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# Free flight aviaries in EAZA zoos

*A pilot study to retrieve information about  
free flight aviaries in Dutch, Belgian and German  
EAZA zoos*

Steven van den Heuvel  
Kitty Ludwig



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This report is written in the scope of the EAZA bird TAGs  
Van Hall Larenstein  
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## Summary

To increase overall knowledge of housing, the experience of individual institutes needs to be shared with other zoos. To coordinate the exchange of knowledge on housing and husbandry between European zoos, the European Association of Zoos and Aquaria (EAZA), was formed in 1992. EAZA set up Taxon Advisory Groups (TAGs), these groups consist of people with a special expertise in taxonomical related species. Currently, there are 41 TAGs of which 15 TAGs are specialized in bird species. The bird TAGs indicate that EAZA members do not have access to an overview of recommendations regarding optimal housing of different bird species. To increase the exchange of holding birds in these enclosures and encourage zoos to use free-flight aviaries to house birds, this study on aviaries will concentrate on free-flight aviaries and walk-through aviaries.

The bird TAGs have the need for a database, which is accessible online for all EAZA zoos and shows the required information about free-flight aviaries. In order to obtain the required information about free-flight aviary design in a structured manner, Cathy King, chair, and Andrea Bracko, vice-chair, of the Ciconiiformes TAG have set up a questionnaire on behalf of the bird TAGs. A pilot study was conducted, focussed on twelve relevant free-flight aviaries, to provide insight on whether the questions of the questionnaire can be answered. Furthermore, the requirements of the database were listed to select the database software.

During the pilot study, 39% of the questions (n=102) were answered by visually observing the aviary, 45% was answered during the interview with the curator and 3% by using the information sent afterwards or calculating the answer. The results showed that 39% of the questionnaire can be filled in without consulting the curator or keeper, since the information is visible for observation. However, letting a student or intern retrieve these answers has different advantages. The remaining 61% of the questions need to be answered during an interview with the curator, because the questions focus on the management and experiences of the zoo. An interview of at least 60 minutes is advisable as the results show that significantly more information can be retrieved during a conversation of 60-90 minutes.

89% of the questions was answered for all 12 aviaries of the research. For the remaining 11% of the questions difficulties occurred while answering. Only the total costs of the aviary were found, but not divided into the three costs questions of the questionnaire. The questions of the costs should be combined to one cost question to retrieve more results. Next to the costs, the questions about the manufacturer, supplier and product name were difficult to answer because the information had to be retrieved through the technical department of the zoo. In order to retrieve the information for the other aviaries, both the curator and technical service of the zoo should be contacted and the questionnaire should be published online on an easy to find location.

The retrieved information about free-flight aviaries is stored in a Microsoft Access file. Microsoft Access was selected as database software, because it is easy to use, accessible, relatively cheap and provides a good basis that can also be used by other software. In order to expand the database and look for possibilities to combine the database with Microsoft Sharepoint, the EAZA office should be contacted. If the EAZA office choses to enlarge the project, it is possible to combine the database with other databases such as ZIMS or make a new website where all the information of the enclosures of different animal groups is placed.

## **Preface**

This research report, written by Steven van den Heuvel and Kitty Ludwig, is the thesis project for the study Animal Management at Van Hall Larenstein in Leeuwarden. This research was conducted on behalf of the bird TAGs of EAZA. We decided to focus our project on the free-flight aviary assignment of the TAGs because we wanted to learn more about the housing of birds and methods to improve the housing. Furthermore, the project highly focusses on the management of zoos, which is of great interest to us. We were excited to contribute to a project of EAZA, which will be used to improve the quality of future aviaries.

First we would like to thank our two supervisors, Ms Griede and Mr van Belle, for their effort in this project. When we were not sure if the right methods were used, they helped us to find a solution. Thanks for all your trouble and comments during this period.

For this study we met a lot of people. In name of the bird TAGs Cathy King and Andrea Bracko, the initiators, helped us during this research. When problems or ambiguities occurred with the questionnaire, they helped us and gave us advise. The presentation in Walsrode was the final peak for us, to present our results for so many interested people. Thank you very much!

As our IT- and database knowledge was not enough to set up a database, Erwin Moll, Michael Sullivan and William van Lint helped us to understand the database and showed us the possibilities that were available for a database.

Finally we would like to thank all the zoos that we have visited. We sometimes spent hours to find the right results and every curator and keeper was highly motivated and helpful to give us the right results.

Steven van den Heuvel and Kitty Ludwig  
Leeuwarden, 29 May 2012

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## 1. Introduction

In 2005 the World Zoo and Aquarium Conservation Strategy was published by the World Association of Zoos and Aquariums (WAZA) which summarises that zoos are prepared to contribute in conservation and highlights the importance of current zoo networks (WAZA, 2005). The strategy led to developments in the attitude of zoos towards conservation. These developments in conservation need to be accompanied by improvements concerning the housing of animals in zoos, as this affects the way visitors perceive the animals (Bell, 2001). Enclosures need to match better with the natural requirements and biology of the animals (Hutchins, 2003). In order to create such new enclosures, zoos continuously need to obtain up to date information about the housing of different species (Hosey, Melfi and Pankhurst, 2009).

To increase overall knowledge of housing and improve the quality, the experience of individual institutes needs to be shared with other zoos (Ebenhöh, 2002). Therefore cooperation between zoos is essential. To improve cooperation between European zoos, and coordinate the exchange of knowledge on housing and husbandry, the European Association of Zoos and Aquaria (EAZA), was formed in 1992. Nowadays, EAZA has more than 300 member institutions in 35 different countries. EAZA ensures that all members have and maintain the highest standard of care for and housing of their species. (EAZA, 2011)

EAZA set up Taxon Advisory Groups (TAGs), a group of people with a special expertise in a certain animal group with taxonomical related species. TAGs coordinate animal collection planning and breeding programs between individual member zoos, by developing Regional Collection Plans. These plans provide recommendations for zoos on which species to keep. Additionally, a TAG provides information on how zoos should take care of the species recommended in the Regional Collection Plan, by creating Husbandry Guidelines. Currently, there are 41 TAGs of which 15 TAGs are specialized in bird species. (EAZA<sup>1</sup>, 2011)

During a meeting at the 2011 Annual EAZA Conference in Montpellier the bird TAGs indicated that EAZA members do not have access to an overview of recommendations regarding optimal housing of different bird species. With this overview future breeding results should improve. (Griede, *Pers. Comm.*, 2012) Captive breeding is necessary to ensure a future captive population (Foeken, 2008) and, for some species, reintroduction into the wild (Snyder, 1996). Different studies on breeding problems of birds have been conducted (Jensen, 2006; Hoar, 2007; Potter, 2010), but only a few studies show the relation between housing and breeding (Carpenter, 1991; Blay, 2001). Furthermore, there are many studies related to optimal housing of bird species, without a relation to breeding (e.g. Benthem, 2002; Brown, 2005; Schoo, 2006). Information about optimal housing of birds can mainly be found in Husbandry Guidelines of about thirty different bird species (EAZA<sup>1</sup>, 2011). However, more exchange of information between zoos is needed to improve the housing in EAZA zoos (EAZA, 2010).

There are several ways to house birds in zoos, such as open outdoor exhibits, tropical houses and aviaries (Bell, 2001). This study will only concentrate on free-flight aviaries and walk-through aviaries, to increase the exchange of knowledge of holding birds in these enclosures and encourage zoos to use free-flight aviaries to house birds. The bird TAGs believe that currently many zoos do not have the technological information available, which makes building a free-flight aviary difficult. Open exhibits and tropical houses do not have the same issues. (King, *Pers. Comm.*, 2012)

Knowledge about keeping birds in free-flight aviaries is present (Willems, 1981; Hawkins, 2010), however the exchange of experiences between zoos needs to improve, which can be achieved through a database on the internet. A currently existing website with a

database on enclosure design, Zoolex (Zoolex, 2011), does not include a complete overview of aviary design. The bird TAGs have the need for a database, which is accessible online for all EAZA zoos and shows the required information about free-flight aviaries. In order to obtain the required information about free-flight aviary design in a structured manner, Cathy King, chair, and Andrea Bracko, vice-chair, of the Ciconiiformes TAG have set up a questionnaire (see appendix I) on behalf of the bird TAGs. However, it is still unclear to the bird TAGs if and in what way every question of the questionnaire can be answered and the information entered in a database. A pilot study was conducted, focussed on twelve relevant free-flight aviaries, to provide insight on whether the questions of the questionnaire can be answered. Furthermore, the requirements of the database were listed to select the best database software.

## **1.1 Requirements of the database**

Before an online database can be set up, an overview of the requirements is needed. With this overview the database software, in which the information will be stored, can be chosen and the design of the online database can be created. (*Moll, pers. comm., 2012*)

One of the main requirements is that the content of the database needs to be accessible over the internet, as it must be accessible without installing specific desktop database software. The EAZA office is currently working with Microsoft Sharepoint, a form of intranet, for their website. It will be convenient if the database software can be combined with Microsoft Sharepoint. (*Sullivan, pers. comm., 2012*) When using Microsoft Access as database software, it is possible to place it online using Microsoft Sharepoint (Microsoft corporation, 2011).

Moreover, the online database needs to be functional for the employees of member zoos of EAZA, such as the curator, head keeper and technical service. The users need to be able to search the database for relevant data using clear searching criteria (*King, pers. comm., 2012*). The searching criteria will filter out the aviaries that do not meet the criteria. From the list of aviaries, the user can select an aviary to get a total overview of that aviary. (*King<sup>2</sup>, pers. comm., 2012*)

The information regarding the aviaries should be listed short and clearly to prevent readers from losing their interest (appendix II shows an example)(Ebenhöh, 2002). The online database will contain a lot of different pages, therefore all the pages should have the same layout and use the same terms and names to increase the ease of use for readers. Furthermore, there needs to be possibility to publish pictures and figures. (*King, pers. comm., 2012*)

The internet server only needs to support a few people at once, since it is expected there will not be many users that consult the database at the same time (*King<sup>2</sup>, pers. comm., 2012*). Since the data will only contain information about free-flight aviaries of EAZA zoos, the database software will not require a large storage amount. (*Sullivan, Pers. Comm., 2012*).

The database software needs to be inexpensive, since the EAZA office does not have a budget available to buy new software (EAZA<sup>2</sup>, 2011). An employee of EAZA or bird TAG members, with little IT knowledge, should be able to make the modifications and enter the aviary information. (*Sullivan, pers. comm., 2012*)

## **1.2 Research goal**

The main goal of this study is to have insight in what manner and to what extent the data for the questionnaire<sup>1</sup> about free-flight aviaries, set up by the bird TAGs, can be retrieved. In addition, knowledge will be available on how to present the relevant information in such a way that this information can be made clear and easily accessible to curators and other relevant EAZA staff.

## **1.2 Research questions**

Main question:

How can the data, requested by the TAG about free-flight aviaries, be retrieved from selected EAZA zoos using the questionnaire and made accessible for EAZA zoos?

In order to answer the main question, it is divided into multiple sub questions.

- What part of the information desired about free-flight aviaries can be retrieved?
- How can the desired information about free-flight aviaries be retrieved?
- In what way should the retrieved information be presented?

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<sup>1</sup> Containing the following subjects; size, shape, used materials, construction and construction company, catching area, design, designer and costs of design, successful and unsuccessful kept species and problems of free-flight aviaries.



## 2. Materials and methods

### 2.1 Research population

For this study a try-out was adopted for sixteen selected aviaries in twelve EAZA zoos in the Netherlands, Belgium and Germany within travelling range (see table 1). The bird TAG selected the mixed species aviaries non randomly by taken different aspects into account, such as size, with a minimal of 200 square meters, shape and species.

**Table 1: Overview of the selected aviaries at different Dutch, Belgian and German EAZA zoos**

<b>Zoo</b>	<b>Aviary</b>
<b>Netherlands</b>	
Diergaarde Blijdorp, Rotterdam	Vultures rock
Diergaarde Blijdorp, Rotterdam	Birds of migration aviary
Diergaarde Blijdorp, Rotterdam	Ibis and parrot aviary
Dierenpark Emmen, Emmen	Americasa
Vogelpark Avifauna, Alphen aan den Rijn	Cuba aviary
Ouwehands Dierenpark, Rhenen	Urucu
Ouwehands Dierenpark, Rhenen	Free flight aviary
Gaiazoo, Kerkrade	South-America aviary
Dierenrijk, Mierlo	Vogelrijk
Artis, Amsterdam	Vulture aviary
<b>Belgium</b>	
Zoo Antwerpen, Antwerpen	Waterbird aviary
Paira Daiza, Cambron	Cathedral aviary
Paira Daiza, Cambron	Raptor aviary
<b>Germany</b>	
Allwetterzoo Münster	Large birds aviary
Naturzoo Rheine, Rheine	Walk-through aviary
Weltvogelpark Walsrode, Walsrode	Walk-through aviary

### 2.2 Methods

Information about the selected aviaries was collected by filling in the questionnaire during a visit at the zoo. The data needed to fill in the questionnaire, was expected to be collected using visual observation, making pictures of the aviary and by interviewing the person at the zoo that has access to information about the aviary. During every visit at the zoo, the (bird) curator was addressed first, because the curator could refer to someone with knowledge about the aviary. Generally, the documentation that was given by the curator consisted of the construction plans of the aviary and reports on the opening of the exhibit.

After three zoo visits, the questionnaire was adjusted. The adaptations to the questionnaire were implemented, in consultation with Cathy Kind and Andrea Bracko, to increase the ease of filling in the questionnaire when visiting the other zoos. Appendix III shows the adaptations that were implemented in the questionnaire.

The required information on types of digital databases was acquired by a literature study. The search engine and keywords are listed in the table below (table 2 and 3). Insight about the presentation of the required information was gained by consulting currently existing databases, which focus on exhibit design, such as Zoolex. Finally, a specialist on database

design, Erwin Moll and employees of the EAZA office, William van Lint and Michael Sullivan, were contacted, in order to gain more information on setting up a database and presenting data.

**Table 2: Data bases that were used for the literature study**

Google
Google Scholar
Green-i
WUR- library
Sam-hao catalogue

**Table 3: Keywords that were used for searching in the databases**

<b>Keyword</b>	<b>In combination with</b>
<b>Database</b>	Zoo
	Software
	Archive
	Enclosure design
	Exhibit design
	Aviary
	Access
	Digital
	Create
	Search criteria
	Organise data
	Present data
	Definition
	Building
	List of
	Accessible
<b>Types of databases</b>	

## 2.3 Data analysis

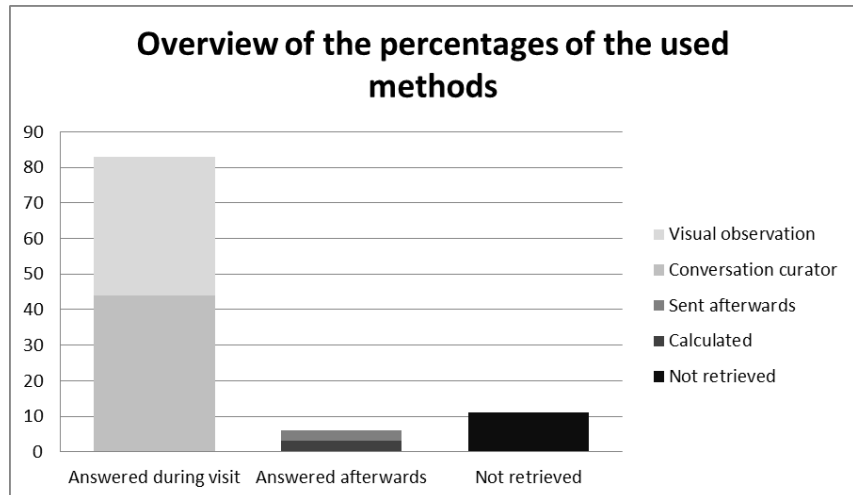
After data about aviary design was collected, an overview of the results was made to determine if all zoos could provide every item of the questionnaire and which methods were used to retrieve the information. This overview was analysed by categorizing the questions into groups, respectively husbandry, experience of het zoo and furnishing, design and materials of the aviary. The answers to the questions were also grouped into visible and non-visible.

Furthermore, all insights of the currently existing databases about exhibit design will be used to conclude how the data should be presented in the database. By analysing the results of the literary study about digital databases we will determine which database meets all requirements and should therefore be used to present the collected data.

### 3. Results

During the pilot study, twelve EAZA zoos were approached. With three of the contacted zoos it was not possible to make an appointment within the time frame of the study. Thus, the questionnaire was filled in for twelve different aviaries in nine EAZA zoos, seven in the Netherlands and one in Belgium and Germany each.

The questionnaire (n=102) was answered by visual observing the aviary (39%) and an interview with the curator (45%). The questions that were not answered during the interview or by visual observation, were answered afterwards using information that was sent by e-mail (3%). Another 3% of the questions were answered, by calculating the answer with information that was found during the visit at the zoo. It took up to six weeks to retrieve the answers that were calculated or sent afterwards. Figure 1 shows an overview of the used methods and their share of the total number of questions. The following paragraphs show detailed results of the data collection methods. Appendix IV contains a complete overview of methods used to answer the questions per zoo. To illustrate details of the aviary, pictures were made of the whole enclosure and some facts which were hard to describe through text, for example construction points, mesh, indoor enclosure and furnishing.



**Figure 1 - Overview of the percentages of the used methods divided into the questions that were answered during the visit or afterwards (n=102)**

#### 3.1 Visual observation

Visually observing the aviary was sufficient for 39% of the questions. Fifteen questions could be answered through visual observation for all aviaries. Box 1 shows subjects that represent these questions.

**Box 1: The subjects of the questions that were always answered by visual observation.**

Questions answered by visual observation:

- **Design**
  - Shape aviary
  - Placement main support structure
  - Interface net/mesh
  - Walk through
  - Barriers between visitor and animals
  - Special viewing features
  - Visitor doors
  - Visitor viewing indoor enclosure
- **Materials**
  - Material sides
  - Colour mesh
  - Configuration mesh
  - Visibility through mesh
- **Furnishing**
  - % water area
  - Substrates
  - Vegetation

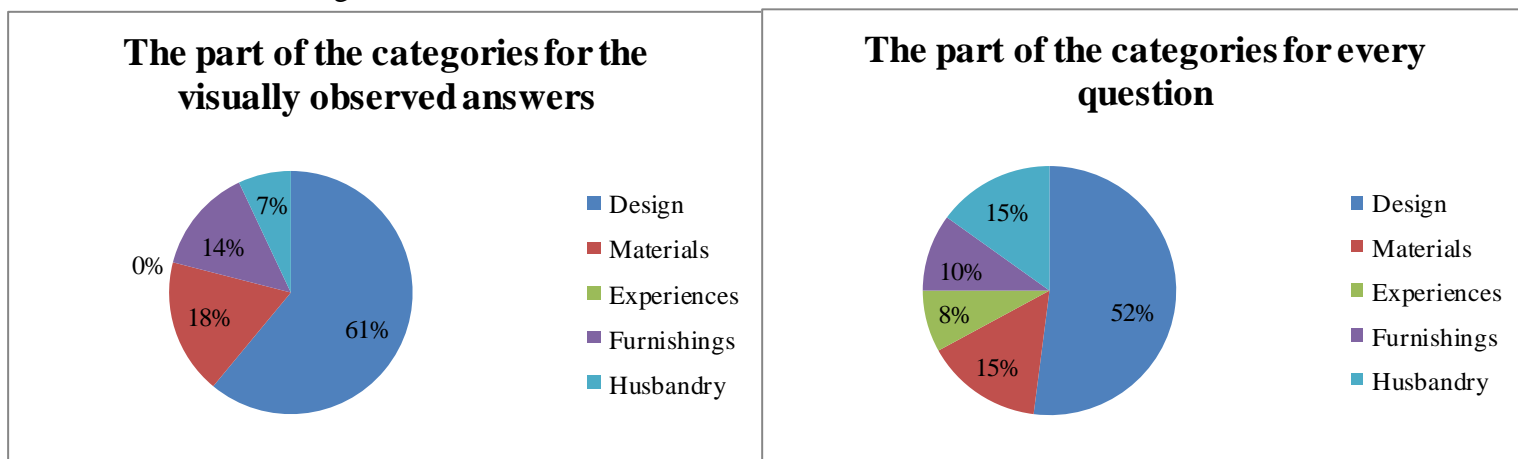
The subjects that were always answered by visual observation (see box 1) all focus on the design, furnishing and materials of the aviary, but none of the subjects is aimed at the experience of the curator or husbandry. The information to answer these questions was always visible. Every question that focuses on the zoo visitors was answered by visual observation.

In other cases, visual observation alone was insufficient to answer the question and the interview with the curator was required. These questions are mentioned in table 4.

**Table 4: The questions that required interviews for at least one of the aviaries (n=12).**

Question	Retrieved by visual observing	Retrieved during interview
<b>Design</b>		
Protection main support	75%	25%
Secondary supporting structures	83%	17%
Lowering top aviary	67%	33%
Mesh attached to aviary	92%	8%
Electric fencing	58%	42%
Different meshing along bottom	83%	17%
Plastic parameter	75%	25%
Access main aviary	58%	42%
<b>Materials</b>		
Material main support	67%	33%
<b>Husbandry</b>		
Supplemental lighting	83%	17%
Indoor enclosure attached	67%	33%

Most of the questions found in table 4 focus on the design of the aviary, a few are aimed at the materials and husbandry and again none of the questions focus on the experience of the zoo. Figure 2 shows the distribution of the questions based on the design, materials, experience, husbandry and furnishing, when distributed on all the questions (right) and on the questions answered through visual observation only (left). All the information used to answer the questions was visually visible, but with some aviaries the answers were checked with the curator during the interview.



**Figure 2: Distribution of the categories for the questions that were answered by visual observing the aviary (left) and the total distribution of the categories for all the questions of the questionnaire (right) (n = 72).**

### 3.2 Interview curator

The interview with the curator or head keeper was an important source of information for 45% of the questions were answered using this method. The questions that are mentioned in box 2 were always answered during the interview with the curator or head keeper. The questions are mainly focused on the husbandry and a few questions about the design and furnishing of the aviary. All of the questions concerning the experience of the zoo were answered during the interview. None of the questions were visually visible, with the exception of the question about the type of water.

**Box 2: The subjects of the questions that were for every aviary answered during the interview.**

Questions answered during the interview

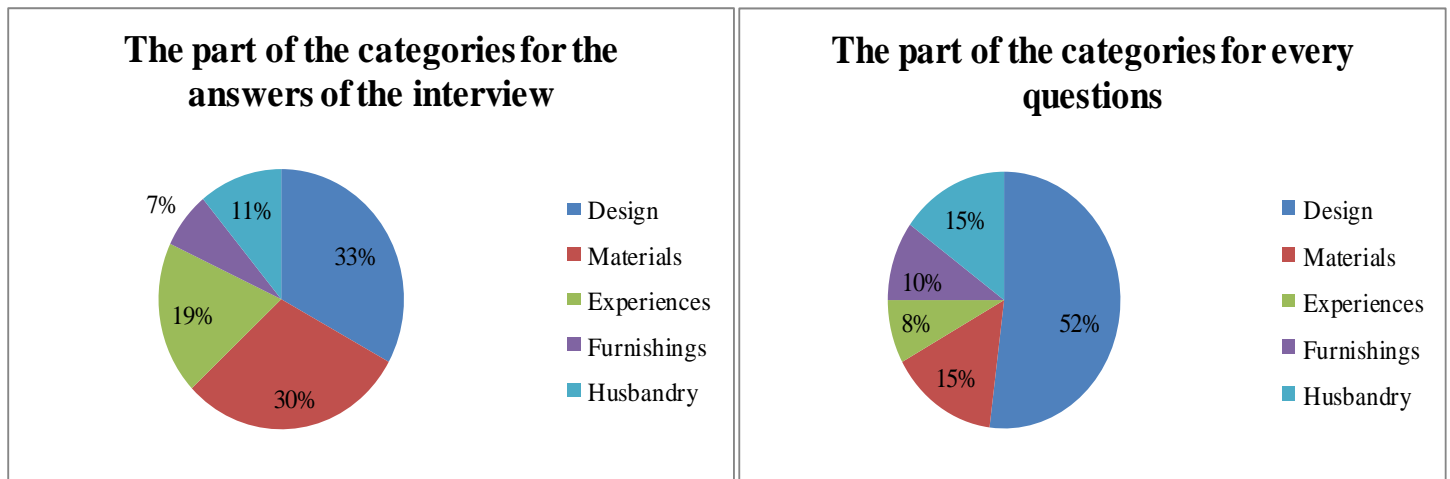
- **Design**
  - Constructor
  - Keeper entrance shared with animals
  - Ventilation indoor
- **Experience**
  - Problems
  - Dissatisfaction keeper/visitor
  - Reduce costs
- **Furnishing**
  - Type of water
- **Husbandry**
  - Frequency drainage water area
  - Depth of water
  - Water surface <20 cm
  - Number of nights and days indoor
  - Sunlight received indoor
  - Hours of artificial lighting indoor
  - Heating indoor

Table 5 shows the questions that were answered for more than six aviaries during the interview with the curator. The information to answer the questions about material mesh and opening size of the mesh is visually visible, but was still answered for most of the aviaries during the interview. The answers to these questions could only be estimated and had to be checked with the curator.

**Table 5: The subjects that were answered during a conversation in the zoo for more than six aviaries (n=12).**

<b>Subject</b>	<b>Retrieved by observing</b>	<b>Retrieved during interview</b>	<b>Sent afterwards</b>	<b>Not retrieved</b>
<b>Design</b>				
Opening year aviary	25%	67%	8%	
Service double doors/through building	42%	58%		
Door large furnishings	42%	58%		
Filtration system		92%	8%	
Concrete underground	33%	67%		
Access alternative aviary	42%	58%		
<b>Materials</b>				
Material mesh	42%	50%	8%	
Opening size mesh	25%	75%		
Water/UV resistance	25%	75%		
<b>Experience</b>				
Vegetation recommendation and problems		75%		25%
Species not held successfully and reason		75%	25%	
<b>Furnishing</b>				
Substrates indoor	16%	84%		
Water available indoor	33%	67%		
<b>Husbandry</b>				
Introduction area present	25%	75%		
Subdivide indoor enclosure	16%	84%		

Figure 3 shows the share of the questions that were answered through a conversation in the zoo and the total share of all the questions of the questionnaire. The graphs show that the questions about design were answered less often during the interview. The questions about the materials of the aviary were answered more often by consulting the curator.



**Figure 3: Distribution of the categories for the questions that were answered through a conversation in the zoo (left) and the total distribution of the categories for all the questions of the questionnaire (right) (n = 72).**

### 3.3 Information sent afterwards

A small percentage of the questions (3%) was answered using information that was sent by the curator after the visit. The list of species in the aviary was always sent afterwards in the form of an ARKS list. Since the ARKS list shows both present and past kept species, this information was not visually visible.

The information about the height of the aviary and the dimensions of the indoor enclosure was sent by the curator for most of the aviaries. Table 6 shows the methods that were used to answer the questions about the height and the indoor enclosure dimensions. All the information that was sent afterwards focuses on the design of the aviary.

**Table 6: The subjects that were answered via a mail that was sent afterwards for more than six aviaries (n=12).**

Subject	Retrieved by observing	Retrieved during interview	Sent afterwards	Calculated	Not retrieved
<b>Design</b>					
Height		25%	50%	25%	
Dimensions indoor enclosure		25%	58%	17%	

### 3.4 Answered using information that was given in the zoo

Three questions of the questionnaire (3%) had to be calculated using previously retrieved information. The information consisted of construction plans and answers of other questions of the questionnaire, such as the area and height. The volume of the aviary was answered for every aviary through a calculation, using the information about the area and height. The diameter of the meshing was also retrieved by calculation, using the opening size of the mesh, for every aviary.

For 50% of the aviaries, the area of the aviary had to be calculated using the construction plans. For 42% of the aviaries the information about the area had to be retrieved using the information that was sent afterwards and for one aviary (8%) the area was retrieved during the interview. Both the volume and the area of the aviary and the diameter of the mesh are not visually visible and focus on the design of the aviary.

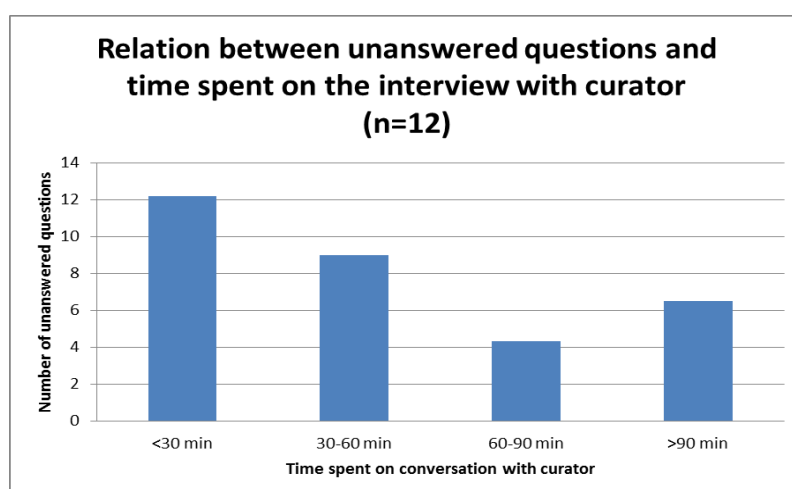
### 3.5 Unanswered questions

In total 89% of the questions were answered for every aviary. These questions were all answered using one of the previously mentioned methods. Eleven questions of the questionnaire showed problems with retrieving the answer. The question about the costs of the design and costs of maintenance were not answered for any of the aviaries. The question about costs of the materials and labour was not answered for 58% of the aviaries. The zoos could only retrieve the total costs of the aviary. The question about the product name was answered for one aviary. The questions about the supplier and manufacturer were not answered for 67% of the aviaries. Table 7 shows the questions that were hard to answer. The table also shows which methods were used when the questions were answered.

**Table 7: The subjects of the questionnaire that could not be retrieved for more than one aviary and the percentages of the methods when they were retrieved (n=12).**

Subject	Retrieved through the interview	Sent afterwards	Retrieved by calculating	Not retrieved
<b>Design</b>				
Height aviary	25%	25%	25%	25%
Constructor	83%			17%
Costs design				100%
Costs material and labour		42%		58%
Costs maintenance				100%
<b>Materials</b>				
Manufacturer	25%	8%		67%
Supplier	17%	17%		67%
Product name mesh		8%		92%
<b>Experience</b>				
Vegetation recommendation	75%			25%
Vegetation problems	75%			25%
<b>Husbandry</b>				
% Surface <20 cm	75%			25%

All of the answers to the questions mentioned in table 7 are not visually visible and none of the questions focus on the furnishing of the aviary. The number of not answered questions per aviary has a significant relation to the time that was spent talking to the curator (n = 12; p = 0,023). When the interview with the curator takes at least 60 minutes, most of the questions will be answered (see figure 4). There is no significant relation between the number of not answered questions per aviary and the opening year of the aviary (n = 12; P = 0,643 ; r = 0,15)



**Figure 4: The relation between the unanswered questions and the time spent on the interview with the curator (n = 12)**



### **3.6 Specific problems with the questionnaire**

When filling in the questionnaire, some questions presented difficulties, e.g. because there was not enough space to fill in the complete answer.

The questions about the lowering of the top, problems withstanding winds and predator protection inside the aviary was always answered negatively. There was no aviary that had the possibility of lowering the top, no problems with the aviary withstanding winds and none of the zoos use predator protection inside.

The questionnaire did not provide enough space to place the answers about the indoor enclosure and the barriers between the animal and visitor. The questionnaire only had space for one indoor enclosure, while most of the aviaries had more than one indoor enclosure. Further, some aviaries had more than one type of barrier between the animal and the visitor.

The aviaries that had no flat roof had multiple heights, however the questionnaire only provide room for one height. It is not clear if the maximum or average height should be filled in. The precise volume of the aviary and the shape of the roof were hard to retrieve for the irregularly shaped aviaries.

### **3.7 Database**

A literary study was carried out to retrieve the features of desktop and server databases. The literature resulted in the following facts about the two types of databases on the basis of the requirements mentioned in the introduction.

Desktop databases do not provide the possibility to storage large amounts of data. If a desktop database has too much data to process it will react much slower and when the database is placed on a website, the website will also operate slower. Server databases will not show this problem, because the large scalability lets the website grow without any problems with crashing. (Peterson, 2002; EUKhost LTD, 2012) In addition, desktop databases have problems with supporting several users simultaneously, which can result in an inaccessible database when more people use it. Server databases do not have any problems with supporting many users at the same time. (EUKhost LTD, 2012)

Desktop databases have less possibilities to create searching machines and other specific aspects. Server databases provide the possibility to create almost any kind of database with many aspects. (Chapple, 2012) However, server databases are more complicated to create than desktop databases since you have to work with Structured Query Language (SQL) in order to manage the data effectively (EUKhost LTD, 2012). When working with desktop databases it is not necessary to have a lot of knowledge about SQL, which makes them more user friendly (Chapple, 2012).

Server databases are more expensive to purchase than desktop databases, with costs up to €10.000,00 (Ianywhere solutions, 2006) in comparison to €350,00 of desktop databases (QuinStreet Inc., 2012). Table 8 sums up the characteristics of desktop and server databases.

The EAZA office is currently using Microsoft Sharepoint for the website. In order to spare costs, it would be ideal to place the database on the EAZA website. When using the desktop database Microsoft Access, it can easily be placed on the Microsoft Sharepoint server (Microsoft corporation, 2011).

**Table 8: Comparison of server and desktop databases looking at different criteria (Peterson, 2002; Microsoft corporation, 2011; Chapple, 2012)**

<b>Criteria</b>	<b>Desktop database</b>	<b>Server database</b>
<b>Costs</b>	Inexpensive (€70,00 - €350,00)	Expensive (€55,00 - €10.000,00)
<b>SQL* knowledge needed</b>	No	Yes
<b>Able to publish data online</b>	Yes	Yes
<b>Able to manage large amounts of data</b>	No	Yes
<b>Available to more users simultaneously</b>	No	Yes
<b>Possibility to combine with Sharepoint</b>	Yes	No
<b>Maximal storage amount</b>	4.000 GB	Unlimited
<b>Possibilities</b>	Small scale	Large scale
<b>Ease of use</b>	Easy and clear	Flexible but complicated

\* SQL: Structured Query Language, an international standard for database manipulation

For this pilot study, the questions and their answers were put in a desktop database, Microsoft Access. The tables that are used in the database are classified using the categories that were used for the questionnaire, such as dimensions, visitor viewing etc. There were a few answers that were difficult to enter into the database. The questions referring to the dimensions of the indoor enclosure were hard to present in the database, since each aviary had more than one indoor enclosure. Therefore, the total area of the indoor enclosure and the number of indoor enclosures were noted in the database. The interface between the netting and construction were hard to describe, so a picture is added which illustrates the interface.

Since the list of species that are held is a long list, there was a lot of room needed to place it in the database. Eventually, all the species were placed in the database with the sex ratio mentioned as well.

#### 4. Discussion

During the pilot study, insight was gained in which questions of the questionnaire could be answered and in what manner the information concerning free-flight aviaries could be found. 89% of the questions was answered for all twelve aviaries. The remaining eleven questions showed problems with answering. Two of these questions, about the costs of design and costs of maintenance, were not answered for any of the aviaries. Only the total costs of the aviary were retrieved for 42% of the aviaries, which was interpreted as costs of materials and labour. This result corresponds with the conclusions of Ebenhöh (2002), who concluded that information on the costs of enclosures is not always available and especially not divided in different parts. By combining the three questions about the costs, the question is better targeted on the information that the curator has at hand.

Next to the costs, the questions about the manufacturer, supplier and product name were difficult to answer. The answers to those questions could not be found for all the aviaries, because the information had to be retrieved through the technical department of the zoo. The bird TAG and some of the curators indicated that information about the manufacturer, supplier and product name are valuable when building new aviaries and therefore would be an important aspect of the questionnaire. In order to retrieve this information for aviaries of other EAZA zoos, both the curator and technical service of the zoo should be contacted. Moreover, the questionnaire should be published online on an easy to find location. So the curator can fill in the questions after building a new aviary when it is easier to retrieve the information.

The results show that 39% of the questionnaire can be filled in without consulting the curator, since the information is visible for observation. The curator can retrieve the same information, without the help of a student, but the involvement of an external person has advantages. This person can ask more targeted questions about the experiences and the curator only has to spend one appointment on the questionnaire. 61% of the questions could not be visually observed, because these questions focus on the management and experience of the zoo. A conversation with the curator was needed to answer the questions. A conversation of at least 60 minutes is advisable as the results show that significantly more information can be retrieved during a conversation of 60 to 90 minutes.

The bird TAGs need to be able to store data about different free-flight aviaries of EAZA zoos. A desktop database meets most of the requirements since the database does not need to store large amounts of data and support many users simultaneously. Moreover, the database needs to be easy to modify and low in costs. So the best option is to store the data in a desktop database and publish the database online.

The retrieved information about free-flight aviaries is stored in a Microsoft Access file. Microsoft Access was selected as database software, because it is easy to use, accessible, relatively cheap and provides a good basis that can also be used by other software. The database file still needs to be expanded with a searching machine and the final reports of every aviary need to be designed. As creating the database was not part of the research and IT knowledge is not a part of our study, this was not further taken into account and it takes time to finish the database. In order to expand the database and look for possibilities to combine the database with Microsoft Sharepoint, the EAZA office should be contacted.

As it is difficult to set up a whole website for a small group of interested people, as it is now for the birds, it could be helpful if other TAGs are interested in this database and want to join this project with information about other species exhibits to make the whole project larger (Sullivan, *pers. comm.*, 2012). If the EAZA office choses to enlarge the project, it is possible to combine the database with other databases such as ZIMS or make a new website where all the information of the enclosures of different animal groups is placed.

## **5. Conclusion**

For this research, the main question was if and how the questions of the questionnaire could be answered. No significant problems were encountered with regard to 89% of the questions of the questionnaire. The questions concerning manufacturer, supplier, product name and costs showed the largest problems with answering. Costs of design and costs of maintenance were not retrieved for any of the aviaries. 83% of the questions was answered during the visit of the zoo, by visual observing the aviary and an interview with the curator. 6% of the questions was answered using information that was sent afterwards or by calculating the answer.

For 39% of the questions, the knowledge of a curator is not necessary to answer the question. The remaining questions needed to be answered by consulting the curator. A meeting of 60 to 90 minutes is necessary to retrieve the most results. Therefore it can be said that the majority of the questions can be answered and that visual observation and an interview with the curator are the main ways of answering these questions.

The retrieved information about the aviaries can be presented in a desktop database which can be published online. It is advisable to see if other TAGs are interested in a similar database, as a larger platform provide more possibilities for a whole website about exhibit design or a combination with other databases.

## 6. Recommendations

### 6.1 General recommendations

As a result of the pilot study, the following general recommendations are formulated:

- The most effective way to retrieve the information of the remaining aviaries is to let a student or employee contact and interview the zoos.
- Also contact the technical department of the zoo for the information about the manufacturer, supplier, product name and costs.
- Publish the questionnaire online on the EAZA website to make it accessible for the zoos.

### 6.2 Recommendations database

The following actions are recommended to take regarding the database:

- Expand the Microsoft Access database and communicate with the EAZA office on how to publish it online using Microsoft Sharepoint.
- Discuss with the TAGs if other species should be added to the database, which can result in a whole website based on the experiences of housing animals in zoos.
- Create a searching machine using the recommended searching criteria mentioned in appendix V.

### 6.3 Recommended changes questionnaire

The following changes to the questionnaire are recommended as these questions showed problems when filling in the questionnaire:

- **Height:** Change the question to maximum height as an average height is difficult to calculate and does not provide more information.
- **Volume:** Delete the volume question as this question is often hard to calculate. Interested people can multiply height and square meters to have an estimation.
- **Shape top aviary:** Add an extra possibility to the drop down form with multiple shapes.
- **Lowering or removal top:** Change this question into: What is done to prevent snow problems? This question can be answered via a drop-down form with: Remove or lowering top, large mesh size on top, possibility to walk on the roof, strong materials used, other or nothing.
- **Product name:** Skip this question. With the material of the net and the supplier you can ask him at the possibilities. This question was difficult to find for most of the zoos.
- **Barriers between public and birds:** Give the possibility to fill in multiple barriers.
- **Electric fencing inside:** Skip this question as none of the zoos had predator protection inside the aviary.
- **Dimensions indoor enclosure:** Divide the questions into two questions; the total area of the indoor enclosures and number of indoor enclosures. Add a question about the average height of the enclosures.
- **Heavy winds or snow experienced:** Change the question from problems with aviary withstanding heavy winds or snow to problems with heavy winds or snow.
- **Costs:** Combine the three questions about the costs to one question about the total costs of the aviary.

## 7. Literature

### Books/articles

Bell, C.E., 2001. *Encyclopaedia of the World's Zoos; Volume I*. 1st ed. Chicago and London: Fitzroy Dearborn Publishers.

Bentham, van J., 2002. *Marabou stork Husbandry guidelines*. [pdf] Amsterdam: EAZA. Available at:

[http://www.eaza.net/member\\_area/TAGs/Ciconiiformes/Shared%20Documents/HG%20Marabou%20Stork%20\(Leptoptilos%20crumeniferus\)%202002.pdf](http://www.eaza.net/member_area/TAGs/Ciconiiformes/Shared%20Documents/HG%20Marabou%20Stork%20(Leptoptilos%20crumeniferus)%202002.pdf) [Accessed 11 January 2012]

Blay, N. and Côte, I.M., 2001. *Optimal conditions for breeding of captive humboldt penguins (Spheniscus humboldti): A survey of British zoos*. Zoo Biology, 20(6), p. 545-555.

Brown, C. and King, C., 2005. *Flamingo Husbandry Guidelines, a Joint Effort of the AZA and EAZA in Cooperation With WWT*. [pdf] Amsterdam: EAZA. Available at:

[http://www.eaza.net/member\\_area/TAGs/Ciconiiformes/Shared%20Documents/HG%20Flamingo%20\(Phoenicopteridae\)%202005.pdf](http://www.eaza.net/member_area/TAGs/Ciconiiformes/Shared%20Documents/HG%20Flamingo%20(Phoenicopteridae)%202005.pdf) [Accessed 11 January 2012]

Carpenter, J.W., Gabel, R.R. and Goodwin, J.G., 1991. *Captive breeding and reintroduction of the endangered masked bobwhite*. Zoo Biology, 10(6), p. 439-449.

EAZA, 2010. *Minutes of EAZA Ciconiiformes & Phoenicopteriformes TAG Meeting*. Verona, Italy 22 September 2010. EAZA.

Ebenhöh, M. 2000. *Improvements in Zoo Design by Internet-Based Exchange of Expertise*. [pdf] Available at: <http://www.zoolex.org/thesis/thesisA4.pdf> [Accessed 22 March 2012]

Foeken, S.G., Vries, de M., Hudson, E., Sheppard, C.D. and Dierenfeld, E.S., 2008. *Determining Nitrogen Requirements of Aceors and Buceros Hornbills*. Zoo Biology, 27, p. 282-293.

Hawkins, P., 2010. *The Welfare of Domestic Fowl and Other Captive Birds*. Animal Welfare, 9(1), p. 53-102.

Hoar, B.M., Whiteside, D.P., Ward, L., Inglis, G.D. and Morck, D.W., 2007. *Evaluation of the Enteric Microflora of Captive Whooping Cranes (Grus americana) and Sandhill Cranes (Grus canadensis)*. Zoo Biology, 27, p. 141-153.

Hosey, G., Melfi, V. and Pankhurst, S., 2009. *Zoo Animals, Behaviour, Management and Welfare*. 2nd ed. Oxford: Oxford University Press.

Hutchins, M. and Smith, B., 2003. *Characteristics of a world-class zoo or aquarium in the 21st century*. International Zoo Yearbook, 38(1), p. 130-141.

Jensen, T. and Durrant, B., 2006. *Assessment of Reproductive Status and Ovulation in Female Brown Kiwi (Apteryx mantelli) Using Fecal Steroids and Ovarian Follicle Size*. Zoo Biology, 25, p. 25-34.

Peterson, J.V., 2002. *Absolute Beginner's Guide to Databases*. 1st ed. Indiana: Que Publishing.

Potter, M.A., Hendriks, W.H., Lentle, R.G., Thomas, D.V., Minson, C.J. and Pindur, N.B., 2010. *Suitability of Diets Fed to a Flightless Insectivore, the North Island Brown Kiwi (Apteryx mantelli), in New Zealand*. Zoo Biology, 29, p. 537-550.

Schoo, W., 2006. *Husbandry guidelines for northern gannet (Morus bassanus)*. [pdf] Arnhem: Burgers' Zoo. Available at: [http://www.eaza.net/member\\_area/TAGs/Pelecaniformes/Shared%20Documents/HG%20Northern%20gannets%20\(Morus%20bassanus\)%202007.pdf](http://www.eaza.net/member_area/TAGs/Pelecaniformes/Shared%20Documents/HG%20Northern%20gannets%20(Morus%20bassanus)%202007.pdf) [Accessed on 11 January 2012]

Snyder, N.F.R., Derrickson, S.R., Beissinger, S.R., Wiley, J.W., Smith, T.B., Toone, W.D. and Miller, B, 1996. *Limitations of Captive Breeding in Endangered Species Recovery*. Conservation Biology, 10(2), p. 338-347.

WAZA, 2005. *Building a Future for Wildlife: The World Zoo and Aquarium Conservation Strategy*. 1st ed. Berne: World Association of Zoos and Aquariums.

Willems, J. , 1981. *Moderne dierentuinen in Nederland en België*. Inmerc bv.Wormer.

### Websites

Chapple, M., 2012. *Choosing a database for your organization*. [online] Available at: [http://databases.about.com/od/administration/a/choosing\\_a\\_db.htm](http://databases.about.com/od/administration/a/choosing_a_db.htm) [Accessed 2 March 2012]

EAZA, 2011. *About EAZA*. [online] Available at: <http://www.eaza.net/about/Pages/Introduction.aspx> [Accessed 16 November 2011]

EAZA<sup>1</sup>, 2011. *Taxon Advisory Groups (TAGs)*. [online] Available at: <http://www.eaza.net/activities/cp/Pages/TAGs.aspx> [Accessed 16 November 2011]

EAZA<sup>2</sup>, 2011. *Annual report 2010; European Association of Zoos and Aquaria*. [pdf] Amsterdam: EAZA. Available at: <http://www.eaza.net/about/About%20EAZA%20Documents/EAZA-AR2010.pdf> [Accessed 6 March 2012]

EUKhost LTD, 2012. *Desktop Database Programs vs. SQL Database Servers*. [online] Available at: <http://blog.eukhost.com/webhosting/desktop-database-programs-vs-sql-database-servers/> [Accessed on 6 March 2012]

Ianywhere solutions, 2006. *Advantage database server vs. Oracle vs. Microsoft Cost Comparison*. [pdf] Available at: [http://www.costguard.com/advantage/Advantage\\_vs%20Oracle\\_vs\\_Microsoft.pdf](http://www.costguard.com/advantage/Advantage_vs%20Oracle_vs_Microsoft.pdf) [ Accessed on 23 May 2012]

Jon Coe, 2007. *First view of the aviary*. [photograph] Available at: <http://www.zoolex.org/zoolexcgi/viewpicture.py?id=529&pic=0> [Accessed 5 December 2011]

Microsoft corporation, 2011. *Feature details*. [online] Available at: <http://sharepoint.microsoft.com/en-us/product/Pages/Feature-Details.aspx?Capability=Composites&FeatureID=4> [Accessed 2 March 2012]

QuinStreet Inc., 2012. *Desktop Database Buying Guide*. [online] Available at: <http://www.databasejournal.com/features/msaccess/desktop-database-buying-guide.html> [Accessed 23 May 2012]

Zoolex, 2011. *About Zoolex*. [online] Available at: <http://www.zoolex.org/about.html> [Accessed 16 December 2011]

### **Personal communication**

Griede T., 2012. *Accompanying discussion about the research proposal*. [Conversation] (Personal communication, 26 January 2012).

T. Griede, ex-situ docent at Van Hall Larenstein, Leeuwarden.

King, C., 2012. *Aviary project*. [e-mail] (Personal communication, 31 January 2012)

C. King, the chair of the Ciconiiformes and Phoenicopteriformes TAG.

King<sup>2</sup>, C., 2012. *Aviary project*. [e-mail] (Personal communication, 2 February 2012)

C. King, the chair of the Ciconiiformes and Phoenicopteriformes TAG.

Moll, E., 2012. *Conversation on database possibilities*. [conversation] (Personal communication, 17 February 2012)

E. Moll, database adviser and designer at Nazca IT Solutions B.V.

Sullivan, M., 2012. *Conversation on database possibilities*. [conversation] (Personal communication, 9 February 2012)

M. Sullivan, communication and membership manager of EAZA.



## Appendix I – Questionnaire

The questionnaire was generated in an Excel file with selection bars to select the right answer. In order to give the reader an overview of the questionnaire in Word, the selection bars needed to be removed and replaced with a dash possibility. The figure below is a copy of the adjusted questionnaire.



### Ciconiiformes and Phoenicopteriformes TAG

Name of Zoo \_\_\_\_\_  
 Name of respondent \_\_\_\_\_  
 E-mail address of respondent \_\_\_\_\_  
 Name of Exhibit \_\_\_\_\_  
 Opening Date/ Year \_\_\_\_\_

#### 1. DIMENSIONS

a) height in m \_\_\_\_\_  
 b) area in m<sup>2</sup> \_\_\_\_\_  
 c) volume in m<sup>3</sup> \_\_\_\_\_

#### 2. SHAPE

a) shape sides Round - oval - rectangular - square - L-shaped - irregular - other  
 b) shape of top Flat - doomed - peaks - multiple peaks - other

#### 3. CONSTRUCTION

##### Frame

1) placement main support structures Inside - parameter - arched - external - other  
 2) materials main support Untreated wooden poles - wooden poles treated with - live trees - metal specify type - other  
 3) special supports/protection for (a) interface net/mesh and main support (specify)  
(b) protection from main supports rotting in ground (specify )  
 4) secondary supporting structures Cables - beams - other  
 5) lowering of top when snow or severe winds expected possible Yes - No  
 6) constructor In-house - external company, specify

##### Material sides

1) solid (rock, brick wood etc) Number of sides \_\_\_\_\_  
 2) glass Number of sides \_\_\_\_\_  
 3) piano wire Number of sides \_\_\_\_\_  
 4) netting/mesh Number of sides \_\_\_\_\_  
 a) material Nylon - propylene - polyethelen - galvanized wire (before welding) -  
galvanized wire (after welding) - PVC coated wire - stainless steel - aluminum - other  
 b) name manufacturer \_\_\_\_\_  
 c) supplier \_\_\_\_\_  
 d) product name \_\_\_\_\_  
 e) opening size \_\_\_\_\_  
 f) diameter \_\_\_\_\_  
 g) color \_\_\_\_\_  
 h) configuration Woven - knotted - coiled - chain linked - other  
 i) how is netting/meshing attached to aviary structure? \_\_\_\_\_  
 j) visibility through net/mesh Excellent - satisfactory - unsatisfactory  
 k) water resistance Excellent - satisfactory - unsatisfactory  
 l) UV resistance Excellent - satisfactory - unsatisfactory

Material top		
1) Same as sides	Yes - No	If yes, continue to 4. Visitor viewing
2) Not same as sides		
	a) name manufacturer	
	b) supplier	
	c) name product	
	d) material	Nylon - proporpylene - polyethelen - galvanized wire (before welding) -
		galvanized wire (after welding) - PVC coated wire - stainless steel - aluminum - other
	e) configuration	Woven - knotted - coiled - chain linked - other
	f) opening size	
	g) diameter	
	h) color	
	i) water resistance	Excellent - satisfactory - unsatisfactory
	j) UV resistance	Excellent - satisfactory - unsatisfactory
4. VISITOR VIEWING		
a) walk through / walk in	Yes - No, specify number of sides visible to public	
b) barriers between public and birds	Netting/mesh - glass - rails - vegetation - water - other	
c) other special features to enhance viewing possibilities, specify		
5. ENTRANCES AND EXITS		
a) service	i. double doors with area between	Yes - no
	ii. through attached building	Yes - no
	iii: describe how large enclosure furnishings that are too large can be brought through the doors	
b) visitor	Single sliding door - single swinging door - double sliding door - double swing door - single plus curtain - double plus curtain	
c) curtains	None - flexible plastic strands - ropes - chains - pieces of bamboo	
6. WATER AREA		
a) % surface area water (versus land)		
b) frequency of drainage and cleaning		
c) type of water	Running - still	
d) filtration system	Yes, specify - no	
e) depth in cm	i. minimum	
	ii. maximum	
	iii. % surface area < 20 cm	
7. SUBSTRATES		
a) sand		% area
b) grass		% area
c) dirt		% area
d) rocks		% area
e) visitor path		% area
f) other		% area
8. VEGETATION		
a) grass/other herbacious plants < 20 cm high cover		% area
b) herbacious plants/shrubs 20 cm- 1m high cover		% area
c) herbacious plants/shrubs/trees 1 m-3 m high cover		% area
d) number of coniferous trees > 3 m high		
e) number of deciduous trees > 3 m high		
f) are there any plants you would recommend for aviaries?		
g) are there any plants that have been problematic in this aviary?		
9. PREDATOR PROTECTION		
a) electric fence inside	Yes - no	cm high
b) electric fence outside	Yes - no	cm high
c) different type meshing along bottom	Yes - no	cm high
d) plastic along perimeter	Yes - no	cm high
e) concrete under ground	Yes - no	cm deep
f) other (specify)		
10. SUPPLEMENTAL LIGHTING		
supplemental lighting outside	Yes - no	
11. PERMANENT INTRODUCTION/CATCHING AREA PRESENT		
Introduction and/or catching area present	Yes - no	

12. INDOOR ENCLOSURE	
a) attached to aviary	Yes - no
b) dimensions	i. length ii. width iii. Height
c) average number of nights used per year	
d) average number of days used per year	
e) direct access to main outside enclosure	Yes - no
f) direct access to alternative outdoor area	Yes - no
g) substrates (specify)	
h) usable water area present for bathing	Yes - no
i) possibility to subdivide area if need to	Yes - no
j) keeper access area not shared by birds	Yes - no
k) natural sunlight received	Yes - no
l) number of hours of artifical light	
m) heating supplied	No - heat lamps - standing radiators - heating in floors - heating in walls - combination, specify
n) please describe ventilation system	
o) visitor viewing	Yes - no

13. SPECIES	
a) species currently held (if possible also historically) list	
b) species not held successfully	
c) reason per species (please list species below)	i. escape ii. incompatibility iii. health issues iv. stress v. accidents (e.g. collisions) vi. other

14. PROBLEMS	
<b>Problems with:</b>	
a) Indigenous bird species entering enclosure	Yes, specify - no
b) Predation in enclosures	Yes, specify - no
c) Aviary withstanding winds experienced	Yes, specify - no
d) Aviary withstanding snow experienced	Yes, specify - no
e) Excessive mortality and or accidents with one or more species	Yes, specify - no
f) other health issues, e.g. foot lesions	Yes, specify - no
g) frequent replacement or repair of materials	Yes, specify - no
h) husbandry issues e.g. cleaning, heating, moving birds	Yes, specify - no

15. DISSATISFACTION	
a) Visitor	Yes, specify - no
b) Keeper	Yes, specify - no

16. COSTS (in EUR)	
a) Design	
b) Materials and labor	
c) Maintenance (e.g. replacement of netting etc.)	
d) Were there any choices made/possibilities to reduce costs?	

16. ENCLOSURE DATA SUBMISSION	
a) Contact person	
b) data submitted	

Figure 5: The final version of the aviary questionnaire, made by Andrea Bracko and Cathy King, used during the pilot study

## Appendix II – Database Lay-out

As all the aviaries will be mentioned in a database in the future, a possible lay-out of this database is showed in this appendix.

### Urucu

#### Ouwehands Dierenpark Rhenen

Opening year: 2001

Respondent: G. Meijer, curator

[gerard.meijer@ouwehand.nl](mailto:gerard.meijer@ouwehand.nl)



#### 1. Dimensions

Height: 12 m  
Area: 390 m<sup>2</sup>  
Volume: 3500 m<sup>3</sup>

#### 2. Shapes

Shape Sides: Oval  
Shape Top: Domed

#### 3. Construction

Placement main supporting structures:	Inside	
Materials main support:		Metal, steel
Special supports interface net and main support:		None
Protection from main supports rotting in ground:		Not available
Secondary supporting structures:		Beams
Lowering or removal of top possible:		No
Constructor:		In-house

#### 4a. Material sides

Material	Number of sides
Solid (rock, brick, wood)	0
Glass	1
Piano Wire	0
Netting/mesh	3

Material:	Galvanized wire
Name manufacturer:	Metaalbedrijf den Oudsten
Supplier:	-
Product name:	-
Opening size:	2x5 cm
Diameter:	5,4 cm
Colour:	Grey
Configuration:	Woven
How is netting/meshing attached to aviary:	Screw
Visibility through net/mesh:	Satisfactory
Water resistance:	Excellent
UV-resistance:	Excellent

#### 4b. Material top

Same as sides: Yes

#### 5. Visitor viewing

Walk-through/Walk-in: No, 3 sides  
Barriers between public and birds: Netting/mesh  
Other features to enhance viewing possibilities: Yes, Glass windows

#### 6. Entrances and Exits

Service  
Double doors with area between: No  
Through attached building: No  
How is large furnishing bringing in: Double doors where large furnishings can brought through.



Figure 1 - Overview of the aviary



Figure 2 - Walk through the aviary

Visitors  
Access: None  
Curtains: None

7. Water area  
% Water area (versus land): 10  
Frequency of drainage and cleaning: Once a week  
Type of water: Running  
Filtration system: Yes  
Depth in cm: min: 10 max: 80  
% < 20 cm: 30

#### 8. Substrates

Substrate	% of area
Sand	0
Grass	10
Dirt	30
Rocks	0
Visitor path	10
Others	20

#### 9. Vegetation

Type of vegetation	% of area
Grass/other herbaceous species <20 cm high	10
Herbaceous plants/shrubs 20 - 100 cm high	20
Herbaceous plants/shrubs/trees 1 - 3 m high	10

Number of coniferous trees >3 m: 0  
Number of deciduous trees >3 m: 3  
Recommended plants for aviary: -  
Problematic plants for aviary: -

#### 10. Predator protection

Electric fence inside: No  
Electric fence outside: No  
Different type meshing along bottom: No  
Plastic along perimeter: No  
Concrete underground: Yes

#### 11. Supplemental lighting

Supplemental lighting outside: Yes

#### 12. Introduction/catching area present

Permanent introduction/catching area present: No

#### 13. Indoor enclosure

Attached to aviary: Yes  
Number of enclosures: 3  
Area size: 20-35 m<sup>2</sup>  
Height: 3,5-6m  
Average number of night and days used per year: Nights: 365  
Days: 365  
Direct access to main outside enclosure: Yes  
Direct access to alternative outside enclosure: No  
Substrates: Wooden chips  
Usable water area present for bathing: Yes  
Possibility to subdivide area if need to: No  
Keepers access area not shared by birds: Yes  
Natural sunlight received: Yes  
Number of hours of artificial light: 12  
Heating supplied: No  
Please describe ventilation system: -  
Visitor viewing: Yes



Figure 3 - Interior of the aviary



Figure 4 - Attachment of meshing at the aviary



Figure 5 - Indoor enclosure

#### 14. Species

Currently held species and species hold in the past

Species name	Number of animals
Red Ibis	14.9.0
Spoonbill	0.3.0.
Macaw	6.6.0.

Species not held successfully

Species name	Reason not held successfully

#### 15. Problems

Indigenous bird species entering enclosure:	Yes, sparrows and blackbirds
Predation in enclosure:	No
Aviary withstanding winds experienced:	No
Aviary withstanding snow experienced:	No
Excessive mortality or accidents with species:	No
Other health issues:	No
Frequent replacement or repair of materials:	No
Husbandry issues:	No

#### 16. Dissatisfaction

Group	Dissatisfaction
Visitor	No
Keeper	Yes, difficult to get an overview of the animals

#### 17. Costs (in Euro)

Design: -

Materials and labor: -

Maintenance: -

Were there any choices made to reduce costs: -

## Appendix III – Implemented changes to aviary questionnaire

Table 8: Overview of the changes that were implemented to the aviary questionnaire. The second column shows how it is placed in the first version of the questionnaire and the third show how that subject is changed for the second version

Subject questionnaire	First version	Changed in second version
<b>Opening date</b>	Opening date	Opening date/year
<b>Construction</b>	Not present	5) Lowering or removal of top when snow or severe winds expected possible
<b>Construction</b>	Not present	6) Constructor
<b>Material sides</b>	Not present	c) Supplier
<b>Material top</b>	Not present	If yes, continue to 4. Visitor viewing b) Supplier
<b>Entrance and exits service</b>	Not present	Iii: please describe how you bring in large enclosure furnishings
<b>Entrance and exits visitors</b>	Choices: Double doors with area between Plastic strands as second door Ropes as second door Chains as second door Sliding doors Swinging doors	Choices: Single sliding door Single swinging door Double swing door with space between Double sliding door with space between Single door plus curtain Double door plus curtain
<b>Entrance and exits visitors</b>	Not present	c) Curtains
<b>Visitor viewing</b>	Visibility	Visitor viewing
<b>Visitor viewing</b>	Number of sides visible to public	Not present
<b>Visitor viewing</b>	Walk through or walk in aviary Choices: Yes No	Walk through or walk in aviary Choices: Yes No, specify number of sides visible to public
<b>Visitor viewing</b>	Barriers between public and birds Choices: Rails Vegetation Water Other	Barriers between public and birds Choices: Netting/mesh Glass Rails Vegetation Water Other
<b>Vegetation</b>	Not present	a) grass/herbaceous plants <20 cm b) herbaceous plants/shrubs 20cm-1m c) herbaceous plants/shrubs 1m-3m d) number of coniferous trees > 3m

		e) number of deciduous tree >3m f) are there any plants you would recommend for aviaries? g) are there any plants that have been problematic in this aviary?
<b>Permanent introduction and/or catching area present</b>	Additional area	Permanent introduction and/or catching area present
<b>Indoor enclosure</b>	Not present	m) heating supplied Choices: No Heat lamps Standing radiators Heating in floors Heating in walls Combination
<b>Indoor enclosure</b>	Not present	n) please describe ventilation system o) visitor viewing
<b>Problems</b>	Not present	f) other health issues, e.g. foot lesions g) frequent replacement or repair of materials h) husbandry issues e.g. cleaning, heating, moving birds
<b>Problems</b>	f) maintenance problems	Not present
<b>Enclosure data submission</b>	Not present	a) contact person b) date submitted



## Appendix IV – Method of retrieving per question

**Table 9: Overview of the methods used to retrieve each subject of the questionnaire. Meaning of numbers; 1 Observation, 2 Conversation curator, 3 Through the mail, 4 Calculated, 5 Not retrieved**

Question	Free flight aviary	Urucu	American Free flight aviary	Vogelrijk	Vulture aviary Blijdorp	Meadow bird aviary	Ibis aviary	Cuba aviary	Swamp aviary	South america aviary	Large bird aviary	Vulture aviary Artis
Opening year	2	2	2	2	1	1	1	3	2	2	2	2
Height	2	2	2	4	5	5	3	3	3	5	4	4
Area	4	4	4	4	3	3	3	3	2	3	4	4
Volume	4	4	4	4	4	4	4	4	4	4	4	4
Shape sides	1	1	1	1	1	1	1	1	1	1	1	1
Shape top	1	1	1	1	1	1	1	1	1	1	1	1
Placement main support	1	1	1	1	1	1	1	1	1	1	1	1
Material main support	2	1	2	1	1	1	1	2	1	1	2	1
Interface support and mesh	1	1	1	1	1	1	1	1	1	1	1	1
Protection main support	1	1	1	1	1	1	2	2	1	2	1	1
Secondary support structure	1	1	1	2	1	1	1	2	1	1	1	1
Lowering top	1	1	1	2	1	1	1	2	2	2	1	1
Constructor	2	2	2	2	5	2	5	2	2	2	2	2
Material sides	1	1	1	1	1	1	1	1	1	1	1	1
Material mesh*	1	2	2	3	1	1	1	2	1	2	2	2
Manufacturer*	2	2	5	3	5	5	5	5	5	2	5	5
Supplier*	2	2	5	3	5	5	5	5	5	3	5	5
Product name*	5	5	5	5	5	5	5	5	5	3	5	5
Opening size*	2	2	2	2	1	1	1	2	2	2	2	2
Diameter*	4	4	4	4	4	4	4	4	4	4	4	4

Colour mesh*	1	1	1	1	1	1	1	1	1	1	1	1
Configuration*	1	1	1	1	1	1	1	1	1	1	1	1
Mesh attached aviary*	1	1	1	2	1	1	1	1	1	1	1	1
Visibility mesh	1	1	1	1	1	1	1	1	1	1	1	1
Water resistance*	2	2	2	2	1	1	1	2	2	2	2	2
UV resistance*	2	2	2	2	1	1	1	2	2	2	2	2
Walkthrough	1	1	1	1	1	1	1	1	1	1	1	1
Barriers visitor animal	1	1	1	1	1	1	1	1	1	1	1	1
Special viewing features	1	1	1	1	1	1	1	1	1	1	1	1
Service double doors	2	1	2	2	1	1	1	2	1	2	2	2
Service through building	2	1	2	2	1	1	1	2	1	2	2	2
Large furnishing	1	1	2	2	1	1	1	2	2	2	2	2
Visitor door	1	1	1	1	1	1	1	1	1	1	1	1
Curtains visitor door	1	1	1	1	1	1	1	1	1	1	1	1
% Water area	1	1	1	1	1	1	1	1	1	1	1	1
Frequency drainage	2	2	2	2	2	2	2	2	2	2	2	2
Type of water	2	2	2	2	2	2	2	2	2	2	2	2
Filtration system	2	2	2	2	2	2	2	2	3	2	2	2
Depth in cm	2	2	2	2	2	2	2	2	2	2	2	2
Surface <20 cm	2	2	2	2	5	5	5	2	2	2	2	2
Substrates **	1	1	1	1	1	1	1	1	1	1	1	1
Vegetation***	1	1	1	1	1	1	1	1	1	1	1	1
Vegetation recommendation	2	2	2	2	5	5	5	2	2	2	2	2
Vegetation problems	2	2	2	2	5	5	5	2	2	2	2	2

Electric fencing	2	1	1	2	1	1	1	2	1	2	2	1
Different meshing	1	1	1	2	1	1	1	2	1	1	1	1
Plastic parameter	1	1	2	2	1	1	1	2	1	1	1	1
Concrete underground	2	2	2	2	1	1	1	2	2	2	2	1
Supplemental lighting	1	1	1	2	1	1	1	2	1	1	1	1
Introduction area present	2	2	2	2	1	1	1	2	2	2	2	2
Indoor enclosure attached	1	1	1	2	1	1	1	2	1	2	1	2
Dimensions indoor	2	2	4	4	3	3	3	3	3	3	3	2
Number of nights indoor	2	2	2	2	2	2	2	2	2	2	2	2
Number of days indoor	2	2	2	2	2	2	2	2	2	2	2	2
Access main aviary	1	1	1	2	2	1	1	1	2	2	1	2
Access alternative aviary	2	2	2	2	2	1	1	1	2	2	1	1
Substrates indoor	1	1	2	2	2	1	1	2	2	1	2	1
Water available	2	1	2	2	2	1	1	2	2	2	2	1
Subdivide indoor enclosure	1	1	2	2	2	1	1	2	2	1	2	1
Keeper entrance shared	2	2	2	2	2	2	2	2	2	2	2	2
Sunlight received	2	2	2	2	2	2	2	2	2	2	2	2
Hours artificial light	2	2	2	2	2	2	2	2	2	2	2	2

Heating indoor	2	2	2	2	2	2	2	2	2	2	2	2
Ventilation indoor	2	2	2	2	2	2	2	2	2	2	2	2
Visitor viewing indoor	1	1	1	1	1	1	1	1	1	1	1	1
Species held	3	3	3	3	3	3	3	3	3	3	3	2
Species not held successfully	2	2	2	2	3	3	3	2	2	2	2	2
Reason per species	2	2	2	2	3	3	3	2	2	2	2	2
Problems *****	2	2	2	2	3	3	3	2	2	2	2	2
Dissatisfaction visitor	2	2	2	2	2	2	2	2	2	2	2	2
Dissatisfaction keeper	2	2	2	2	2	2	2	2	2	2	2	2
Costs design	5	5	5	5	5	5	5	5	5	5	5	5
Costs material and labour	5	5	5	3	3	3	3	5	5	3	5	5
Costs maintenance	5	5	5	5	5	5	5	5	5	5	5	5
Reduce costs	2	2	2	2	2	2	2	2	2	2	2	2
#Not collected	5	5	9	4	13	12	12	9	9	3	9	9
% Not collected	5%	5%	9%	4%	13%	12%	12%	9%	9%	3%	9%	9%

\* These questions had the same results for both the sides and top

\*\* Substrates consists of 6 questions, but answered in the same way

\*\*\* Vegetation consists of 5 question, but answered in the same way

\*\*\*\* Problems consists of 8 question, but answered in the same way

## Appendix V – Searching Criteria

For the database, several searching criteria were selected because they are expected to be interesting for zoo staff. In table 10 these criteria can be found and the way that these criteria can be selected are mentioned.

**Table 10: Presentation of search criteria for the database**

<b>Criteria questionnaire</b>	<b>Way of selecting search criteria</b>
<b>Zoo</b>	Drop down list with all the zoos present in the database
<b>Opening year</b>	Earlier or later than ....
<b>Height</b>	Drop down list with height subdivided in 3 groups: <10 meter, 10-15 meter and >15 meter
<b>Area</b>	Drop down list with area subdivided in 4 groups: <250m <sup>2</sup> , 250-650m <sup>2</sup> , 650,1-2500m <sup>2</sup> , >2500m <sup>2</sup>
<b>Volume</b>	Smaller or bigger than ....
<b>Shape sides</b>	Drop down list with possible shapes
<b>Shape top</b>	Drop down list with possible shapes
<b>Placement main support structure</b>	Drop down list with possible options
<b>Material main support structure</b>	Drop down list with possible options
<b>Material netting</b>	Drop down list with possible materials
<b>Walkthrough</b>	Option to click a checkbox
<b>Indoor enclosure attached to aviary</b>	Option to click a checkbox
<b>Species</b>	Fill in bar or drop down list with the species
<b>Costs</b>	Lower or higher than ....