Zoo Research Guidelines: Behavioural Profiling
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Zoo Research Guidelines:
Behavioural Profiling

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Preface

Researchers studying animal behaviour have always been aware that individual animals may differ in their behaviour, for a number of reasons such as age, sex, physical condition or past experience. An increasing body of evidence suggests that another factor responsible for consistent and (sometimes) predictable differences in behaviour is temperament. Behavioural profiling is the term used to describe a variety of different methods that attempt to measure individual differences in temperament or personality.

These guidelines consider some of the more commonly used methods of behavioural profiling, and also examine how behavioural profiling can be of use in the captive management of wild animals.

The Behavioural Profiling Guidelines are divided into the following headings and it is useful to read all sections before beginning a project:

1. Introduction to Behavioural Profiling
2. Methodology
3. Advice for Researchers
4. Resources
5. References and Further Reading

1. Introduction to Behavioural Profiling

1.1 Terminology

Differences between individual animals in their behaviour have been described by many different terms, such as temperament, behavioural syndromes, and personality. For the purposes of these guidelines we will use the following definitions:

**Personality:** a combination of measurable behavioural traits that is consistent across time and situation.
**Personality trait:** a measurable aspect of an animal’s behavioural repertoire, that, when taken together with other behaviour traits, represent the animal’s personality.

**Behavioural profiling:** methodology for measuring personality traits in animals.

(Incidentally, the term *animality*, to describe personality in non-human animals, was first suggested by Geoff Hosey at the 2004 annual BIAZA research symposium, held at Edinburgh Zoo).

### 1.2 Do animals have personalities?

Looking at the peer-reviewed scientific literature, there is, evidently, a large body of researchers who not only believe that individual animals have quantifiable differences in behaviour which can be described in terms of personality traits, but that these personality traits have a genetic basis - and are often highly heritable.

Gosling and Vazire (2002) base their assertion that personality does exist in animals on an evaluation of a number of published studies of personality ratings that:

- show strong levels of inter-observer agreement
- show evidence of validity in terms of predicting behaviours and real-world outcomes
- do not merely reflect the implicit theories of observers projected onto animals

Gosling (2001) conducted an extensive review of published studies that involved some sort of personality research. He found evidence for personalities in a wide range of taxa. He also found that there is considerable cross-species evidence for personality traits such as nervousness, fearfulness or anxiety and also boldness vs. shyness. He found no evidence, however, for conscientiousness (defined as the ability to focus on a task and to delay gratification) in animals other than humans and chimpanzees.

Dingemanse *et al.*, (2002) measured variability in exploratory behaviour in great tits (*Parus major*) and found that the birds showed consistent and heritable variation in a behavioural trait (exploratory behaviour in a novel environment); another Dutch research team (van Oers *et al.*, 2004) found that risk-taking behaviour was linked to exploratory behaviour in great tits and concluded “we therefore have evidence for the existence of avian personalities”.

In a study of more than 300 vervet monkeys (*Cercopithecus aethiops sabeus*), Fairbanks *et al.*, (2004) found both consistency and heritability of social impulsivity and suggested that the same genes may influence variation in both impulsive approach and aggression. Bouchard and Loehlin (2001) also looked at the relationship between genes and personality, and noted that, “There is abundant evidence ... that personality traits (in animals) are substantially influenced by the genes”.


1.3 Benefits to Zoos of Personality Research

1.3.1 Research

Behavioural profiling of wild animals in zoos could provide interesting (and possibly useful) information on how humans perceive animals, for example:

- Is there high or low inter-observer reliability for a particular animal, and why?
- Do human judgments of personality (e.g. fearfulness) actually predict real responses (e.g. to novel objects or situations)?

This is perhaps the easiest use of behavioural profiling for zoos to justify - zoos are committed to research and data on human-animal interactions are certainly of academic interest.

A third question that could be added to the list above is whether or not animals respond differently to different humans - there is certainly some good evidence from studies of livestock that this is the case. What is still not fully clear (but is becoming clearer) is how zoos can make practical use of such information to inform their management decisions in areas such as welfare, or captive breeding.

1.3.2 Captive breeding

Carlstead et al.’s (1999a; 1999b) work on black rhinoceros (Diceros bicornis) first drew attention to the value of including personality traits in any assessment of compatibility between potential mates in a captive breeding programme. They found that, for black rhinoceros, personality scores grouped into the overall trait “dominant” were negatively correlated with reproductive success for males. Moreover, the higher the female’s score in the “dominant” category relative to her male partner, the greater the breeding success of the pair. This corroborates anecdotal evidence that black rhinoceros compatibility is greatest when older, more dominant females are paired with younger males.

Wielebnowski (1999) found that, in captive cheetah (Acinonyx jubatus), non-breeders of both sexes scored significantly higher on the personality component “tense-fearful” than breeders. Wielebnowski concluded that, “Assessment of individual behavioral variation through questionnaire ratings may therefore provide a simple and non-invasive tool for predicting an individual’s ability to adjust to the constraints of certain husbandry regimens and to reproduce in captivity.”
In guppies (*Poecilia reticulata*), which are bred in large numbers in captivity, albeit not as part of conservation-related captive breeding programmes, females prefer to mate with bold rather than shy males (Godin & Dugatkin, 1996).

So personality traits clearly can influence the success or otherwise of zoo efforts to breed wild animals in captivity.

1.3.3 Reintroduction into the wild

Very few studies to date have specifically considered the relationship between personality and survival in reintroduced wild animals. A notable exception is the work by Bremner-Harrison *et al.*, (2004), who looked at personality assessment as a predictor of survival rates of captive-bred swift foxes (*Vulpes velox*). They found a significant correlation between “boldness” scores and poor survival after release into the wild, implying that bolder foxes have lower survival rates. It is worth noting, however, that in a study of bighorn ewes (*Ovis canadensis*), Réale and Festa-Bianchet (2003) found the opposite to be true; here, selection favoured the bold, with less docile ewes better able to avoid predation by cougars.

Some of the work carried out in the Netherlands on great tits (e.g. Dingemanse *et al.*, 2004) has direct implications for differential survival of varying personality types. In their work on these birds, Dingemanse *et al.* (2004) showed that annual adult survival was related to a specific and highly heritable personality trait (behaviour in novel environments).

1.3.4 Welfare Assessment

"Individual differences in temperament are particularly relevant to animal welfare studies, for the welfare of an individual largely depends on whether it can cope with environmental challenge" (Manteca & Deag, 1993)

Some personality traits may be selected against in captivity because animals do 'less well' or are difficult to manage because they are particularly aggressive. In the context of mink in fur farms, Hansen and Møller (2001) have suggested that the welfare of captive animals can be improved, not by changing the captive environment, but by the deliberate selection of the animals kept in captivity so that they are better able to cope.

1.3.5. Health and Safety

Can behavioural profiling of zoo animals help inform decisions about (human) health and safety? The key problem here is of validation - potentially useful methods cannot be tested experimentally, because of the risk of injury to keepers and other zoo staff.
2. Methodology

2.1 How can we measure differences in personality?

2.1.1 Behavioural observations

This can be carried out by doing a simple behavioural study (see appropriate guidelines in the BIAZA series). By splitting behaviours into categories such as bold behaviours, shy behaviours, neurotic behaviours and so on. You can get an individual score for each animal for each behaviour and thus each personality factor that you wish to investigate.

**Pros:** A relatively simple way of carrying out a personality study as the whole project is carried out by the researcher and is purely observational.

**Cons:** As with any behavioural study you will only get an idea of the animal’s behaviour during the time period you are watching it. Your results may be biased by outside disturbances, or not reflect an animal’s actual personality.

2.1.2 Coding personality traits

For this method humans that are familiar with the animals, e.g. animal keepers, are asked to rate each individual animal on a set of traits such as ‘aggressive’, ‘happy’ or ‘intelligent’ on some sort of scale, e.g. a Likert scale (1 – the trait is not represented in the animal to 7 – the trait is strongly represented in the animal).

**Pros:** This method of collecting personality data is very efficient because it allows the observers to amalgamate their experience of an animal, perhaps across its lifetime, a task which would be quite difficult if basing ratings on behavioural observations of only a few weeks.

**Cons:** relies on the ability of the human observer to be able to accurately describe individuals based on their knowledge and experience of that particular animal. Therefore this method is thought to be more subjective than recorded observations of behaviour.

One large scale investigation that uses trait ratings is the Methods of Behavioural Assessment (MBA) project.

The Methods of Behavioural Assessment (MBA) Project is a cross-institutional research initiative developed by researchers from twelve leading North American zoos (see Carlstead et al., 1999a & 1999b). To date, the MBA Project has surveyed 50-80 animals from each of four model species, across 15-20 zoos in North America. The model
species are the black rhinoceros, maned wolf (*Chrysocyon brachyurus*), cheetah, and great hornbill (*Buceros bicornis*). These species were chosen because of their endangered status and because they exhibit inconsistent reproductive results in captivity.

The aim of the MBA Project is to create a tool for standardized assessment of the behaviour of individual animals across different zoos. The MBA Project also considers how captive breeding success is influenced by environmental conditions in captivity.

**MBA Methods**

- Keepers are asked to score (from 1-5 or 1-7) individual animals on a range of behavioural traits (these are taken from the rhino survey).

  e.g. **ENVIRONMENT DIRECTED BEHAVIOUR**

  - **Curious** – not hesitant to investigate novel objects (1 = does not apply; 7 = strongly applies)
  - **Vigilant** – watchful, observant, scans frequently
  - **Anxious** – interested but fearful and uneasy

**2.1.3 Free choice profiling**

The previous methods use behaviours or personality traits that have been previously defined by the investigator. Free choice profiling involves observers picking their own descriptive terms when describing an animal. This method has been used with domestic pigs (Wemelsfelder *et al.*, 2001), nine naive observers on four separate occasions showed significant agreement when assessing pig temperament in this way. **Pros**: Relatively simple to carry out, i.e. there is no need to generate a list of traits and a rating system beforehand, as it is all generated by the observers. **Cons**: A relatively new technique therefore there is no large body of evidence to support or reject its effectiveness. If using this technique it would be essential to include validation (see below).

**2.1.4 Controlled experiments**

Controlled experiments are usually used when investigators want to look at one aspect of personality such as the bold shy continuum. These usually involve placing animals in a novel situation and recording their responses. Bremner-Harrison *et al.*’s (2004) study on swift foxes is a good example of this. **Pros**: Extremely useful for studying one aspect of personality. **Cons**: Difficult to carry out in the zoo situation.
2.2 Reliability and Validity

In order to be able to use these methods of assessment confidently, we must consider whether they stand up to certain criteria; i) that trait ratings show strong levels of inter-observer agreement and ii) they show evidence of validity in terms of being able to predict behaviour and real world outcomes.

2.2.1 Reliability

Inter-observer reliability is the most commonly used method to assess reliability of observer’s ratings, however it is still an area which receives little attention. For example in Gosling’s (2001) review of animal personality literature, only 21 of the 187 studies reviewed, reported inter-observer reliability for trait items. While reliability scores for individual traits may be highly variable e.g. Wielebnowski’s (1999) study on zoo-housed cheetahs found reliabilities ranging from 0.48 (playful) to 0.82 (active), the mean reliabilities computed for these studies were relatively high; the mean inter-observer agreement was 0.52, a figure comparable with that of human personality research. In Gosling et al.’s (2003) comparison of human and domestic dog personality, the authors used parallel procedures and instruments and found that judgments of dogs were as accurate as those of humans.

Inter-observer agreement is obviously an important consideration when rating personality traits, and there may be factors that affect the outcome. Gosling (2001) suggests a number of things to take into consideration when looking at inter-observer agreement, raters’ acquaintance of the animal improving reliability, and communication between observers falsely inflating inter-observer agreement.

2.2.2 Validity

By assigning an animal with a ‘personality’ we should be able to know something about that animal; therefore we would expect to be able to use information about personality to predict behaviour and real world outcomes. Therefore if we can correlate personality ratings with some other variable it can validate our original personality assessment. With validity comes the problem of what is the ultimate measure of personality. Within most animal studies two types of validity have been investigated, personality traits are either i) correlated with behaviour, and/or, ii) correlated with real world outcomes.

The first is assessed by correlating observer’s trait ratings with, independently assessed, observed behaviours; this has been done in many studies covering a wide range of taxa. Lloyd et al., (2007) found several correlations between behavioural measures and personality components in horses, e.g. the ‘dominance’ component had significant positive correlations with herding and head threat behaviour and negative
correlations with submissive, kicked, and groom-receiving behaviour. In a study on zoo-housed bachelor lowland gorilla (*Gorilla gorilla*) groups, Kuhar *et al.*, (2006) found that, high ‘extroverts' are more likely to initiate and receive affiliative behaviours, while high ‘dominant' individuals are more likely to initiate and less likely to receive displacement behaviours. These and other studies, often include correlates with behaviour as an aside to the main study, however some articles have solely investigated the personality-behaviour relationship. Pederson *et al.*, (2006) investigated the behaviour-personality relationship within zoo-housed chimpanzees (*Pan troglodytes*) and found that behaviours could be split into four contexts, and all were significantly correlated with one or more personality dimensions, agonistic, affinitive, submissive and public orientation.

As well as predicting behaviour, personality traits should be able to be used to predict real world outcomes such as stages in life history or physiological correlates. A study on vervet monkeys found that ‘impulsivity’ scores peaked at four years of age, an age when vervet males typically emigrate from the natal group (Fairbanks *et al*., 2001). Leblond and Reebs (2006), established that boldness (willingness to pass through a dark u-shaped tube) in golden shiners (*Notemigonus crysoleucas*) correlated with the tendency to lead shoals. Byrne and Suomi (2002) investigated correlations between cortisol reactivity measures and subjectively judged personality ratings in juvenile tufted capuchins (*Cebus apella*). Personality traits, aggressive, confident, curious, effective, and opportunistic were all negatively correlated with cortisol reactivity levels, while apprehensive, fearful, insecure, submissive and tense were positively correlated with cortisol reactivity.

A commonly used method to test the ability of personality to predict real-world outcomes is to perform a novel test. This may involve introducing a novel object, sound, situation into an animal’s environment and recording each individual’s response.

### 3. Advice for Researchers

The following section will give you advice on carrying out a personality study using the second method, coding personality traits. This is probably the most applicable method for a zoo setting.

#### 3.1 Study aims.

As with any scientific study it is important that you are aware of your aims before you begin data collection otherwise you will end up with lots of data which you won’t know what to do with.

What is the purpose of your project, are you interested in the subject of personality itself or do you want to see if personality affects another variable such as health, or do you want to know how variables such as enclosure type might affect personality traits?
Below are some common aims of personality research accompanied by examples and references. This is not an exhaustive list but is intended to be a starting point for further reading on each subject.

3.1.1. Personality
These are studies for which the intended aim is just to investigate the concept of personality.

- Personality dimensions in spotted hyenas (*Crocuta crocuta*), (Gosling, 1998).
- Investigation of the five factor model in chimpanzees, (King & Figueredo, 1997).

3.1.2. Personality traits
These studies look at one trait of personality such as the bold/shy continuum rather than investigating personality as a whole. They are often difficult to carry out in the zoo setting due to the experimental nature of the investigation therefore zoo examples are rare.

- *In situ* examination of boldness-shyness traits in the tropical poeciliid (*Brachyrhaphis episcope*), (Brown et al., 2005).
- Investigation of the boldness-shyness traits in different contexts in the pumpkinseed fish (*Lepomis gibbosus*) (Coleman & Sloan-Wilson, 1998).
- Behavioural trait assessment as a release criterion in a reintroduction programme for captive-bred swift fox (Bremner-Harrison *et al*., 2004).

3.1.3. Comparative studies (multi-species)

- A comparison of methods using two different species, the stump tail macque (*Macaca arctoides*) and the zebra finch (*Taeniopygia guttata*) (Figeuredo *et al*., 1995).

3.1.4. Personality and captive environment

- Comparison of chimpanzee personality structure in zoological parks and African sanctuaries (King *et al*., 2005).
- The affects of age and housing on animal’s scores on the gorilla behaviour index (Kuhar *et al*., 2006).

3.1.5. Personality and welfare

- Can chimpanzee happiness be estimated by human raters (King & Landau, 2003).
- Heritability of subjective well-being in chimpanzees (Weiss *et al*., 2002).
3.1.6. Personality and conservation/reintroduction

- Predator discrimination and personality in Vancouver marmots (*Marmota vancouverensis*) (Blumstein et al., 2006).
- Behavioural trait assessment as a release criterion in a reintroduction programme for captive-bred swift fox (*Vulpes velox*) (Bremner-Harrison et al., 2004).
- The effects of anti-predator training on the shyness-boldness trait in greater rheas (*Rhea americana*) (de Azevedo & Young, 2006).

3.2 Preparing a questionnaire

Depending on the species you decide to study you will probably need to carry out a multi-zoo study to achieve a good sample size. Therefore it is very likely that you will need to achieve some proportion of your data by means of a questionnaire, as you may not be able to visit all these zoos in person.

Details of questionnaire design are given in the BIAZA research guidelines series (Plowman et al., 2006) and you should refer to this for general details about questionnaires. However the following issues are specific to using a questionnaire for personality research.

3.2.1 Provide background information and instructions.

As with all questionnaires it is important that you provide some sort of background to the study and a set of instructions for completing the questionnaire. Instructions specific to personality questionnaires;

- People completing the questionnaire should be able to individually identify and be familiar with the species in question, i.e. keepers, researchers, other individuals who spend a lot of time around the animals.
- At least two people are required to carry out the questionnaire (for inter-observer reliability analysis).
- It is recommended that these individuals do not carry out the questionnaire together.

3.2.2 Personality traits.

One of the first things you should do is come up with a list of personality traits and some behavioural definitions for them. These behavioural definitions will aid keepers when completing the questionnaire. The best way to go about this is to look at the kind of traits previous researchers have used. Always have more than you think you need but not too many that the rater will get bored, 25-40 is common.
3.2.3 Types of questions and ratings.

You will probably want some information on the individuals completing the questionnaire so if you decide later in your study that inexperienced raters are unreliable you can check this by using appropriate analysis. Some typical questions include, age, sex, experience with the study group, experience within zoos.

You should then have a list of all your personality traits (with their definitions) with space for the person to rate each individual animal on each individual trait. The type of rating scale used is up to you. Likert scales like the one in the example below are most common and usually range from 1-5 or 1-7.

Please rate these animals based on your knowledge and general impression of their behaviour. Please rate each item on a scale from 1 (the trait is not represented in the animal at all) to 7 (the trait is very strongly represented in the animal). Please do not discuss your answers with anyone else.

Table 1 Example of a Personality Questionnaire.

<table>
<thead>
<tr>
<th>Personality Trait</th>
<th>Name of animal</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alvin</td>
<td>Simon</td>
<td>Theodore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cautious</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Takes a long time to approach unfamiliar situations/objects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curious</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is interested in changes in the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has priority access to resources and can displace other animals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2.4 Other variables

Depending on the aim of your study you may be interested in other variables that will need to be collected in the same questionnaire. These may include things such as enclosure design, enrichment, and breeding success. You should refer back to the questionnaire guidelines for further details, but the main point you need to take home is that you must be aware of your specific aims in order to construct a suitable questionnaire. There is no point in collecting lots of information that you do not need and equally you don’t want to receive all your surveys only to find that you missed a vital question for your research.
3.3 Data analysis

3.3.1 General

As with most investigations calculation of descriptive statistics is usually the first step. This may include things such as:
- Response rates (all, by species, by area/country).
- General information on who completed the survey.

3.3.2 Reliability

Some sort of inter-observer reliability analysis is essential in order to be able to say that observers are rating personality in a reliable way. Which method you use will depend on how many people completed your questionnaire for each group of study animals.

Whichever method you use you should calculate inter-observer reliability for each trait for each individual study group (you can only assess reliability between raters that are rating the same animals). Once you have calculated these values there are two options for further analysis;
1. Disregard any personality traits that fall below a minimum threshold value for inter-observer reliability (depends on the method of analyses but usually around 0.60, consult textbooks for information) from further analysis.
2. If the average inter-observer reliability value is above the threshold conclude that general inter-observer reliability is good and therefore include all personality traits in further analysis.

3.3.3 Validity

There are a number of ways in which the validity of questionnaire or survey-based personality assessments can be tested. These include direct behavioural observations, often in combination with tests such as placing a novel object into an animal’s enclosure and measuring the time taken (latency) before the animal responds (see e.g. McKay, 2003; Kinnally et al., 2008). Another measure of the validity of an initial assessment of personality can be obtained by revisiting the same animals after a period of time (perhaps a year) and repeating (see e.g. Hsu & Serpell, 2003).

While it may not be feasible to use validation methods for all the animals in your study group, due to the logistics of data collection, you should nevertheless try to incorporate some validation of your personality assessments into your study.
3.3.4 Factor analysis

Factor analysis is the process of reducing numerous variables (i.e. personality traits) into a smaller number of latent variables or factors (i.e. personality dimensions).

If you wish to look at all of your personality traits individually then you do not have to carry out factor analysis (this is perhaps the case if you have a low number of traits reaching good levels of inter-observer reliability), however if you have large numbers of traits then some form of factor analysis is recommended.

3.3.5 Other relationships

Depending on the aims of your study you may wish to analyse the relationship between personality and other variables such as disease incidence or breeding success. You can look at the relationship between your dependant variable (i.e. breeding success) with either your personality dimensions (factors) or individual personality traits. Either way the analysis will be the same and will require some form of correlation or regression technique.

4. Resources

4.1 Personality resources

API: The Animal Personality Institute (www.animalpersonality.org)
Founded in 2004, is an interdisciplinary organization for bringing together research scientists whose work contributes to understanding personality and temperament in non-human animals. It is dedicated to building a stronger and more integrative study of animal personality and has a very good bibliography.

Primate Personality Net: (www.primate-personality.net)
Primate Personality Net is a new research group at the Humboldt University Berlin, Germany, dedicated to the scientific investigation of personality differences and their influences on social relationships in primate species.

4.2 General Zoo Resources

BIAZA: British and Irish Association of Zoos and Aquariums (www.biaza.org.uk)
Members of BIAZA must maintain certain standards of husbandry, education and research. The BIAZA Research Group aims to promote the benefits of zoo research and to improve the quality of research in zoos in the UK and Ireland. The Research section of the website includes other issues of this series of guidelines and extensive advice for researchers, particularly where to find readily available information without contacting zoos. It is strongly recommended that anyone considering any form of zoo research should consult this website before starting and particularly before contacting any zoos.
**EAZA**: European Association of Zoos and Aquaria ([www.eaza.net](http://www.eaza.net)).
EAZA has a number of TAGs (Taxon Advisory Groups) which co-ordinate co-operative European Breeding Programmes (EEPs) and European Studbooks (ESBs) within Europe, including the UK. The EAZA website will give you information on how this is done and for which species.

**AZA**: (American) Association of Zoos and Aquaria ([www.aza.org](http://www.aza.org)).
Like EAZA, AZA has a number of TAGs which co-ordinate breeding programmes (Species Survival Plans (SSPs) and Population Management Plans (PMPs) in North America. Like BIAZA and EAZA they hold annual conferences, the proceedings of the most recent of which are available on their website. Older proceedings should be accessed through your library.

**WAZA**: World Association of Zoos and Aquaria ([www.waza.org](http://www.waza.org)).
Although there are a small number of global or international studbooks (ISBs), this organization’s main role is not co-ordination of captive breeding, but rather raising standards of husbandry, education and conservation activity in zoos worldwide. It has recently published an updated edition of the World Zoo and Aquarium Conservation Strategy (2005) and has some useful conservation examples on its web site.

**ISIS**: International Species Information System ([www.isis.org](http://www.isis.org)).
This organization produces the software that zoos use to maintain animal records. It also compiles central records from all member zoos. Their website has information on what species and numbers of each are held in zoos around the world. It is therefore a very useful starting point in selecting the zoos that hold the species you are interested in studying.

### 5. References & Further Reading


**FURTHER READING**


