressive behaviour.

Table: Aggression factors of WWD towards conspecifics (Best Practice Guidelines Questionnaire)



2.3.2 Changing Group Structure

It would be preferable to house young adults together initially, and monitoring the formation of pair bonds would help lead to stronger pairs (Foote, 2023). When changing the group structure, the keeper can observe if the new pair will succeed, such as spending most of their time together or displaying courtship behaviours. For weakly bonded pairs, allowing parents to rear offspring has been effective in reinforcing the bond (Foote, 2023).

2.3.3 Sharing Enclosure with Other Species

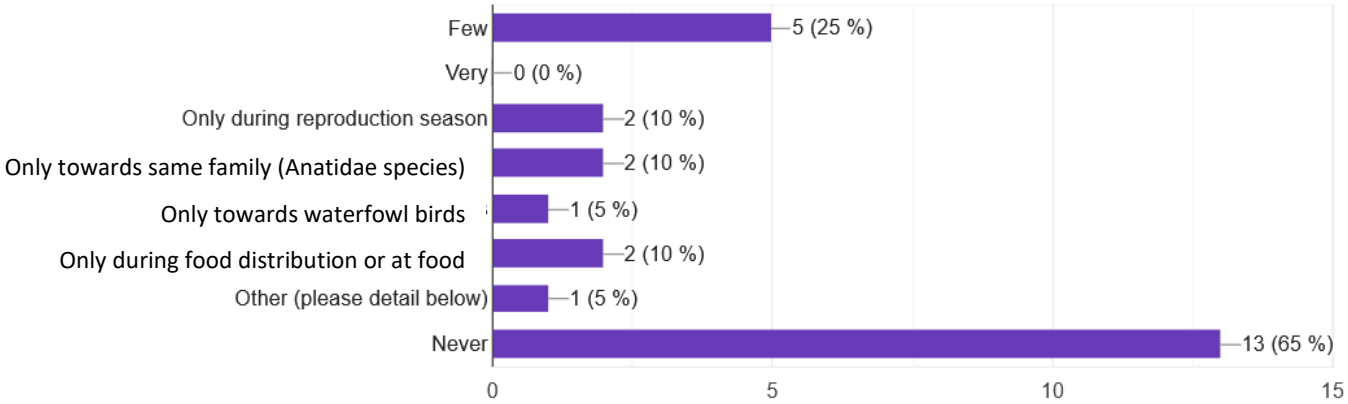
The white-winged duck is a territorial bird. In the wild a pair can have a territory of 250 acres (Das & Deori, 2011). In captivity they have a reputation for aggression towards other species sharing the aviary, especially during the breeding season and by the male.

However nowadays the great majority of parks (95% of respondents to the Best Practice Guidelines Questionnaire) keep them in mixed aviaries with a large variety of avian species (see the table below), mostly without any problems (no aggression recorded in 80% of cases). Numerous agonistic behaviours are observed towards other Anatidae species, probably because they share same habitats, especially ponds. Aggressive behaviours have been particularly observed towards Anas species. A behavioural study conducted on agonistic interactions between a breeding pair of white-winged ducks and other birds in a mixed aviary (Davoigneau, accessible on request, Branféré, 2024), concluded that Anatidae species were the target of the vast majority of aggression, particularly Sunda teal. In this study, Sunda teals were recently introduced to the aviary, which may explain these results. It is important to keep the other species of duck fully winged and not to mix white-winged ducks with other territorial aggressive species. Occasionally it seems that white-winged ducks can drag passerines into the water (Best Practice Guidelines Questionnaire).

Although they will share enclosure space without issues for the majority of the year, caution must be shown during breeding season. Some institutions only keep pairs of white-winged ducks in mixed groups outside the breeding season. In the behavioural study carried out (Davoigneau, Available on request, Branféré, 2024), and contrary to predictions, agonistic behaviours were mainly initiated by females, both outside and during the breeding period. The male initiated significantly more agonistic behaviours during the breeding period, but still much less than the female (with no nesting or incubation

period in this study). There was no increase in the frequency or intensity of these behaviours during the breeding period. Further studies are needed to better understand the factors leading to possible intra/interspecific agonistic behaviour). In the case of conservation breeding with the direct aim of reintroduction (in India for instance), it is recommended to keep the species separate from other captive waterfowl to limit the risk of avian tuberculosis (Foote, 2023).

Table: Aggression factors of WWD towards another species in mixed aviaries (Best Practice Guidelines Questionnaire)



Aggressive behaviours observed can be threat display, vocalizations, but also chases and physical attacks like body contact, pecking or biting. Ducks can possibly drown passerines or chicks. Chasing and physical attack have been observed in ponds towards other Anseriformes species, or towards any bird species that came close to the nest site during the incubation period. Sometimes they can show food aggression towards other Anseriformes species if insects are present (Best Practice Guidelines Questionnaire).

At the same time, there are also a few examples where white-winged ducks have fallen victim to the aggressive behaviour of other species (for example magpie geese in Harteman Wildfowl and kingfisher in Chester Zoo), including the death of some individuals (pers.com. Van Lint, previous EEP coordinator). In mixed aviaries, birds must be monitored carefully. In fact, in a multispecies enclosure, each stage of life must be monitored with great care: reproduction, birth, introduction of new individuals, geriatrics, etc. to ensure that all individuals benefit from optimal well-being. To limit aggressive behaviour and its fatal consequences, mixed aviaries must be well-equipped with aerial supports, a sufficient number of ponds, and offer sufficient vegetation for escape or hiding. When mixing species for the first time, it is advisable to examine the size and furnishings of the aviary, and check whether it is large enough to allow the species to share the space. It is also important to multiply feeding areas to limit food competition. Insects and greens can be scattered in ponds when given.

In annex 1, a table lists various species with which white-winged ducks have shared enclosures in actual institutions and any problems associated with these mixes (based on Best Practice Guidelines Questionnaire 2024). Please note this list is not definitive and does not mention the exhibit size. We should also mention the fact that some species which are considered incompatible in certain institutions are nevertheless present in other collections. A large number of external factors come into play (aviary

size and composition, variety of supports and areas for escape or hiding, number of individuals and species, group composition, etc.), and further studies should be carried out in this area.

2.4 Breeding

As previously described in chapter 1.7, in captivity in temperate countries, the breeding season lasts globally from March to June, with an egg-laying period extending from April to July (with a peak in May). Captive females and males are generally mature at the age of two-three years, but females can lay fertile eggs at 1-year-old.

2.4.1 Mating

The white-winged duck has a monogamous mating system possibly with long term pair bond. In captivity, territorial display is a regularly observed behaviour. As described in chapter 1.8.4, the display is generally initiated by the male who performs head-bobbing, often responded to by females with the same behaviour and with vocalizations. Also, zigzag swimming with arching head movements has been seen. The precopulatory display was described as silent vertical head-pumping by both sexes, more obvious in male.

During aquatic mating, the male grabs the female at the base of the neck to hold her underwater. After copulation, male gives loud kick and may swim quickly in random directions while female bathes. The pair performs mutual head-bobbing, they bath and start a grooming session. During the breeding period, care must be taken to ensure that subordinate individuals (groups) or the female have the opportunity to rest and feed (if the male becomes too enterprising).

After two unsuccessful breeding seasons, valuable pairs should have their aviary environment modified: increasing vegetation cover, adding more nests, and moving the existing nest, for example. After these modifications, they can be kept together for a third breeding season before being split and paired with new partners (Foote, 2023). (Foote, 2023). In some institutions, a dietary transition is made during the breeding season (dried insects, concentrated pellets, food supplements, more fresh food for example, Best Practice Guidelines Questionnaire). The installation of several nesting boxes is also known to boost breeding success (see following paragraph 2.4.2).

2.4.2 Egg Laying and Incubation

In captivity the female often lays between 6 and 13 eggs (sometimes only between 4 and 6 eggs) with a mode of 10 (Best Practice Guidelines Questionnaire; Green et al., 2005). The eggs are laid in approximately 24 hour intervals. The female will not incubate till all eggs are laid. Before she incubates, she will surround her eggs with a grey white down. This down can be an indication for keepers, whether or not a female is incubating. The incubating female will leave the nest several times during the day to feed. Incubation lasts for 33 days. All eggs will hatch within 48 hours of the 33rd incubation day (Ounsted, 1985). The eggs (parents from Assam) are on average 67.0 x 49.5 mm (Green et al., 2005).

When offspring are wanted, nesting sites should be available. In captivity white-winged ducks can nest in artificial nests (90% of institutions with breeding programs use artificial nest boxes according to the Best Practice Guidelines Questionnaire). The artificial nests are wooden boxes placed in cover in the shade and quiet place, preferably positioned high up (3 m or more above ground). In the event of exceptional flight restrictions, nesting boxes can be placed at a height of 50 cm to 1 m from the ground, with access ramps (Mackenzie & Kear, 1976; Ounsted, 1985). This way, the birds can enter the nest by a discreet route.

The nest box does not need any furniture. It is recommended to line the box with soil or blond peat and even a sprinkling of dried grass, to make it comparable to a hollowed tree. The sizes of the ideal nest box, according to Ounsted (1985), is shown in the picture below. However alternative nesting boxes are also possible (see pictures below).

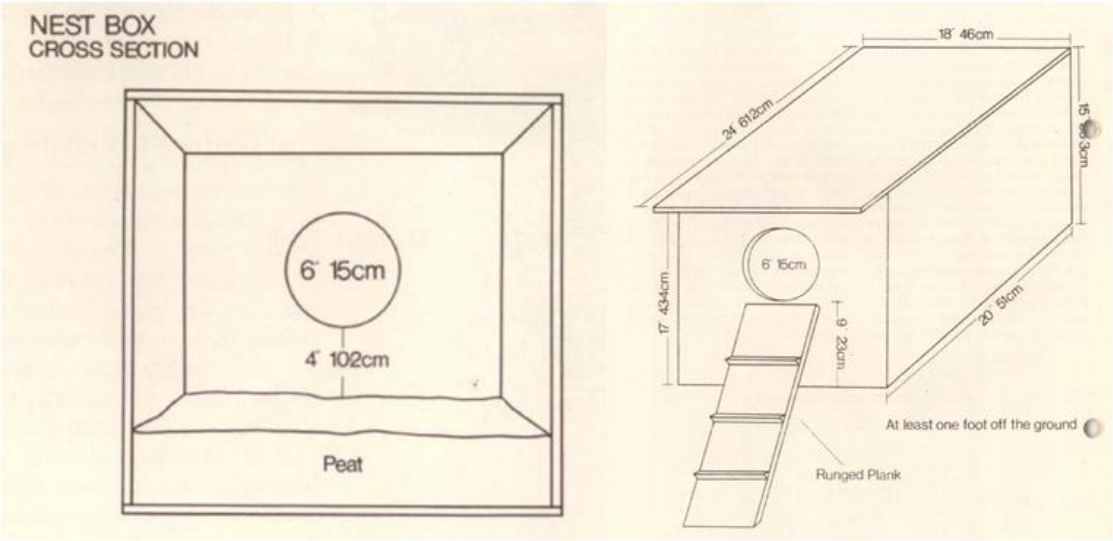


Fig: Sizes and shape of a nesting box (Ounsted, 1985)

Fig: Examples of nesting boxes on the ground (© WWT Slimbridge at left, © Harteman, 2021 in the middle, © Zlin at right)

Fig: Examples of elevated nesting boxes (© Branféré, 2023 at left, © Ménagerie du Jardin des plantes at right)

Occasionally the birds are also known to just breed under a big poll of grass or somewhere else hidden away on the ground, even if a nest box is available. It is therefore important to manage them in a sufficiently vegetated environment, where they have plenty of places to hide. Sometimes, white-winged duck are also using nest for other species, like tragopan / pheasant basket (pers. comm. Harteman 2019).

Fig: Female incubating between the bushes (© Leipzig, 2012)

For new breeding pairs and the first breeding season, it is recommended to place several nest boxes (3 artificial nests per pair according to Ounsted, 1985) in different locations and at different heights, to give the birds a choice and promote breeding success (Best Practice Guidelines Questionnaire). One of the artificial nests should be placed near the ducks' preferred area. For subsequent breeding periods, keep the nest where there has been breeding success. In multi-species aviaries, be sure to place enough nests

for all species, to limit competition and intrusion into the WWD nesting box. Attention must also be paid to the configuration of other species' nesting boxes in order to avoid negative interactions (personal observation of a WWD female catching a Sunda teal in an Anatidae nesting box at Branféré).

White-winged ducks are usually very close to their nests. The female is the only one who incubates, but the male is usually close by and escorts the female on feeding trips.

Fig: Females incubating in their nest box (© WWT, Slimbridge at left; © Harteman, 2021 at right) and a clutch of 14 fertile eggs (© Harteman, 2021)

If the female laid her eggs early in the season and she is at the right age, she can lay another clutch within 20 days (Mackenzie & Kear, 1976; Ounsted, 1985). Thus a second clutch can follow the removal of the first one. However, a 2nd clutch is not recommended if the first eggs are fertile. Please note that under the EEP program, the number of eggs to be kept each year depends on the current population and the coordinator's recommendations.

Trying to monitor the eggs by keepers can lead to conflicts, which may cause the breaking of the eggs or scaring the birds. When the birds have been scared too much, there is a chance that they will not return to their nest. It is recommended that the nest should only be looked at when the female has naturally left it to feed (Ounsted, 1985). If the EEP coordinator has requested a reduction in clutch size, the eggs must be removed before incubation begins, to prevent embryonic development (see chapter 2.4.6 below). After the removal of the eggs, it's important to check if the female returns to incubate the eggs again and to monitor the embryonic development to ensure it is progressing well (vascularization inside the egg when candling).

2.4.3 Birth/Hatching

At 24h the female chicks weigh on average 48.7 grams and the males on average 48.4 grams (Mackenzie & Kear, 1976). The female leaves the nest with her ducklings a day after hatching. Disturbance during this period could be disastrous, but they should be closely monitored (Ounsted, 1985).

When the chicks are hatched, the male bird is often removed from the enclosure. He can be very aggressive towards his own chicks, catching them and even dunking them in ponds (Best Practice

Guidelines Questionnaire; Matthews et al, 1972; Ounsted, 1985). They can return to the enclosure when the chicks are fully grown and separated from their mother. However, in some institutions, both parents raise ducklings without any problems of aggression or fatal outcome (Best Practice Guidelines Questionnaire). Further studies are needed to identify any parameters (aviary configuration and size, group composition, etc.) that may influence male aggression towards ducklings. Since these behaviours are also dependent on the individual, it is highly recommended to closely monitor the male during the first hatching and to remove him or the female with the ducklings at the first sign of aggression. Be aware that the male's behaviour can change from one breeding season to another due to age or other environmental factors. The initial moments of the ducklings need to be closely monitored.

2.4.4 Development and Care of Young

The female takes care of the young. If the ducklings are parent reared in their enclosure it is recommended to keep an eye on the male's behaviour as in some instances the male can be aggressive towards ducklings, even resulting in loses.

Fig: A family group (© Cologne Zoo).

The ducklings take 2 months to fully grow and juveniles take 14 weeks to fledge (Green et al., 2005). When they are completely feathered, they can be separated from their mother. However, in many institutions, juveniles are kept with their parents for longer periods, from at least 6 months to 1 year (Best Practice Guidelines Questionnaire). We recommend leaving juveniles with their parents until the next breeding season, depending on the parents' behaviour. In the event of aggressive behaviour, juveniles must be removed. The ducklings can stay together for one year or more (Best Practice Guidelines Questionnaire; Ounsted, 1985).

During the rearing period, ducks need a large amount of food. It is recommended to have two dishes with food available at all times (see previous chapter 2.2). Extra food can be presented at the water edge.

2.4.5 Hand-Rearing – versus Foster rearing

Within the EEP program, holders *should not* raise chicks by hand although it was still occasionally used (in particular due to aggressive male problems). Foster rearing is a preferred option to hand-rearing, but not currently used in EAZA institutions (Best Practice Guidelines Questionnaire). The chicks can be foster reared using a hen or a duck (like a Muscovy duck). A keeper with some experience with broody hens is advisable. Artificial incubation in an incubator is authorized by the EEP program. Currently, half of the EAZA institutions carry out natural incubation and rearing by the WWD female (questionnaire on best practice guidelines).

The eggs of the white-winged duck can be removed daily while she is feeding and when they are still cold. They need to be replaced by white painted wooden eggs of a similar size. There are only 5 artificial eggs needed to replace all the natural eggs. The eggs should be stored in a cool place on their side and should be turned horizontally at least once a day. If the female start to incubate the last egg, then the stored clutch should be set under one or two broody hens, depending on the clutch size and the size of the broody hens. When the female white-winged duck leaves the nest to feed, the last egg can be removed and placed under a broody hen.

If the female laid her eggs early in the season and she is at the right age (usually third year of laying), she can lay another clutch within 20 days. Removing the eggs can trigger a second egg-laying (Mackenzie & Kear, 1976; Ounsted, 1985). However, a 2nd clutch is not recommended if the first eggs are fertile (remember that the number of eggs to be kept each year depends on the current population and the coordinator's recommendations). It is therefore advisable not to empty the nesting box completely (keep artificial eggs until the end of the theoretical incubation period).

The broody hen should be removed daily from the nest for half an hour to feed and drink. From the 5th day, an experienced keeper can handle the eggs and look through the egg shell using a light. Using this light, the keeper can tell whether the egg is fertile or not, and he can monitor the development of the embryo (Ounsted, 1985).

When the chicks are hatched, the broody hen and the chicks should be removed to a new enclosure. The ducklings need to get the same food as described in paragraph 2.4.4. Development and Care of Young. When the ducklings are 3 to 4 weeks, the broody hen should be removed from the ducklings. The enclosure the ducklings are in should be fresh ground and with short grass (Ounsted, 1985).

Fig: Foster rearing by a Muscovy duck (© Zlin Zoo, 2013)

Instead of a broody hen, the chicks can be artificially incubated using an incubator (37.4 °C, Humidity: 50-60%, pers. com. Branféré). To facilitate hatching, eggs can be moved to a hatcher shortly before hatching (Humidity: 100%).

The hatched chicks need to be kept in a high-sided coop placed on a table. It may be necessary to place a wire frame on top of the coop to prevent escape. A heat bulb needs to be placed at the end of the coop set at 35 °C. The coop needs to be cleaned every day. The food can be presented the same way as described above. Again it is really important to give them green food as this ensures that the ducklings drink. After 15 days the coop with heat bulb can be removed outside but only when the weather is suitable. The ducklings need to be closed up at night or when it rains until they are feathered. When they are feathered they can also be introduced to water (Ounsted, 1985).

2.4.6 Details on contraception possibilities are highlighted

Under the EEP program, the number of eggs to be kept each year depends on the current population and the coordinator's recommendations. Clutch sizes can be reduced if necessary: remove part or totality of the eggs (before incubation begins to prevent embryonic development), provide dummy eggs (partly), freeze eggs or oil eggs (the oil should be applied once a week on average). Keeping dummy eggs or oiled eggs in the nest will help maintain the female's incubation behaviour (and limit a second laying). Eggs must be removed at the end of the theoretical incubation period. Please note that eggs must not be removed without the coordinator's approval.

In order to control reproduction, ducks can also be managed in single-sex groups. Several zoos within EAZA already keep (or have kept) groups of female White-winged Ducks, ranging from 2 to 6 individuals. No particular issues have been reported, and these large groups are very beneficial for educational purposes. Currently, no trials have been conducted with groups of males, but this will be documented in the coming years.

2.5 Population management

The first recorded pair was housed at London Zoo in 1851. The current captive population in Europe and North America was established from birds collected in Assam and imported by WWT Slimbridge Center in 1969 and in 1970: 7 males and 5 females. (Mackenzie & Kear, 1976). During the 1970s and the 1980s, offspring were exported to United States, Hong Kong and Singapore from the 4.2 founders. In 1986, there was an exchange with India involving 2.0 ducks. During the 1990s, 6.5 ducks were imported by Zoologischer Garten Berlin, Zoo Wuppertal and Weltvogelpark Walrsode from Hong Kong and Singapore (ZIMS for Studbooks, 2024).

There is a European Studbook for white-winged ducks since 2012, transformed into a New Style EAZA Ex-Situ program since 2021.

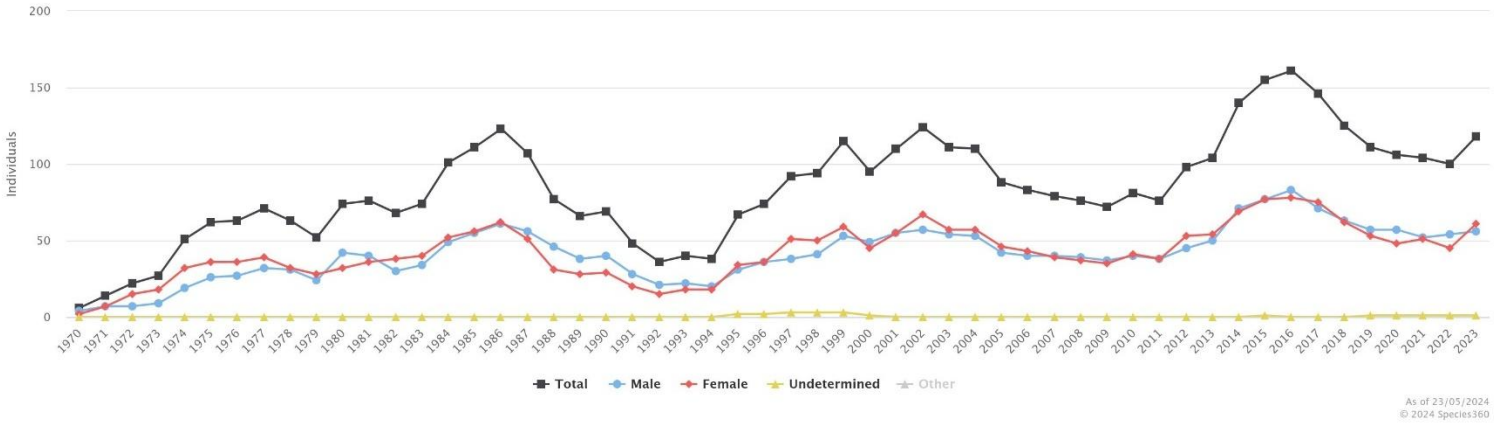


Fig: Trends in WWD's captive European population since 1970 (Species360, 2024).

With the declining white-winged duck population size, many facilities invested in other species of waterfowl and reduced their white-winged duck breeding efforts. It can be difficult to coordinate timely recommendations between facilities for short-lived species that can reproduce prolifically for only a few years, as is currently the case for this species. Transfers between facilities require time, resources, coordination, health certificates, quarantine periods, and permits, not to mention stress for animals that fail to reproduce (Foote, 2023).

2.6 Animal welfare

Providing an aviary that contains a variety of furnishings like trees and bushes, tree stems, perches, ponds with soft shores, running water and soft substrate allow the ducks to express their natural behaviour. A dense canopy will provide them with shade and quiet areas. The nature and diversity of the substrate (meadows, barks, shrubby or aquatic plants) and the shallow depth of ponds should enable them to forage. The presence of ponds also permits white-winged duck to perform courtship behaviour (bowing movements between the pair) and copulation in water. Natural marshland with rivulets or small ponds with slow-flowing streams will recreate their natural habitat. Waterfalls or sprinklers can be added. Food enrichment usually consists of insects and greens.

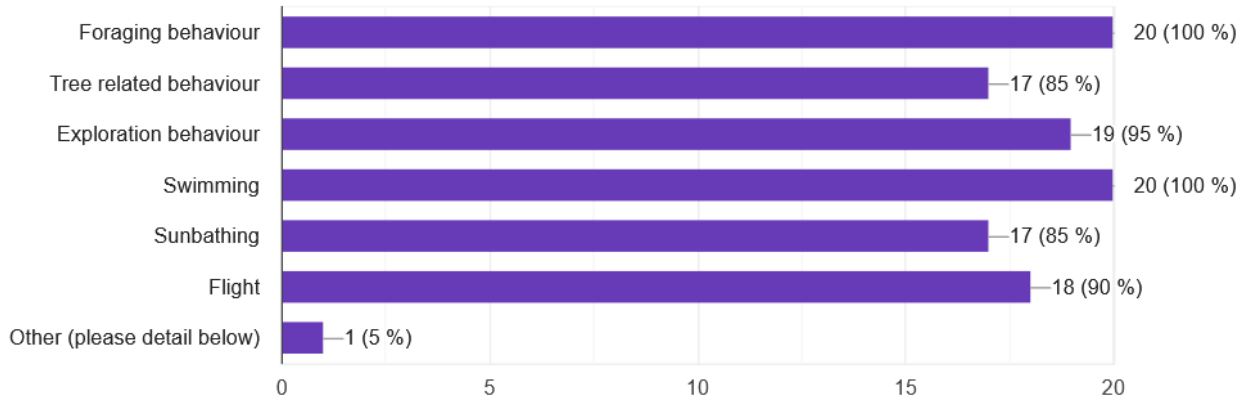


Fig: Natural behaviours expressed by captive WWD (Best Practice Guidelines Questionnaire)

Within the class Aves, welfare is still poorly understood and not well studied (Woods et al. 2022). The holders must optimize the well-being of their white-winged ducks and should regularly assess their practices to ensure that the physical and psychological needs of the ducks are filled. The most up-to-date approach to assessing zoo animals welfare is the Five Domains Model from Mellor and Beausoleil (Mellor & Beausoleil, 2015). This model evaluates the four physical domains: nutrition, environment, health, and behaviour, using objective data to ensure that the fifth domain, mental state, is also optimal. Below are some key indicators for the measurable domains :

Nutrition

White-winged ducks require a variety and a quantity of food that meets their nutritional needs (refer to chapter 2.2 Feeding for specific information). Beyond providing well-balanced pellets, it's important to stimulate natural foraging behaviour, for example with aquatic plants or insects on the ground.

Key-words : Aquatic plants, insects, several food places

Environment

White-winged ducks naturally inhabit large water bodies near or within dense forests. In zoological parks, we must provide ponds with high-quality water, along with numerous shelters for privacy. These shelters can be natural (plants, rocks) or, if necessary, artificial. Ducks must have choices regarding their substrates and should be able to protect themselves from weather conditions (rain, extreme sun etc). Choice and control are crucial for animals (see the paragraph below).

Key-words : High-quality water pond, natural or artificial shelters, choice and control

Health

Maintaining a healthy state for the birds is essential, including protecting them from injuries or diseases. Individuals that show signs of pain or discomfort must be examined by a veterinarian and

medical treatment should be implemented to address any issues. Positive health monitoring is recommending for all white-winged ducks within the EEP population.

Key-words : Preventative medicine (deworming, vaccination), regular health check

Behaviour

Even though space is limited in zoological parks, white-winged ducks need to exhibit a diversity of natural behaviours and maintain positive relationship with humans (keepers and visitors). As a semi-social species, they require the company of conspecifics but also need privacy and should not be continuously harassed by a dominant individual. Natural breeding behaviours (courtship, nesting) are encouraged when males and females are housed together, even when the pair is not allowed to produce chicks (eggs can be oiled or shaken to prevent incubation).

Key-words : Behaviour diversity, breeding behaviours, semi-social species

By specifically addressing the needs of white-winged ducks in these four physical domains—nutrition, environment, health, and behaviour—zoological parks can provide a high standard of care that supports both the physical and mental wellbeing of these birds.

Pinioning or flight restriction

Deflighting birds is a very sensitive subject because it can affect their behaviours and may be negatively perceived by visitors (Reese et al. 2020). White-winged duck is a perching duck species and typically spends most of its day very high in trees, regularly flying from a place to place. Pinioning is therefore not permitted within the EEP. Feather clipping may be used as a temporary husbandry practice (e.g. : during introduction process, for temporary housing …) but must be approved by the EEP coordinator. During this period, the welfare of the birds must be closely monitored and it must be ensured that the birds have safe perching opportunities and are protected from predators.

Choice and control

To ensure good welfare and wellbeing, zoological parks must allow white-winged ducks to make decisions about their environment and behaviours, thereby giving them control over their daily lives. This can be achieved by providing a well-adapted and diverse habitat where individuals can choose their locations and activities. Resources should be multiplied, for example, by offering multiple feeding locations or several nesting areas during the breeding season. Environmental enrichments, such as live food, sensory walls or floors, and new materials, should be provided regularly.

Finally, interactions with humans must be positive and can be avoided by the birds. If the white-winged duck is kept in an isolation area with no possibility of retreat, the presence of keepers should be minimized. Regarding interactions with visitors, it is important to provide hiding opportunities for the birds. It is not recommended to keep them in an aviary with more than two sides exposed to public viewing. In the case of immersive aviaries, retreat areas (vegetation, visual obstacles) must be provided

so that the animals can move away from visitors and hide from their view. The public should not have access to the entire aviary, and certain areas must remain dedicated to the animals.

2.7 Handling

2.7.1 General Handling

Where historically white-winged ducks were also kept pinioned, it is now clearly recommended by the EEP – in line with the called EAZA Standards for Welfare, Accommodation, and Management of Animals in Zoos and Aquariums - to keep the birds fully winged. This is especially the case for a perching duck, such as white-winged ducks, as flight is crucial to practice the full spectrum of their behaviour. In addition, pinioning should continue to be restricted to encourage birds to leave the ground and reduce exposure to mycobacteria such as avian tuberculosis (see chapter 2.8 below).

Wing-clipping is a temporary flight restriction, allowed in the White-winged duck's EEP for specific husbandry purposes (introduction and contact between new individuals, temporary hold in an open enclosure…) and provided that there is no risk of predation.

According to the Best Practice Guidelines Questionnaire, less than 7 % of captive WWD (6 birds) are still pinioned today.

2.7.2 Individual Identification and Sexing

White-winged ducks should be identified at one month of age with a 14 or 15 mm (for males) closed band (Aviornis France International, 2024; pers.com. Branféré). On the leg band, the following information should be present: year of birth, serial number from the institution, band size and individual number for each bird (remember that the species is classified in Appendix I-A). This information should be provided to the studbook keeper who will give the bird its studbook number. The studbook number, institutional ID and the information on the band should be kept in a register at each individual institution together with other observations about the animal (veterinary reports, breeding results, pairing, etc.).

Electronic identification chips can be placed into the pectoral muscles of the birds, but this should be done by a qualified veterinarian. Subject to the national legislation of each country, authorization may be granted if the animal's biological needs are incompatible with the installation of a ring (a nest too high for example).

Fig: Metal identification ring at left, and electronic chip reading at right (© Branféré, 2024)

White-winged ducks can be sexed when 2 months of age (pers.com. Branféré) via non-invasive DNA sexing from feathers (the option frequently used and recommended), or through blood test. Vent sexing is generally carried out as a last resort, as it's a delicate method that risks injuring the chick if it's not carried out properly. Sexing needs to be done with care, and ideally double checked. Recent cases of incorrectly sexed birds underline the need for this. These can frustrate the management of a jointly managed population. Sexual dimorphism appears too late to be used as a sexing method.

2.7.3 Catching/Restraining

To avoid injuries, it is better to catch white-winged ducks in small areas like indoor spaces or small isolation aviaries. Use of a net is recommended (the net's mesh has to be not too large to avoid trapping) but ducks are also caught by hand. When the duck is being held, the keeper should keep the wings together in front of them or close to the body.

Catches should be kept as short as possible, as they can be stressful. If birds have to be moved regularly, it is better to think about training. Food can be placed in cages or indoor pens to get them used to going in and out Through habituation, birds will become more comfortable going inside.

Fig: Restraint technique (© Branféré, 2024)

2.7.4 Transportation

These species should always be accompanied by a CITES document. This includes the date of birth, species name, sex and other information such as the ring number and ring diameter that are relevant to identify the animal. This international passport should always stay with the animal wherever it goes. Keepers of CITES A species should keep a register (accounting) in which one notes, among other things, the number of the CITES document, species name, date of purchase and any subsequent sale, juveniles obtained and date of death. An example of this register can be downloaded from CITES website. Offspring from CITES A birds should be ringed with a recognised, registered ring with a fixed diameter. According to the same principle, birds may carry a microchip if biological conditions did not allow for fitting them with a closed ring at the appropriate age. Within the European Union, each individual must be accompanied by an EU Certificate to demonstrate the legality of the animal's acquisition. Outside EU, the document is necessary in case of movement. When a transfer is planned, a CITES document should be applied for, for the offspring. This is done on the basis of the CITES documents of both parent birds, and before the departure. The destination is then noted in the register (pers.com. German CITES authorities).

Fig: Example of travelling box (© Branféré, 2024)

2.7.5 Safety

Aviaries, especially immersive aviaries open to the public, must have entry and exit locks to limit the risk of escape.

The keeper must be careful when catching a duck, as the wings can hurt. Be cautious with the feet too because of the claws, and with the beak because of biting.

2.8 Veterinary: Considerations for health and welfare

Chapter written by Michelle O'Brien, WWT Slimbridge Wetlands Center

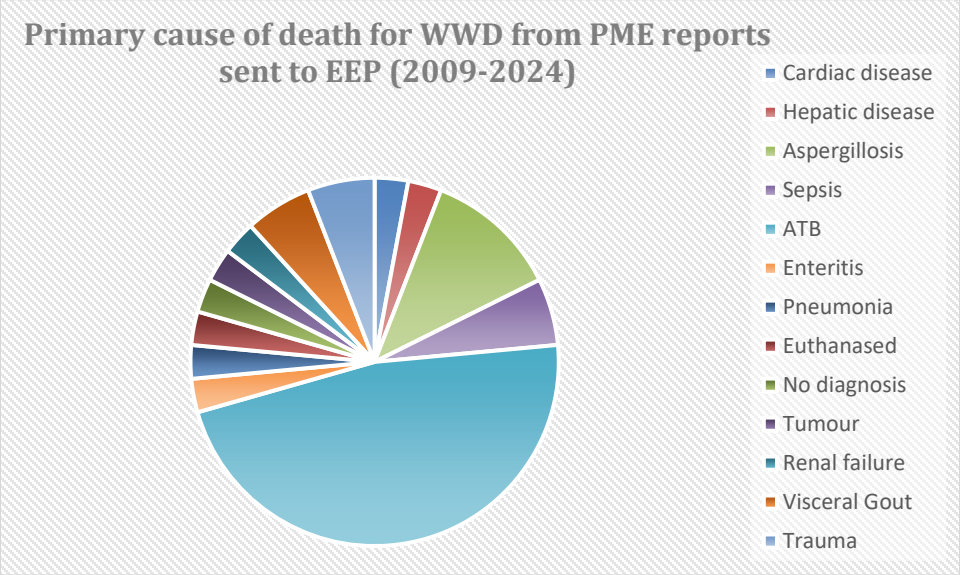


Fig: Of those post mortem reports provided to the EEP veterinary advisor from the last 15 years, avian tuberculosis caused by Mycobacterium avium (ATB) has been either the primary or secondary cause of death in 54% of cases, showing that it is the most important disease to be aware of and mitigate for in this species.

2.8.1 Avian tuberculosis

One of the management disease issues in white-winged ducks is the disease avian tuberculosis (ATB) caused by *Mycobacterium avium spp. Avium*. Perching ducks seem to be extremely vulnerable to this disease. In particular, white-winged ducks have high susceptibility to ATB compared to other waterfowl species (Cromie et al., 1992; Green, 1990), which can result in their premature death (Cook, 2016; Tomlinson et al., 1991).

Between 1976 and 1991, 102 of 121 (84%) white-winged duck deaths at The Wildfowl & Wetlands Trust Centre at Slimbridge were due to avian tuberculosis and there was no sex difference in mortality rate (Cromie et al., 1992). Efforts to conserve the species via captive breeding have been hindered because captive populations appear to be highly susceptible to this disease. This infection results in the premature mortality of over 80% of these birds. Despite sanitary improvements in captivity conditions, Sylvan Heights Bird Park (North America) noticed a drastic increase of avian TB mortality in 2019 (Foote, 2023).

A contributing factor may be that perching ducks normally have less contact with the ground and thus less contact with mycobacteria. As a result, they may show reduced natural immunity to these organisms. The white-winged duck is especially vulnerable, as they need a shaded pen to achieve breeding success. Due

to the absence of ultraviolet radiation, and thus the absence of its sterilizing effects, *M. avium* thrives within the pen (Cromie et al., 1992; Hillgarth & Kear, 1981; Milton & Roffe, 1999).
Mycobacteria are found in the faeces of contaminated animals, and can contaminate the ground, the water and the food (Fitzgerald, 2009; Thorel et al., 1997). As the bacteria can live outside a host for a long period (for at least three years in the soil), ingestion of the bacterium in contaminated feed and water is the most common means of disease transmission (Hillgarth & Kear, 1981; Milton & Roffe, 1999).

No clinical signs specifically identify avian tuberculosis in birds. Infected birds are often emaciated, weak, and lethargic, and they exhibit wasting of the muscles (signs like those of lead poisoning and other debilitating conditions) (Milton & Roffe, 1999). The feathers may develop a dull and ruffled appearance and the comb and wattles become anaemic. On palpation of the coelom of the emaciated birds, the liver may be hypertrophied, and nodular masses may be detected along the intestine. The coelom may also appear swollen due to a buildup of fluid in that area. Affected birds die within 2 months or may survive for 6 months depending on the extent of disease (Thorel et al., 1997). They may also survive for longer periods in some cases.

Treating infected birds is ineffective therefore monitoring and precautions are very important (Fitzgerald, 2009). Ultraviolet rays in sunlight are the best sterilizing agent, so the perching duck's general preference for shady conditions invites infection (Hillgarth & Kear, 1981). Cleaning of any hard surfaces within the enclosure with an appropriate disinfectant can also help to reduce contamination (e.g. Safe4 Disinfectant at 1:100 dilution, contact time 30 minutes).

Mycobacterium avium can be detected using faecal cultures (Fitzgerald, 2009) although the significance for clinical disease is questionable. For example – a bird may be infected but not shedding bacteria into the gut lumen thereby leading to a false negative result, or a different species of mycobacteria may be passing through the gut and lead to a false positive results for *M. avium* in some cases.

It is recommended to quarantine new birds and to test faecal cultures for Mycobacterium prior to introduction in an aviary (Fitzgerald, 2009). PCR testing of choanal and cloacal swabs for *M. avium* can also be carried out as part of pre-screening procedures although the clinical relevance of some results can be difficult to determine.

Quarantine, re-testing, or euthanasia are recommended for faecal culture positive birds and the depopulation of the entire exhibit is necessary if infection spreads to multiple birds. Control of exposure to wild birds and their faeces is critical, as wild birds are an endemic reservoir (Fitzgerald, 2009). Blood samples can also be taken to assess the leucogram which can also provide information related to whether a bird is suffering from mycobacteriosis. Because of the long-term environmental persistence of the tubercle bacilli, additional bird use of the site should be avoided for approximately 2 years. Vegetation removal and turning of the soil several times during this period will facilitate sunlight-induced environmental decay of the bacilli (Milton & Roffe, 1999). Another option is to remove the surface substrate, allow sunlight to sterilize the surface, and replace with clean topsoil which allow the use of the exhibit after approximately 6 months. Hard surfaces in the exhibit should also be cleaned using an

appropriate disinfectant to reduce contamination (e.g. Safe4 Disinfectant at 1:100 dilution, contact time 30 minutes).

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Some recommendations to deal with avian TB issue (Foote, 2023):

- Aviaries should be heavily perched to encourage birds off the ground and reduce mycobacterium exposure (strategy based on their tree-nesting ecology). Accordingly, pinioning (surgical flight restriction) should continue to be limited.

- Water features should be designed to reduce soil, faecal, and detritus particle loads, and come from either well, filtered, or other non-surface water sources.

- The soil of the pen should be replaced frequently for small aviaries (Mackenzie & Kear, 1976).

- Creating alkaline soil with lime has been shown to reduce avian TB loads, though the duration of effectiveness after such treatments is unknown (Riggs, 2005). This is a process that cannot be carried out with birds in situ and will also harm vegetation so is best to carry out if an exhibit has been emptied for another reason. It can also be used if depopulation of an exhibit has had to be carried out if mycobacteriosis has been diagnosed.

- High standards of hygiene need to be maintained and particular attention should be paid to possible contamination from wardens' footwear, crates, feed barrows and so on (Cromie et al., 1992). Keeping equipment specific for the enclosure and providing a footbath or separate footwear for people inside the enclosure can help to reduce contamination.

If mycobacteriosis is suspected in an individual bird, the bird should be isolated from other individuals and repeated blood samples should be taken to allow assessment of changes in the leucogram. General anaesthesia, radiography and endoscopy can also be carried out to assess the shape of the liver and potential presence of mycobacterial lesions.

Differential diagnoses that can present in similar ways to mycobacteriosis include other bacterial diseases, amyloidosis and neoplasia so it is important for veterinarians to rule out other causes of symptoms as avian tuberculosis is incurable and any bird diagnosed with this disease will need to be euthanized.

For birds that have been in contact with a bird that has been diagnosed at post mortem examination with ATB, they should be isolated from birds that have not been exposed, and carefully monitored. As it may take several weeks or months for any symptoms to show, it is difficult to determine if a bird has been infected and it may be safer to consider all in-contact birds as potentially infected and not return them to clean groups.

2.8.2 Other diseases

Aspergillosis

Aspergillosis is a fungal disease caused by *Aspergillus fumigatus*. Clinical signs include respiratory compromise, weight loss, lethargy and anorexia. Lesions in the trachea or syrinx can lead to a change of "voice".

Aspergillus sp. spores are ubiquitous, but disease is often more likely in birds that are in a highly vegetated environment, have genetic susceptibility, are suffering from stress, or suffering from a concurrent disease. Diagnosis can be confirmed with blood tests and by endoscopy and visualization of aspergillus lesions (Kubiak 2021).

Treatment can be challenging with courses of antifungal medication and supportive care often being required for weeks or months. Treatment is usually more successful when the disease is caught early. In 75% of those EEP PME reports showing aspergillosis as the cause of death, the birds also had secondary ATB.

Bacterial diseases

Bacterial infections can affect the organs, leading to disease and reduced function of these systems. Depending on the causal agent and severity of infection prior to diagnosis, most bacterial infections can be treated using antibiotics. Culture and sensitivity samples should be taken when possible, to ensure that the correct antibiotic can be chosen for treatment.

Trauma

The WWD is a heavy duck and is not particularly manoeuvrable in flight, they can therefore be prone to traumatic injuries caused by collisions with structures in their aviaries. The females can also occasionally crush their own eggs and injure their ducklings leading to trauma issues. Leg injuries can also be caused due to trauma and these can sometimes take an extended period of treatment to heal and may lead to arthritis as the bird ages.

Fig: Accidental cause of death (© Leeuwarden)

Pododermatitis is also a frequent issue in these large ducks and can be due to incorrect substrate, trauma to the underside of the feet, infection or other causes. Treatment can be difficult and required over extended periods and it is often husbandry or environmental issues that must be adjusted before lesions will fully resolve.

Pneumonia

Due to their equatorial origins, there is a high incidence of pneumonia in very young perching ducks. Most pneumonia-like illnesses in young birds can be attributed to a combination of low temperatures and damp down or plumage. Floor and ceiling heating of the resting area will help prevent this condition in newly hatched birds (Hillgarth & Kear, 1981). Diagnosis is usually by assessment of respiratory signs during examination. Treatment with antibiotics can work well if started soon enough. If any ducklings are lost to respiratory diseases, samples and swabs should be taken at post-mortem examination for culture and sensitivity to ensure the correct antibiotic is used for treatment.

Miscellaneous

Organ failure, amyloidosis and neoplasia have also been documented as causes of death in WWD whose PME reports have been submitted to the EEP veterinary advisor. Amyloidosis is a condition that is usually seen secondary to a chronic disease condition such as ATB (Chen et al 2019). Neoplasia is also seen occasionally in this species.

Avian influenza

Highly pathogenic avian influenza (HPAI) is a disease that can affect all avian species – causing mass mortalities in some species and minor symptoms in others. In waterfowl collections, biosecurity is extremely important, including ensuring no contact between wild and captive birds and that keepers do

not spread fomites from external sources into bio secure exhibits. As the strains of avian influenza change, their pathogenicity for different species will also change so it is best to maintain high levels of biosecurity. Once an effective vaccine has been developed against the currently circulating strains of HPAI, then vaccination may also be considered as a method of protection for this species.

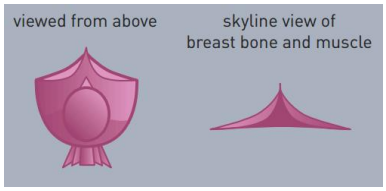
Fig: Swab for avian influenza tests : tracheal & cloacal. (© Branféré, 2025)

Other notable health problems (sometimes cause of death) surveyed in EAZA institutions: aspergillosis, clostridia, neoplasia, intestinal hernia, pododermatitis and visceral gout, hepatic and splenic bacterial infection, weight related limb issues or arthritis in old age (Best Practice Guidelines Questionnaire). Principal causes of death in current WWD population are diseases and health issues (avian TB, aspergillosis notably). Hatchling mortality accounts for 15% of all causes of death (Best Practice Guidelines Questionnaire).

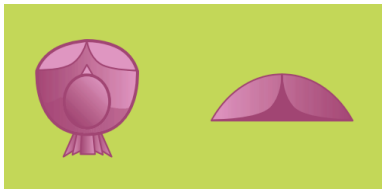
2.8.3. Routine veterinary procedures

Body condition scoring

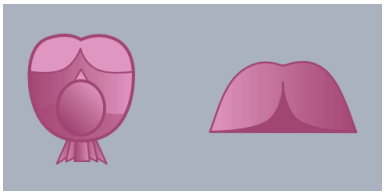
Each time a bird is caught in the hand, the body condition should be assessed and recorded. This is done by feeling for the keel and then running the fingers along the breast muscle on both sides and noting the muscle mass contour and the degree of prominence of the keel. Depending on the scoring system used, scores may range from 1-5 or 1-9. When using the 1-9 system, birds showing BCS 1/9 or 2/9 are likely to have an underlying medical issue, while BCS 8/9 or 9/9 are overconditioned - veterinary advice should be sought in these extreme cases.



Body condition score 1/9- emaciated



Body condition score 5/9 – ideal



Body condition score 9/9 – obese

Blood sampling

The primary site on a WWD to take a blood sample from is the medial metatarsal vein on the inside of the leg. It is also possible to obtain blood from the ulna vein on the underside of the wing, although this can be somewhat more challenging in these large birds under manual restraint. It is also possible to obtain a blood sample from the jugular vein but this is less easy to locate than the other options and therefore would not be recommended under normal circumstances. Blood samples should be placed into heparin tubes for both biochemistry and haematology as the use of EDTA can lead to haemolysis of red blood cells like in other birds (Joseph 1999).

The majority of institutions do not vaccinate their WWD population (70% of respondents to the Best Practice Guidelines Questionnaire). A quarter of respondents vaccinate ducks against avian influenza. One institution vaccinates WWD against Duck virus enteritis (DVE) and another against botulism.

As WWD are susceptible to DVE it is advisable to vaccinate them if they are held in either open topped exhibits or with access to facilities that may have been contaminated by wild waterfowl carrier species (e.g. mallards).

Most institutions implement a routine veterinary procedure (65% of respondents to the Best Practice Guidelines Questionnaire). It is advisable to realize preventive coprology tests and to apply anti-parasitic treatment/deworming twice a year (at least once a year). Physical checks should also be regularly done, and mixed waterfowl species should be particularly monitored. It is also important to balance regular checks with stress levels, as stress can reduce the immunity of birds to diseases such as ATB.

2.9. Recommended research

According to the Best Practice Guidelines Questionnaire, only a few institutions are involved in WWD-related research and/or conservation projects, but all EAZA members would be willing to participate in future research programs in relation to the WWD EEP Long-term Management Plan 2023 (Van Lint, 2023).

Genetic diversity

There are not many white-winged ducks kept in captivity. The main problem which occurs is inbreeding. For that reason, more research on the genetic value of the EAZA population is needed, such as the consequences of the low genetic diversity on the birds themselves (body condition, health, breeding success).

In fact, the entire current captive population is descended from fewer than ten founders collected in 1969-1970 in Assam (northern India) (Cook, 2016; Tomlinson et al. 1991). According to Foote (2023), without the addition of captive European ducks, the North American captive white-winged duck population will be extinct by 2027. The genome-wide diversity for the species is extremely low (with more homozygosity and less major histocompatibility complex diversity than wild), with an expected decline in genetic diversity over time in captive birds (Foote, 2023; Tomlinson et al., 1991). This may be explained because of the high levels of inbreeding and bottlenecking in the population which have occurred since the importation of the wild individuals.

The deleterious effects of inbreeding may not be evident in white-winged ducks if the founders come from small, isolated populations or from populations that have already suffered a bottleneck. In this case, deleterious alleles may have been eliminated by inbreeding prior to capture (Tomlinson et al., 1991). The wild Southeast Asian population has shown a steady decline that started well before the last glacial maximum and subsequent sea-level rise. Rather, it seems that long-term environmental changes have acted in conjunction with anthropogenic effects, leading to the current conservation crisis for this species (Foote, 2023).

Collection of new wild individuals is advocated to increase genetic diversity. However, understanding genetic diversity in the wild is crucial to the sampling design of a captive breeding program. Due to their shy nature and IUCN Endangered status, there is nothing known about the genetic differences across their range. The visible phenotypic variation in the amount of white plumage on the head, and the “high white” plumage phenotype more common in the lower latitudes, specifically Indonesia and Malaysia, suggest possible genetic differentiation across the species range (Holmes, 1977; Mackenzie, 1990). Strong evidence of genetic differentiation was found among captive (from India) and wild populations from Indonesia, suggesting substantial genetic differentiation among populations in their wild range (Foote, 2023). Wild-captured individuals from Indonesia harboured a low level of genetic diversity. As a non-migratory, semi-social species of waterfowl, the white-winged duck most likely has strong differentiation between populations throughout its range (Foote, 2023).

According to the study of Tomlinson et al. (1991), in order to assess the minimum viable population size required to maintain a population with 90% heterozygosity retained for 200 years, ideally 20 genetically effective founders are needed and a realistic minimum population size of 500 to 600 individuals. It is also recommended to increase the ratio between the size of the actual population and that of the census population, to take into account the geographical origins of the founders and, if possible, to vary them in order to sample a greater number of rare alleles. Finally, a strong correlation was

observed between inbreeding levels and lifespan, arguing for improving the genetic diversity of captive-bred birds (Foote, 2023).

Avian tuberculosis

As previously described in chapter 2.8.1, it has been suggested that the high incidence of mycobacteriosis in captive white-winged ducks could be explained by evolutionary and genetic characteristics of these species (Cromie et al., 1991; Hillgarth & Kear, 1981). However, despite its similar habits and common presence at zoos and waterfowl collections, there are few reports of mycobacteriosis in Muscovy ducks. The disseminated nature of the disease, the high concentration of mycobacteria and the absence of multinucleated giant cells in the lesions suggest that white-winged ducks were unable to kill the mycobacteria effectively, and point to a possible defect or inhibition of cell-mediated immunity (Saggese et al., 2007). The study hypothesized that the minimal heterozygosis previously shown in these ducks could be contributing to an apparently ineffective immune response.

According to the authors, mycobacterial infections are the most significant factor limiting the *ex-situ* recovery of this species. They recommend improving the genetic diversity of the captive breeding population, as well as a scientifically managed breeding program to maintain genetic diversity and improve breeding protocols that mitigate exposure to avian tuberculosis (Foote, 2023; Saggese et al., 2007). As this is impacting on the feasibility of an insurance population and could be a risk for any reintroduction potential, research into best breeding practices for avian tuberculosis is also one of EAZA's priorities (Van Lint, 2023). All institutions are strongly encouraged to share their post-mortem reports with the EEP coordinator and veterinary advisor, and include detailed data on the type of exhibit (covered vs not covered), exhibit mates, substrate etc. In addition, further guidance is needed on how to increase the reliability of avian TB testing and how to manage diagnosed birds (Van Lint, 2023).

Reproduction and aggressive behaviour

Future research could focus on factors linked to reproductive success. Additionally, developing management experiments with different social structures (mixing several pairs, 1 male with an adult female and her female offspring from the year before, etc.) would enable us to better understand the stability of these groups and the parameters that favour reproduction and the natural rearing of young (by limiting aggressive behaviour towards chicks, for example). Better understanding of the use of the nest boxes could be also helpful for *in-situ* applications; further research is needed (Van Lint, 2023).

Further studies need to be carried out to better understand the factors leading to possible intra/interspecific aggressive behaviour, with a view to improving WWD management in multi-species aviaries and developing its presence in captivity. The increase in the number of institutions will encourage the creation of new breeding pairs and a better genetic mix, which is already impoverished.

Research Husbandry

To support the development and maintenance of Best Practice Guidelines, research is needed on several husbandry topics (Van Lint, 2023):

- Link between infanticide and aviary design
- Bumble foot in relation to different exhibit substrates, pictures of feet should be taken whenever a bird is captured.
- Welfare assessments: winter enclosures, how does the presence or absence affect the welfare/survival of birds?
- General knowledge of management and design of facilities in comparison between different institutions.

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List of species that have previously shared their enclosure with white-winged ducks (based on Best Practice Guidelines Questionnaire). Please note this list is not definitive and does not mention the exhibit size. We should also mention the fact that some species considered incompatible in certain institutions are nevertheless present in other collections (See more in chapter 2.3.3. Sharing Enclosure with Other Species).

Common name	Taxonomic name and family	Problems associated with mix	Species considered as non compatible
Anseriformes			
Laysan teal	*Anas laysanensis* (Anatidae)	Agonistic behaviours against Anatidae species have been observed, particularly towards Anas species. The other duck species that should be mixed with the White-winged ducks should be fully winged and faster than them. During breeding	Spectacled duck _ *Speculanas specularis* (Anatidae) Chloephaga species (Anatidae) Pateke _ *Anas chlorotis* (Anatidae) Black swan _ *Cygnus atratus* (Anatidae) Muscovy duck _ *Cairina moschata* (Anatidae) Cape Barren goose _ *Cereopsis novaehollandiae* (Anatidae) Other large Anatidae For some institutions all waterfowl species are considered as non-compatible especially during White-winged duck breeding season.
Common teal	*Anas crecca* (Anatidae)		
Grey teal	*Anas gracilis* (Anatidae)		
Sunda Teal	*Anas gibberifrons* (Anatidae)		
Indian spot-billed duck	*Anas poecilorhyncha* (Anatidae)		
Marbled teal	*Marmaronetta angustirostris* (Anatidae)		
Baer's pochard	*Aythya baeri* (Anatidae)		
Scaly sided merganser	*Mergus squamatus* (Anatidae)		
Red breasted Merganser	*Mergus serrator* (Anatidae)		
Hooded merganser	*Lophodytes cucullatus* (Anatidae)		
Black-bellied whistling duck	*Dendrocygna autumnalis* (Anatidae)		
Lesser Whistling Duck	*Dendrocygna javanica* (Anatidae)		
White faced whistling duck	*Dendrocygna viduata* (Anatidae)		
Mandarin duck	*Aix galericulata* (Anatidae)		
Northern shoveler	*Spatula clypeata* (Anatidae)		
Smew	*Mergellus albellus* (Anatidae)		
Common shelduck	*Tadorna tadorna* (Anatidae)		
Comb duck	*Sarkidiornis sylvicola* (Anatidae)		
Hawaiian goose	*Branta sandvicensis* (Anatidae)		
Bar-headed goose	*Anser indicus* (Anatidae)		
Swan goose	*Anser cygnoides* (Anatidae)		
Magpie goose	*Anseranas semipalmata* (Anseranatidae)		
Chauna and Anhima species	family Anhimidae		
Oxyura species	family Anatidae		
Cygnus species	family Anatidae		
Mareca species	family Anatidae		

		season, males can become aggressive. Some institutions only keep pairs of white-winged ducks in mixed groups outside the breeding season. Outside the breeding season they are considered as very rarely aggressive unless you have other territorial aggressive species like sheldgeese, shelduck or bronzewings species.	
Passeriformes			
Bali myna	*Leucopsar rothschildi* (Sturnidae)	Ducks can have a tendency to drag passerines into the water (passerines have been found drowned or half-eaten in ponds according to	
Asian glossy starling	*Aplonis panayensis* (Sturnidae)		
Bank myna	*Acridotheres ginginianus* (Sturnidae)		
Crested myna	*Acridotheres cristatellus* (Sturnidae)		
Common hill myna	*Gracula religiosa* (Sturnidae)		
Rosy starling	*Pastor roseus* (Sturnidae)		
Brahminy Starling	*Sturnia pagodarum* (Sturnidae)		
Asian pied starling	*Gracupica contra* (Sturnidae)		
white-rumped shama	*Copsychus malabaricus* (Muscicapidae)		
Red-billed leiothrix	*Leiothrix lutea* (Leiothrichidae)		
White-crested laughing thrush	*Garrulax leucolophus* (Leiothrichidae)		
Red whiskered bulbul	*Pycnonotus jocosus* (Pycnonotidae)		
Greater racket-tailed drongo	*Dicrurus paradiseus* (Dicruridae)		
Javan green magpie	*Cissa thalassina* (Corvidae)		
Red-billed blue magpie	*Urocissa erythroryncha* (Corvidae)		

Black-naped oriole	*Oriolus chinensis* (Oriolidae)	an institution).	
Black-breasted thrush	*Turdus dissimilis* (Turdidae)		
Java Sparrow	*Lonchura oryzivora* (Estrildidae)		
Columbiformes			
Pink pigeon	*Nesoenas mayeri* (Columbidae)		
Nicobar pigeon	*Caloenas nicobarica* (Columbidae)		
Pied imperial pigeon	*Ducula bicolor* (Columbidae)		
Elegant imperial pigeon	*Ducula concinna* (Columbidae)		
Pink-headed imperial pigeon	*Ducula rosacea* (Columbidae)		
Green Imperial Pigeon	*Ducula aenea* (Columbidae)		
White-naped pheasant-pigeon	*Otidiphaps aruensis* (Columbidae)		
Western crowned pigeon	*Goura cristata* (Columbidae)		
Victoria crowned pigeon	*Goura victoria* (Columbidae)		
Pink-necked green pigeon	*Treron vernans* (Columbidae)		
Cinnamon Ground Dove	*Gallicolumba rufigula* (Columbidae)		
Common Emerald Dove	*Chalcophaps indica* (Columbidae)		
Galliformes			
Edwards's pheasant	*Lophura edwardsi* (Phasianidae)		Pheasants considered as non-compatible by some keepers
Crested partridge	*Rollulus rouloul* (Phasianidae)		
Cochin-chinese red jungle fowl	*Gallus gallus gallus* (Phasianidae)		
Grey junglefowl	*Gallus sonneratii* (Phasianidae)		
Germain's peacock-pheasant	*Polyplectron germaini* (Phasianidae)		
Grey peacock-pheasant	*Polyplectron bicalcaratum* (Phasianidae)		
Golden pheasant	*Chrysolophus pictus* (Phasianidae)		
Great argus	*Argusianus argus* (Phasianidae)		
Green peafowl	*Pavo muticus* (Phasianidae)		
Pelecaniformes			
Scarlet Ibis	*Eudocimus ruber* (Threskiornithidae)		Roseate spoonbill - *Platalea ajaja* (Threskiornithidae)
Red ibis	*Eudocimus ruber* (Threskiornithidae)		
Puna ibis	*Plegadis ridgwayi* (Threskiornithidae)		
Eurasian Spoonbill	*Platalea leucorodia* (Threskiornithidae)		
Roseate spoonbill	*Platalea ajaja* (Threskiornithidae)		
Black-faced spoonbill	*Platalea minor* (Threskiornithidae)		
Little egret	*Egretta garzeta* (Ardeidae)		
Cattle egret	*Bubulcus ibis* (Ardeidae)		
Black-crowned night heron	*Nycticorax nycticorax* (Ardeidae)		
Rufous night heron	*Nycticorax caledonicus* (Ardeidae)		
Night herons species	family Ardeidae		
Purple herons	*Ardea purpurea* (Ardeidae)		
Javan pond heron	*Ardeola speciosa* (Ardeidae)		
Spot-billed pelican	*Pelecanus philippensis* (Pelecanidae)		
Australian pelican	*Pelecanus conspicillatus* (Pelecanidae)		
Ciconiiformes			
Milky stork	*Mycteria cinerea* (Ciconiidae)		
Painted stork	*Mycteria leucocephala* (Ciconiidae)		
White stork	*Ciconia ciconia* (Ciconiidae)		
Wooly necked storks	*Ciconia episcopus* (Ciconiidae)		
Black-necked stork	*Ephippiorhynchus asiaticus* (Ciconiidae)		
Lesser adjutant	*Leptoptilos javanicus* (Ciconiidae)		
Gruiformes			

Red-crowned crane	*Grus japonensis* (Gruidae)		
Stanley crane	*Anthropoides paradiseus* (Gruidae)		
Demoiselle Crane	*Grus virgo* (Gruidae)		
White naped crane	*Antigone vipio* (Gruidae)		
Grey-headed swamphen	*Porphyrio poliocephalus* (Rallidae)		
Psittaciformes			
Red-crowned amazon	*Amazona viridigenalis* (Psittacidae)		
Hyacinth macaw	*Anodorhynchus hyacinthinus* (Psittacidae)		
Plum-headed parakeet	*Psittacula cyanocephala* (Psittaculidae)		
Rose-ringed parakeet	*Psittacula krameri* (Psittaculidae)		
Bucerotiformes			
Papuan hornbill	*Rhyticeros plicatus* (Bucerotidae)		
Luzon hornbill	*Penelopides manillae* (Bucerotidae)		
Oriental-pied hornbill	*Anthracoceros albirostris* (Bucerotidae)		
Other birds			
White collared kingfisher	*Todiramphus chloris* (Alcedinidae)		
Asian koel	*Eudynamys scolopaceus* (Cuculidae)		
Stone-curlew	*Burhinus oedicnemus* (Burhinidae)		
Masked lapwing	*Vanellus miles* (Charadriidae)		
Turaco species	family Musophagidae		
Mammals			
Rodrigues flying fox	*Pteropus rodricensis* (Pteropodidae)		
Reptiles			
Malaysian painted river terrapin	*Batagur borneoensis* (Geoemydidae)		