A COMPARISON OF ZOOS AND SELECTED ENDANGERED SPECIES POPULATIONS FROM A GEOGRAPHICAL PERSPECTIVE

By

CECILE MARIE VALASTRO

Bachelor of Arts

Texas A&M University

College Station, Texas

1994

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 2000

A COMPARISON OF ZOOS AND SELECTED

ENDANGERED SPECIES POPULATIONS

FROM A GEOGRAPHICAL

PERSPECTIVE

Thesis Approved:

Alyson Greiner

Thesis Advisor

Dal Lightfoot

Alfred Larzelere

Dean of the Graduate College

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my advisor Dr. Alyson Greiner for her support, valuable guidance, and exceptional patience, which allowed me to complete this project. I want to express my sincere thanks to my other committee members, Dr. Tom Wikle and Dr. Dale Lightfoot for their assistance, and support. I also want to thank the faculty and staff of the Department of Geography, for their assistance and for the knowledge I have gained during my studies here at OSU.

Furthermore, I would like to thank, Dr. Tracy Carter, Professor of Zoology, OSU who inspired hypothesis 3, and Tarren Wagener, Conservation Science Manager, Fort Worth Zoo, for providing me with valuable information. I would also like to thank, Dr. Sarah Christie, Conservation Program Coordinator, London Zoo; Dr. Rob Belterman, Animal Records Officer, Rotterdam Zoo; Dr. Peter Müller, Director, Studbook Keeper, Leipzig Zoo, who sent me 6 volumes of the International Tiger Studbook; Dr. P. Martin Brooks, Chairman, IUCN African Rhino Specialist Group, who so generously provided me with data without which much of this study could not have been done.

Finally, I would like to thank my parents, my family and friends for their incredible support that they have provided throughout my educational endeavors.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

Chapter I

Introduction

Zoos have become "arks" for threatened and endangered species on the verge of extinction. From the menagerie type collections to conservation-based institutions, zoos have evolved in their purposes to include scientific research, and breeding programs to sustain endangered populations. Zoos play an important role in the conservation of endangered species. Arguably, captive populations of animals can serve as genetic reservoirs to infuse wild populations and reintroduce new populations into the wild for those species struggling to survive in the wild (Magin et al. 1994). For example, in 1981 the American Zoological and Aquarium Association (AZA) began a conservation program called the Species Survival Plan (SSP). This program is designed to maintain and increase endangered species populations through breeding. The AZA also performs research, facilitates reintroduction of animals back into the wild, and provides educational programs about animals and their habitats. The program uses flagship species such as tigers, gorillas, and other readily recognized animals that are generally considered charismatic species which are able to enlist support for habitat conservation (Santiapillai, and Jackson, 1990). Flagship species elicit strong feelings within the public to educate and promote awareness about endangered species, and habitat destruction (American Zoo and Aquarium Association, 1999).

Worldwide, there are roughly 1150 zoos, aquariums, and captive breeding centers (Magin et al. 1994). According to Magin and his colleagues, the geographic distribution of these zoos is uneven. Five hundred seventy-three zoos are located in the developed

world, while 165 of these facilities are within the borders of the United States (Magin et al. 1994). Captive breeding programs play an important role in the public awareness of conservation issues, but many are concerned because there are so few of these programs in the developing world where major species losses are predicted (Magin et al. 1994).

In many ways humans have always had a connection with the animals around them. Even in prehistoric times, cave paintings indicate the connection and dependence humans have had on animals. For centuries people have kept animals for food, hunting, recreation, and curiosity. Animals have been kept in collections since 4500 B.C. in Persia, now known as Iran. In Egypt cats, wild dogs, hyenas, leopards and cheetahs were all kept for hunting purposes. The Chinese emperor Wen Wang in 1100 B.C. constructed a 900-acre walled park within Ho Nan province. The park accommodated deer, antelope, birds, and fish. In France, Louis XIV kept a menagerie at Versailles. Henry I of England maintained a zoo in Oxfordshire England, which held lions, leopards and camels. Under the rule of Henry IV the animals were moved to the Tower of London until 1828, when the first zoological park was established by the Zoological Society of London (Marshall, 1994).

In the introduction to the book *Great Zoos of the World: Their Origins and Significance*, Lord Zuckerman discusses the history and evolution of zoos. Zuckerman notes that the word zoo was derived in 1847 as a colloquial abbreviation for the Zoological Gardens in London. The term menagerie was derived from the French word *menager* meaning to manage the household and family. Zuckerman notes that the menagerie in the 17th century was the enclosure for the livestock, but Louis XIV changed the form of the menagerie by keeping exotic animals at his palace in Versailles

(Zuckerman, 1980). As a result this became a display of status among the rich. In his introduction Zuckerman examines the history of zoos by dividing their development into five phases. He explores these five stages from the brutality of the Roman era to conservation of endangered species in today's zoos.

The first public zoos were created for public entertainment and education. In the late nineteenth century zoos were created in the United States because many recognized "the grim realities of diminishing animal populations" (Stott, 1981: 14). The zoological garden would be established as a place to display live animals and as a way to promote preservation and conservation of natural resources and wilderness. The goals of the zoo were to provide recreation for the public, wildlife preservation, and education about conservation (Stott, 1981).

Problem Statement

As zoos have taken on the role of conservation, one can ask these questions: how do captive populations in U.S. zoos compare to the endangered species populations in the wild? Are endangered species populations in zoos higher than endangered species populations in the wild due to controlled breeding programs? Can the percent of protected areas within an endangered species range be an indicator of growth or loss in its population in the wild?

This study will attempt to answer these questions by surveying endangered species populations of selected zoos within the United States. This study will compare selected

endangered species populations in the wild to the captive populations in U.S zoos to determine if there is a relationship between these two populations. This will be accomplished by selecting three different endangered species and then comparing the total number of captive populations housed at selected zoos within the United States to total estimated populations within the wild. Based on these population numbers the relationship between captive and wild populations of endangered species can be determined. This research will also examine the possibility of a relationship between the amount of protected area in a country and the population size of an endangered species within that country. It is stated by Simon Stuart, head of the Species Survival Program of the World Conservation Union, that protected areas provide the most fundamental method of conservation (Stuart, 1994). These protected areas such as national parks and nature reserves are invaluable to endangered species. By comparing the percentage of particular protected areas to the estimated populations of selected endangered species, the stability of populations of these species may be determined through statistical analysis. Finally, some professionals in the field of zoology and wildlife biology, such as Dr. Tracy Carter, a professor at Oklahoma State University, have suggested that there is a bias within zoos towards the African continent in number of animals and exhibits represented at these facilities. This study will investigate if zoos have a bias towards the African continent in representation of animals in their exhibits and, if this is the case, will explore the reasons and consequences of this bias.

The significance of this research to geography is that it will add to the body of work on animal geography, and in particular, on the subject of zoos. There seems to be very little work that has been done in this area of geography. This work may also show biases

in geographic representations within exhibits at zoos. The following hypotheses will guide this research.

Hypotheses

1. As populations of endangered species have decreased in the wild, populations of endangered species within zoos have increased worldwide.
2. There is a connection between the growth or loss of an endangered species to the amount of protected area within its range countries or regions.
3. Zoos have a bias towards the African continent in exhibits and in collections of animals. Zoos show a bias when 40 percent or more of their animals come from the African continent.

Methods

As populations of endangered species have decreased in the wild, populations of endangered species within zoos have increased worldwide. The aim of this hypothesis is to compare changes in populations of zoo captive endangered species to wild populations of the same endangered species. To test this hypothesis, three endangered species will be selected. The species selected are the tiger, including all remaining five subspecies, the white rhino (all subspecies) and Asian elephants (all subspecies). (See Tables 1.1, 1.2 and 1.3.) These species were selected because the data was available on these particular wild populations by country within its range. The data was obtained from the World Wildlife Fund and the IUCN specialist groups Internet site entitled *Threatened Species Account*

[http://www.panda.org/resources/publications/species/threatened/index.htm]. The wild populations of tigers, white rhinos, and Asian elephants will be compared to captive populations in zoos selected from the International Zoo Yearbook that possess AZA affiliation (See Table 1.4.) I have selected zoos in this manner in order to include those that are involved in the AZA's Species Survival Program, and are involved in endangered species conservation, and will be concerned with increasing endangered species populations. The numbers of captive animals will be counted by means of the information provided by the International Species Information System. (See Table 1.5 for example.) The International Species Information System is an organization that supports the conservation and preservation of species by assisting member zoos in management of their animals. The organization provides software to member zoos for specimen record-keeping and for conservation of endangered species. The data from each zoo is then consolidated into abstracts, which contain the records of species holdings for each member zoo (this information is available on the Internet at www.worldzoo.org.). I will compare wild populations of selected endangered species to the captive populations within zoos in order to see trends for these three species populations. The limitations involved are that only a select number of zoos will be surveyed, a limited sample of species is included and population numbers of captive animals will not be complete. Despite these limitations, this research may reveal a trend in the success or failure of breeding of some endangered species in captivity. There is a connection between the growth or loss of an endangered species to the amount of protected area within its range countries or regions. The aim of this hypothesis is to compare the wild populations of the previously selected endangered species to the amount of protected area within their range

countries or regions to determine the relationship between these two factors. I hope to determine if in fact, protected areas are contributing to the protection of endangered species populations. In order to test this hypothesis, I will compare estimated wild populations of the previously selected endangered species to the percent of protected areas by country. Information on protected areas will be taken from the United Nations 1997 list of protected areas. The data is taken from the IUCN World Commission on Protected Areas website [http://www.wcmc.org.uk]. The IUCN divides protected areas into categories based upon management objectives. There are seven categories that IUCN has defined. Category Ia is defined as a Strict Nature Reserve. It is an area protected and managed for scientific research. Category Ib is classified as a Wilderness Area. These sites are managed in order to maintain the natural conditions of an area. National Parks fall under Category II. National parks are managed for ecosystem protection and recreation. Many endangered species are protected within national parks and therefore are included within this study. Finally, Category IV is specifically managed for wildlife and is defined as a Habitat/Species Management Area. This is an area that is protected and managed to ensure the maintenance of habitats and the specific requirements of specific species (World Conservation Union, 1994). The final category is a managed resource protected area. It is designed as a protected area for the sustainable use of natural ecosystems. Only five of the seven categories will be used in this study. The intention in using only five categories is to exclude marine protected areas as marine species are not being considered in this study, and to exclude areas not specifically designated for the protection of wildlife.

My choice of countries to include has been guided by data availability. Population estimates of the selected endangered species (tiger, white rhino, and Asian elephants) are available on a country by country basis. (See Tables 1.1,1.2 and 1.3) A slight problem arises in the case of the Asian Elephant because data are provided for the Island of Borneo rather than for the three political units that comprise it. Specifically, the data is listed as 1000 animals in Sabah in Malaysia and Kalimantan in Indonesia. There is no data listed for Brunei and it will be excluded from consideration. In this instance a proportional distribution based on area will be used to divide the population between the two countries of Malaysia and Indonesia on the island. Statistical analysis will be employed to compare the estimated population of endangered species to the amount of protected area of each country considered part of their range. Relationships of endangered species to protected areas will be determined through the use of a simple regression analysis.

Zoos have a bias towards the African continent in exhibits and in collections of animals. Zoos show a bias when 40 percent or more of their animals come from the African continent. Finally, the goal of this hypothesis is to determine if zoos in the U.S. have a bias towards African species in their collections of animals by surveying mammal species and sub-species. This hypothesis will be tested by surveying the population of mammals held in 65 zoos in the U.S. and categorizing them into geographic regions, first by country and then by continent. Species and sub-species will be grouped by their range as listed by the International Species Information System for each U.S. zoo selected. (See Table 1.5.) For example, the different sub-species of cheetah range in South Africa, Somalia, South Asia, and Arabia and will be grouped accordingly for each zoo surveyed.

For those areas that are not well defined, such as Arabia, the species range (country) is obtained from other sources like the *Encyclopedia of Endangered Species* or the *Convention on International Trade* which has a listing of species and range states (countries). Large areas such as Asia is subdivided into the Middle East/Southwest Asia, South Asia, East Asia, Southeast Asia, and the former Soviet Union for better resolution. Ultimately the total number of species for the different geographic regions and sub-regions represented is calculated and compared to the total number of African species per zoo.

My zoo sample includes those zoos reporting to the International Zoo Yearbook and zoos that are registered with the American Zoo and Aquarium Association (AZA). (See Appendix I.) Zoos will also be selected by size (in acres) using the assumption that the more acres a zoo has, the more species it can accommodate. The survey will be limited to terrestrial species of the class *Mammalia*. Due to the long list of species and in order to keep the data manageable, the classes of birds, reptiles, invertebrates and amphibians will be excluded. This study will also exclude oceanic environments and species. Information on the zoos themselves will come from the International Zoo Yearbook, which contains data on the size (hectares) of the zoo. The data set will include the zoo, the acreage of the zoo, the number of species by class (mammals) and the geographic regions these animals represent. From the data set relevant tables, graphs and maps will be created to illustrate these relationships.

Table 1.1

Estimated Tiger Populations and Percentage of Protected Areas By Country

Species	Subspecies	Common name	Maximum Population Estimates	Country	Area (sq. mile) by country	Area Protected (sq. mile) by country	Percent of Land Protected by country
Panthera tigris	*P.t. altaica*	Siberian (Amur) Tiger	35	China	36,95,000	224,101	6.05
			10	Korea	46,540	2,678	7.05
			476	Russia	6592800	252931	3.84
	P.t. amoyensis	South China Tiger	20	China	3,695,000	224,101	6.05
	P.t. corbetti	Indochinese Tiger	300	Cambodia	69,898	11,569	16.56
			40	China	3,695,000	224,101	6.05
			650	Malaysia	127,320	5,731	4.46
			234	Myanmar	261,218	669	0.26
			501	Thailand	198,115	27,094	13.66
			200	Vietnam	127,301	5,132	4.03
	P.t. sumatrae	Sumatran Tiger	500	Indonesia	741,101	71,650	9.67
	P.t. tigris	Bengal (Indian) Tiger	362	Bangladesh	55,598	374	0.67
			50	Bhutan	18,147	3,729	20.72
			30	China	3,695,000	224,101	6.05
			2,500	India	1,222,243	55,385	4.53
			124	Myanmar	261,218	669	0.26
			93	Nepal	54,362	4,278	7.84

**Sources: The World Wildlife Fund, Threatened Species Accounts and From the IUCN World Commission on Protected Areas 1997 data.*

Table 1.2

Estimated Asian Elephant Populations and Percentage of Protected Areas by Country

Species	Common name	Maximum Estimated Population	Country or Region	Area (sq. mile) by country	Area Protected (sq. mile) by country	Percent of Land Protected by Country
Elephas maximus	Asian (Indian) Elephant	250	Bangladesh	55,598	374	0.67
		150	Bhutan	18,147	3,729	20.72
		No data	Brunei	2,226	444	19.97
		2,000	Cambodia	69,898	11,569	16.56
		350	China	3,695,000	224,101	6.05
		24,000	India	1,222,243	55,385	4.53
		4,500	Indonesia	741,101	71,650	9.67
		4,000	Laos	91,429	9,417	10.3
		6,000	Myanmar	261,218	669	0.26
		1,000	Malaysia	127,320	5,731	4.46
		85	Nepal	54,362	4,278	7.84
		3,000	Sri Lanka	25,332	3,072	12.13
		2,000	Thailand	198,115	27,094	13.66
		400	Vietnam	127,301	5,132	4.03
			Kalimantan, Indo.	539,460		
			Sabah Malaysia	28,417		

*** Searching for the area of Kalimantan and Sabah**

Sources: The World Wildlife Fund, Threatened Species Accounts and From the IUCN World Commission on Protected Areas 1997 data.

Table 1.3

Estimated White Rhinoceros Populations and Percentage of Protected Areas by Country

Species	Subspecies	Common name	Estimated Maximum Population	Country	Area (sq. mile) by country	Area protected (sq. mile) by country	Percent of Land Protected by country
Ceratotherium simum	*C.s. simum*	White Rhinoceros	23	Botswana	231,805	41,154	18.54
			4	Cote d` Ivoire	124,503	7,691	6.18
			137	Kenya	224,960	13,522	6.01
			141	Namibia	318,252	39,434	12.4
			7,913	South Africa	472,281	26,739	5.85
			50	Swaziland	6,704	177	2.64
			6	Zambia	290,586	24,560	8.46
			167	Zimbabwe	150,873	11,840	7.86
	C.s. cottoni	Northern White Rhinoceros	25	Congo	150,873	4,544	3.44

**Sources: The World Wildlife Fund Threatened Species Accounts and From the IUCN World Commission on Protected Areas 1997 data.*

Chapter II

Literature Review

The literature on zoos and endangered species issues is abundant, with topics ranging from the history and evolution of zoos to their role in the conservation of endangered species. Much of the literature found on endangered species focuses on habitat loss and destruction, reintroduction issues, and legislation to protect endangered species. A great deal of the literature has been written by non-geographers. Geographer Chris Philo, has argued that the geographical literature is particularly deficient on the topic of animals. Nevertheless, the study of zoos and endangered species is inherently geographical because it requires examining human and environmental relationships. This literature review covers the following topics: human/animal relationships, zoos today, habitat and environment, other issues that endangered species face, and finally, legislation that affects endangered species populations. In examining human/animal relationships we can discover how, as humans, we view and relate to animals. From this, we can explore the role that zoos play in our relationship to animals. Under zoos today, I examine the controversies and problems that zoos are facing in maintaining and breeding endangered species. Habitat and environment are also important factors in the conservation of endangered animals. By investigating these factors I am discovering how zoos play a part in the conservation of habitats under threat. In addition to habitat and environment, I explore other issues such as poaching, which is considered significant to population losses among some endangered species. Finally, I will consider the topic of legislation as

an important aspect in the protection of endangered species. Specifically, I will examine these topics and how they relate to the role of the zoo and to endangered species populations.

Human/Animal Relationships

In the discipline of geography, animals and their habitats have been examined in the context of their relationship to humans. Yi-Fu Tuan has approached of this subject from a behavioral point of view. By looking at the history of the relationship between animals and humans. He discusses how animals have represented gods worshipped by humans (Tuan, 1984). Over time many wild animals were symbols of power for kings and leaders. To demonstrate their power over the cosmos, many monarchs kept menageries. They were symbols for those with a high social standing as well as signs of wealth. As interest in keeping animals turned scientific, zoos became a place of learning and scientific study. Tuan notes that "although the purposes of a modern zoo are straightforward and commendable, human experiences of the zoo are likely to be ambiguous and mixed" (Tuan, 1984: 80). He continues to state that the experience of visiting the zoo allows humans to feel superior to the captive animals. Tuan also notes that it allows us as humans to acknowledge behaviors, such as eating and copulation, that we may find disturbing and even disgusting when we are engaged in these activities ourselves (Tuan, 1984).

Chris Philo has taken a different approach to the subject of animals and humans by looking at the deeper meanings of human and animals relationships. In his paper entitled "Animals, Geography, and the City: Notes on Inclusions and Exclusions," Philo explores

the geographical literature on how animals are treated within discipline of human geography. Philo argues that "the geographical literature as a whole has largely overlooked animals as distinctive objects of study, often subsuming them within broader discussions of nature and environment and rarely making them into a special issue deserving of special consideration" (Philo, 1995: 657). He discusses the relationship between man and animals in Tuan's book Dominance and Affection and notes that Tuan's "work is to recover hidden dimensions of the workings of power in human reality" (Philo, 1995: 656). Philo expands Tuan's concept of animals as a social group that is caught in a struggle with humans and explores animal geography through the case-study of meat markets and slaughterhouses in 19th century cities. Philo argues that in the geographical context, most human geographers have focused on animals being raised for the products they produce for human consumption. In his view, animals are extensively manipulated by people in order to suit human needs. He states that the purpose of his paper is to consider the possibilities of reviving animal geography as a type of "social cultural animal geography" which counters the human biases in existing geographical works. In doing this Philo attempts to bring about an approach that is more sympathetic to animals as living things (Philo, 1995).

Sarah Whatmore and Lorraine Thorne have also taken a similar philosophical approach to animals and how they have been a part of human social life. In their paper "Wild(er)ness: Reconfiguring the Geographies of Wildlife," Whatmore and Thorne consider the fate of wildlife in terms of its significance to the welfare of the animals and plant communities that reside in the place we call wilderness. They argue that animals have a long history within human circuits of social power. Specifically Whatmore and

Thorne are interested in exploring "moral geographies" and the philosophical meanings of wild and wilderness. Although they do not specifically mention zoos in this study they do state that the wilderness reserve is one kind of place in which we can define human-animal relationships in ways that take into account the social habits, and ecological orderings of all other inhabitants (Whatmore and Thorne, 1998).

Coming from a different perspective, Kay Anderson examines the cultural biases that humans have towards the environment and the animals within that environment by exploring the history of the Adelaide Zoo in Australia. In her paper, *Culture and Nature of the Adelaide Zoo: At Frontiers of Human Geography*, she states that we as humans do not recognize that the places such as parks and other areas set aside for human recreation and human contemplation and those places that we consider "natural" are really often only the human representations of nature (Anderson, 1995). For example, Anderson believes that the Western concept of the zoo is the most "complex and culturally contrived" space where people are supposed to encounter nature. She contends that zoos are cultural institutions that do not reflect nature but the human adaptation of nature where we bring a collection of animals together in one place and call it nature (Anderson, 1995). Anderson also notes that zoos contain a highly selective collection of species from the natural world, which most have never been seen by people in the wild. In addition, she states that exhibits are displayed in a way to meet the cultural demands and public expectation's about the animals and the region of the world they represent. Finally, Anderson argues that zoos ultimately tell us stories about boundary-making activities on the part of humans and that zoos are spaces where humans engage in cultural self-definition against our perceptions of nature (Anderson, 1995). In this context, the

breeding of endangered species in a controlled environment supports Anderson's arguments about zoos as cultural institutions that we create and control. In terms of my research, comparing populations of endangered captive animals in relation to the wild populations may support this further.

Zoos Today

Zoos have taken on new roles as times have changed. The survival of endangered species is very much a part of that role. Today, zoos still cater to public recreation but have expanded their roles within conservation science. A breeding program coordinated by the American Zoo and Aquarium Association entitled *The Species Survival Plan* is designed to "ensure the survival of selected wildlife species" (AZA website, www.aza.org, October, 1999). In 1981 The AZA created the program for population management and conservation of selected endangered species at zoos (AZA website, www.aza.org, October 1999). The goal of the program is to maintain healthy and genetically diverse populations of animals that can sustain themselves through breeding (AZA website, <www.aza.org>, October, 1999).

Zoos have taken on the role of the ark, but controversy accompanies this role. In Philip Haworth and Kathi Travers' article, "Changing Stripes," they examine the role of zoos today and state that zoos are in conflict between two perspectives of the personal and the global (Haworth and Travers, 1993). This means they have to find a balance between the expectation of species conservation and the certainty of captivity. Furthermore, zoos also have to find a balance between the operation of the zoo as a

business, while maintaining a humane ethic in treatment and care of animals (Haworth and Travers, 1993). They examine the AZA's breeding program and state that the SSP has emphasized *ex situ* conservation. This is saving an endangered species within the zoo with the expectation of releasing it back into the wild at a future time. (Haworth and Travers, 1993). With habitat loss as the main concern for endangered species populations, Haworth and Travers note that the SSP's are now shifting their focus to *in situ* conservation and working within the natural habitat to save endangered species (Haworth and Travers, 1993).

Haworth and Travers also examine some of the problems of zoos including behavioral problems of animals and the issue of surplus animals resulting from breeding and limited space. They note that zoos have a unique role in global conservation efforts and acknowledge that zoos have the expertise and the audience to affect change (Haworth and Travers, 1993). They also argue that like religion, they have become a tradition in American society. Zoos are institutions that can preach conservation from the mountaintops for their congregation (zoo visitors) to believe as they do (Haworth and Travers, 1993). Haworth and Travers conclude that conservation is not a cure-all for the problems that zoos experience but, concede that if zoos can save habitats and endangered species with education, direct action, and money their efforts should be supported (Haworth and Travers, 1993).

In a paper by Jeffrey P. Cohen entitled "Decisions at the Zoo" (1992), zoo roles are examined as are some of the controversies associated with captive breeding. Cohen discusses the issues involving the breeding of sub-species and hybrids. He explains the breeding problems that have occurred with orangutans. There are two genetically distinct

species in the wild of this animal. He notes that the breeding of these animals took place without regard to the subspecies in the 1970's and explains that the AZA takes the position that maintenance of hybrids is not considered a valuable effort. He also presents AZA's argument that the goal of their organization is to "preserve the unique genes of each sub-species." In his view, the breeding of sub-species then comes down to politics rather than biology as Cohen states in his paper (Cohen,1992: 655).

Cohen also notes that even with support for breeding programs in zoos the role of the zoo is limited in this respect. He argues that zoos cannot save "the natural habitats, intact ecosystems or the full range of endangered species" (Cohen, 1992: 657). This is a valid argument and is even recognized by zoo administrators. The director of the National Zoo in Washington D.C. has acknowledged this point and states that "Our direct contribution to conservation is minimal"(Cohen, 1992: 657). Cohen points out that regardless of this limitation zoos have expanded conservation efforts through education, conservation, and research in as many as 63 countries worldwide (Cohen, 1992). Zoos have also supported the efforts of countries to protect natural habitats through national parks by donating the money to maintain these parks. It comes down to the fact that although these species can be bred and maintained in the zoo, protected areas and national parks have become extremely important to maintain biodiversity and enable the reintroduction of endangered species into the wild.

Breeding to maintain populations of endangered species is just one aspect of conservation efforts by zoos. The reintroduction and release of captive-born animals is another element in their conservation efforts. In the paper entitled "Should We Put Them Back," Fiona Sunquist examines the issues and questions involved in the reintroduction

of zoo-bred animals back to the wild. Sunquist notes that of the 146 attempts at reintroduction of 126 species through the U.S. National Zoo, only 16 were considered successful (Sunquist, 1993). Natural ecosystems, as pointed out by Sunquist are complex and, it is not that as easy to restore a species that once lived there (Sunquist, 1993). She raises the question: Do we need to examine the source of the problems up front? (Sunquist, 1993). This is an important question that zoo officials need to ask and consider. There are success stories to back up the issue of reintroduction. According to Sunquist, the Arabian Oryx is the best-known success story involving reintroduction. The Bedouin hunters on the Arabian Peninsula hunted the Oryx to near extinction such that the wild populations dwindled to around thirty animals (Sunquist, 1993). With help from the Omani ruler who offered to pay for the reintroduction project, the Arabian Oryx has started to recover and as of 1994 there were 230 animals roaming free in Oman (World Conservation Monitoring Centre/World Wildlife Fund <www.wcmc.org.uk/ species/data/species_sheets/oryx.htm >, 11 March, 1999). But as Sunquist points out, with every success there are many endangered species that may not be able to be reintroduced into their environment. The main cause has been habitat destruction (Sunquist, 1993). Many papers on the subject of endangered species have acknowledged the fact that habitat destruction is the most significant problem for endangered species (Haworth and Travers, 1993; Cohen, 1992; Miller, 1990; and Stuart, 1994).

Wilson and Price's paper called "Reintroduction as a Reason for Captive Breeding" also examines the state of reintroduction programs for endangered species and presents the concept of habitat restoration. He notes that this is a fairly new field of study that is limited however, the concept is being applied in the developed world in

areas such as small prairies, small wetlands, botanical gardens, abandoned mines, and islands (Wilson and Price, 1994). Wilson and Price cite the restoration of tallgrass prairie communities, where bison are being returned, as an important part of the ecological community. Wilson and Price point out that although this type of restoration is expensive, it has been attempted in less developed countries as well such as the Guanacaste National Park in Belize (Wilson and Price, 1994).

In New Zealand, where introduced species now outnumber indigenous ones, the *removal* of exotic species is also considered a form of habitat restoration (Wilson and Price, 1994). Reintroductions in these areas have been regarded as successful but, this success is considered limited because these areas are generally small and the carrying capacity of the areas involved may not be sustainable for a growing population (Wilson and Price, 1994). Wilson and Price also point out that of the 660 species listed as either endangered or rare, as defined by the IUCN, only 68 are recommended for reintroduction (Wilson and Price, 1994). It is noted that in the IUCN Action Plans for endangered species captive breeding is recommended but reintroduction is very seldom suggested (Wilson and Price, 1994). The assumption behind any recommendation for reintroduction is that there is sufficient habitat available for reintroduction (Wilson and Price, 1994). Wilson and Price pose two critical questions: 1.) Who is making the decisions of which species to reintroduce to the wild?, and 2.) Are the zoos, conservationists or governments controlling the process of reintroduction? (Wilson and Price, 1994). In the United States, reintroductions are accomplished by state and federal agencies (Wilson and Price, 1994). Wilson and Price state that as a result of growing human populations, and because the probability of new protected areas being established

in the developing world is very low, reintroduction for many endangered species may not be an option (Wilson and Price, 1994). Many of these protected areas are under the same threats as the endangered species themselves. With respect to my own research, gaining knowledge about the relationship between endangered species populations and protected areas may be significant to the issue of reintroduction.

Habitat and Environment

The protection of the environment and natural habitats is an important factor for the survival of endangered species which zoos must consider as a method of conservation. According to the World Conservation Union, extinction rates around the world are increasing (World Conservation Union, <www.wcmc.org> 1999a). In the next decade it is estimated that 20 percent of the world's species will be lost (Anonymous, 1998). Due to losses in habitat, approximately 2000 vertebrate species and tens of thousands of marine species and invertebrates are in danger of becoming extinct (Anonymous, 1998). According to Stuart (1994), in the examination of threats to species, two possibilities are offered. One is to investigate the immediate threats and second is to explore the underlying factors that give rise to these threats (Stuart, 1994). Such threats include the loss of habitat, over-exploitation from hunting and poaching, the competition from introduced invasive alien species and because of small population size, they may not be viable as a breeding population (Stuart, 1994: xvi).

In G. Tyler Miller's textbook, Living in the Environment, he states that the most significant problem that all wild species encounter is the destruction, fragmentation and

degradation of habitats (Miller, 1990). Miller points out that growing human populations are increasing the use of land and water resources at the cost to other organisms (Miller, 1990). Human activities such as agriculture and mining disturb the natural ecosystem by destroying breeding grounds, food sources, and migration routes of many endangered species (Miller, 1990). Miller discloses some of the statistical losses of habitat experienced by many endangered species. He cites a UN study that found that two-thirds of African and Asian tropical wildlife habitat has been lost or severely degraded (Miller, 1990). Bangladesh, for example, is the most densely populated large country that has the highest losses in wildlife habitat reaching 95 percent (Miller, 1990). This poses a significant threat to the Bengal tiger, an endangered species in that area.

Not only is habitat loss a factor in endangered species issues, habitat fragmentation is also a concern. Miller also addresses this issue in his book. As with habitat loss, fragmentation is due to many human activities such as agriculture, and logging. Fragmentation delegates wildlife into small patches of habitat which may be too small to support the minimum number of individuals to sustain a healthy population (Miller, 1990). Fragmentation is a particular problem for large animals such as tigers, elephants, and rhinos, which generally need large areas of land to support their populations. Fragmentation can also lead to inbreeding creating what Miller describes as "genetically inferior offspring that are vulnerable to extinction" (Miller, 1990: 322). Cheetahs in the wild are facing this particular problem of inbreeding. The significance of these problems of habitat loss and fragmentation for zoos is that they become the refuges for endangered species. If their habitats are degraded to the point where they become

extinct in the wild, zoos then become the genetic repositories of these species and the issue of reintroduction into the wild becomes questionable.

Other Issues Facing Endangered Species

Endangered species not only face issues of habitat loss but other problems that create losses in their populations. Miller cites some of the other issues that have become problems for endangered wildlife. These problems include commercial hunting, and the management of predators and pests that may alter endangered species populations. Many endangered species are illegally taken out of the wild and are kept as pets or used in medical research. Other problems that cause difficulties for endangered species include pollution, the introduction of alien species, human population growth, and affluence and poverty (Miller, 1990). Each one of these factors can adversely affect the environment and threaten endangered species in the wild. In many ways legal and illegal commercial hunting has contributed to the state of endangered species in the wild (Miller, 1990). The hunting and poaching of African elephants for their ivory tusks has put this species on the road to extinction. But as Clifford Sherry notes in Endangered Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has allowed resumption of the ivory trade in some countries in Africa such as Botswana, Namibia and Zimbabwe. However, some have argued that the poaching of African elephants will intensify due to this decision by CITES. Because there is a demand for rhino horns in Asia which are utilized for medicinal uses African rhinos are also under threat from poaching. In parts of the Middle East such as Yemen, the horns have been

made into dagger handles, stimulating additional demand (Sherry, 1998). According to the World Wildlife Fund, during the early 1980's, approximately 1.75 tons, half of the horn traded in the world, went to Northern Yemen (World Wildlife Fund, >, 11 March, <www.panda.org/resources/publications/species/threatened/index.htm>,March, 1999). As of the year 2000, the World Wildlife Fund has indicated that changes in cultural priorities among the Yemenis, along with a required government license for craftsmen, and high penalties for use of rhino horns, have resulted in the decline of the trade within Yemen (World Wildlife Fund, www.panda.org, March 1999). The World Wildlife Fund has noted that a far more significant threat is posed by the demand for the horns in traditional Asian medicines (World Wildlife Fund, <www.panda.org/resources/publications/species/threatened/index.htm>,March, 1999).

Another example of the effects of poaching on populations of endangered species comes from the once successful reintroduction of the Arabian Oryx during the 1980's. Although the breeding and reintroduction of these animals was extremely successful, as of 1996 these animals are facing a second extinction due to poaching. The World Wildlife Fund has reported that between October 1996 and March 1999, the populations of the Arabian Oryx have dwindled from a herd of 400 animals down to 100. Poachers have managed to reduce the herd by 200 making them become a non-viable breeding group. Out of the 100 animals only eleven of these animals are female. Poachers have captured primarily females with calves to be sold to private zoos around the world (World Conservation Monitoring Centre/World Wildlife Fund <www.wcmc.org.uk/species/data/species_sheets/oryx.htm >, 11 March, 1999). Despite the fact that these animals are successful breeders in captivity, this example points out

that conservationists and zoos need to address the reasons why these and other animals become endangered within the wild (World Conservation Monitoring Centre/World Wildlife Fund <www.wcmc.org.uk/species/data/species_sheets/oryx.htm >, 11 March, 1999) As a result of a lack of funds, many developing countries are having difficulty keeping poachers under control. Such countries face the difficult challenge of saving wildlife, in addition to addressing and meeting the needs of its people. Zoos may represent an important step in supporting these countries in the conservation of their endangered species. Zoos are beginning to incorporate as part of their role, the management of protected areas where endangered species are under threat. In another article by Fiona Sunquist entitled "End of the Ark"? she examines the evolution of today's zoos and how they are beginning to invest in field conservation and research as an extension of their role in captive breeding. This is considered a more cost-effective method of conservation. According to Sunquist, some larger zoos have been involved with field conservation for many years (Sunquist, 1995). She notes that New York's Wildlife Conservation Society has created 110 new parks and reserves around the world in the last 30 years. Sunquist also points out that smaller zoos are now becoming involved in field conservation, and are involved with creating new ways to raise money. At the Fort Worth Zoo in Texas, she notes that sales in gift shops from rubber snakes provide funds of about $14,000 a year, which goes to the protection of a Peruvian rainforest (Sunquist, 1995). Sunquist asserts that zoos will still have animal exhibits that emphasize education, but these exhibits will be associated with field conservation programs that will be sponsored by the zoo. Sunquist concludes that the role of the zoo

will change, and that this role will be primarily involved with conservation efforts within the wild (Sunquist, 1995).

In addition to field conservation and research, education is another important area in which zoos can contribute to these countries where endangered species are at risk. Through education, zoos can encourage the conservation of the habitats and species in developing countries to the point where the role of breeding and reintroducing endangered species back into the wild would be worth the effort.

Legislation

If one of the goals of zoos is to reintroduce endangered species back to the wild, then legislation protecting their natural environments and their populations is an important aspect to the conservation and preservation of these species. Chadwick (1995) has noted that since the 1500's the United States alone has lost 500 species and subspecies of plants and animals. In the 1960's and 70's an environmental awareness was taking hold and recognition that some plants and animals were on the verge of extinction prompted the creation of the Endangered Species Act (Chadwick, 1995). In 1973 the United States Congress passed a bill to attempt to protect species that were endangered from extinction. The Endangered Species Act would allow the government to take action to prevent extinction (Chadwick, 1995). The Act was "based on assumptions that each life form may prove valuable in ways we cannot yet measure" (Chadwick, 1995: 7). Controversy has followed the Act since its inception. Chadwick points out that there is considerable debate over how to balance the rights of nature with economic concerns, property rights and growth (Chadwick, 1995). He states that under

the Endangered Species Act the Department of the Interior is required to develop recovery plans for each species listed (Orians, 1994). The act requires each agency within the government to examine any proposed action and how it might affect the endangered species listed under the Endangered Species Act. The U.S. Fish and Wildlife Service and the National Marine Fisheries, an agency under the National Oceanic and Atmospheric Administration, must determine whether proposed actions will have a deleterious affect on an endangered species.

In Clifford Sherry's book Endangered Species, he notes that the U.S. has several other laws that correspond to the Endangered Species Act. Some of these include the National Wildlife Refuge System, the Migratory Bird Treaty Act, the Wild Free Roaming Horses and Burros Act, the Marine Mammal Protection Act and the National Environmental Policy Act, 1969 (Sherry, 1998). Each of these Acts is designed for protection and regulation of wilderness areas and wildlife (Sherry, 1998). In addition to U.S. laws, Sherry cites several international treaties and conventions on the subject of endangered species. As a result of legislation involving the conservation of endangered species and their habitats, zoos have the opportunity to continue breeding for reintroduction of these animals back into their natural environments.

Chapter III

Endangered Species: Zoo and Wild Populations

Introduction

The definition of an endangered species used by the United States Government is "a species (which) is in danger of becoming extinct throughout all or a portion of its range" (United States. Fish & Wildlife Service, 1998a: 2). Many species from every part of the globe are now endangered due to habitat loss, introduction of exotic species, poaching, and human population growth. For these reasons, zoos play a more important role in the survival of endangered species. Breeding programs such as the Species Survival Program under the management of the American Zoological and Aquarium Association assists in the survival of many endangered species. The AZA and most zoos include conservation and management of wildlife as an important part of their mission statements.

The Importance of Zoos

As pointed out by Tilson and Christie (1999), zoos are having to overcome a past where animals were kept as "interesting objects" and where today's zoos are still characterized as having no valuable role in conservation. Tilson and Christie also state that today's zoo shows increasing diversity and that conservation is becoming the principal role of these institutions. In the United States zoos are the top entertainment destination with more than a million people visiting zoos annually (Christian, 1994).

Worldwide there are approximately 600 million people or 10 percent of the current world population that visit zoos each year. Three hundred and eight million people visit zoos each year in Asia alone (Tilson and Christie, 1999). It is noted that because so many people around the world visit zoos, these institutions are perfect places to bring about public awareness and education of the environment and the plight of endangered species (Tilson and Christie, 1999).

This chapter examines the changes in wild populations of selected endangered species and compares them to captive populations of the same selected endangered species. It attempts to show how these populations have grown in captivity due to breeding programs, while their numbers continue to decline within the wild. Three endangered species have been selected for this study in order to compare changes in captive populations to changes in wild populations. The species selected are the tiger, *Panthera tigris,* (all subspecies), the Asian elephant, *Elephas maximus*, (all subspecies), and the white rhinoceros, *Ceratotherium simum*, (all subspecies).

Data and Methodology

As populations of endangered species have decreased in the wild, populations of endangered species within zoos have increased worldwide. The objective of this hypothesis is to compare wild populations of selected endangered species to captive populations of the same endangered species in order to determine whether breeding populations in zoos are stable or growing relative to the wild populations of endangered species. Sources of data for population estimates for wild tigers, Asian elephants and white rhinoceros are varied and include journal articles and information provided from

those who work directly with these species. For the wild population data, I contacted the World Conservation Union Species Survival Commission Specialist Groups for each selected endangered species. This included Dr. Peter Jackson, Cat Specialist Group; Dr. R. Sukumar, Asian Elephant Specialist Group; and Dr. P. Martin Brooks, Chairman of the African Rhino Specialist Group. I obtained various published journal articles about the population status of these three endangered species, which supplemented the information gathered from these specialists. The numbers for wild populations are estimates based upon field surveys and other methods of counting wild populations. Gathering population data for wild and captive animals was a challenge. The population numbers for wild animals are estimates and cannot be completely precise but do provide a general profile of the population status among these endangered species.

Data for captive populations of tigers, Asian elephants, and white rhinoceroses came from the International Species Information System (ISIS) list of Studbook Keepers provided to me by Crispen Wilson of ISIS. Studbook keepers are those who keep track of the breeding populations of the selected endangered species in member zoos. I contacted each studbook keeper via e-mail and written letters and requested population information over a thirty-year to forty-year span of time from the 1960's to 1999. Published journal articles have also helped supplement the population numbers for captive animals.

With the data I received and gathered, estimated wild populations and zoo populations were compiled into tables by species and sub-species for each selected endangered animal. The tables show the years that correspond to the population numbers in the wild and in zoos. The wild population data was given with a minimum and a

maximum population estimate. For these numbers I averaged the minimum and maximum to get one estimated population number.* The averaged numbers were then used to show change over time within the wild populations of the selected endangered species. I also calculated percent change over time for each year given to show growth or loss within the wild and zoo populations.

Results

Tigers

A look at the population changes for tiger sub-species, reveals considerable variety from sub-species to sub-species. As noted previously zoo population numbers come the from the International Tiger Studbooks from 1980 to 1998. These numbers are those animals reported as living. The following sections discuss my findings for the different tiger sub-species.

Bengal Tigers. The Bengal or Indian Tiger is the most abundant of all tiger sub-species. It ranges mainly in the country of India but extends into other countries such as Nepal, Bangladesh, Bhutan and Myannmar. These tigers occupy a variety of habitats that include high altitude coniferous forests, mangroves and swamps, and wet forests (Tiger Information Center, <www.5tigers.org>, March, 2000).

The data for wild populations show that this sub-species has fluctuated quite dramatically from 1951 to 1993 most likely because there probably was not very good

* Admittedly there are drawbacks in doing this since averages are sensitive to extreme values.

data collection during this time. After 1993 the population fell about 6 percent, (Table 3.1) but, from 1996 to 1998 the population appeared to have stabilized. In fact there was a slight increase of 1 percent between 1997 and 1998.

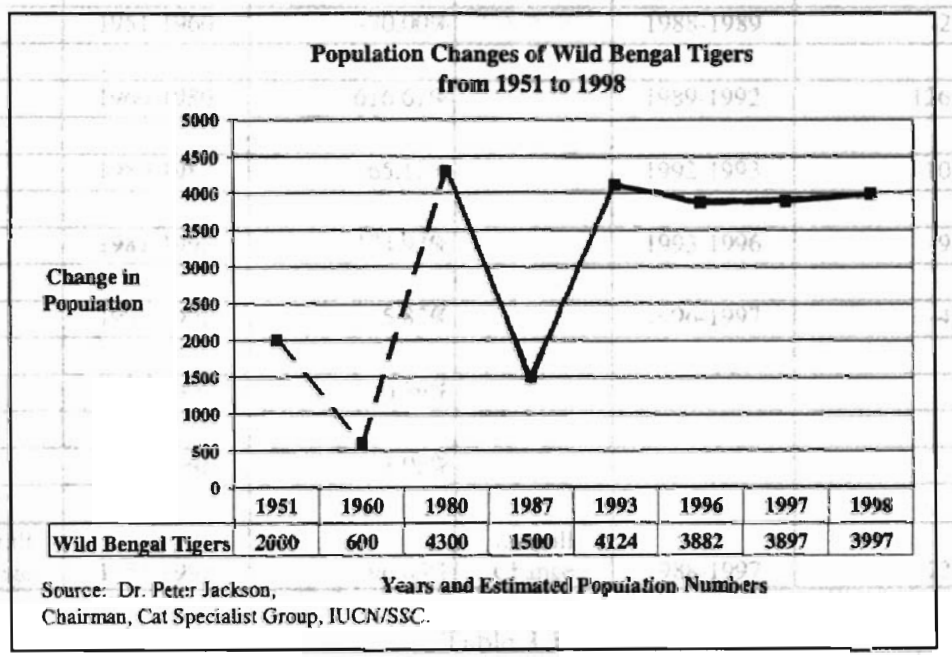

Figure 3.1

Percent Change in Wild and Zoo Populations of Bengal Tigers

Wild Bengal Tigers	Year	Percent Change	Zoo Bengal Tigers	Year	Percent Change
	1951-1960	-70.00%		1988-1989	-2.00%
	1960-1980	616.67%		1989-1992	126.53%
	1980-1987	-65.12%		1992-1993	-10.81%
	1987-1993	174.93%		1993-1996	-9.19%
	1993-1996	-5.87%		1996-1997	-4.78%
	1996-1997	-0.39%			
	1997-1998	1.03%			
Overall Change	1951-1998	96.85%	Overall Change	1988-1997	72.67%

Table 3.1

The breeding program of Bengal tigers in zoos has been extremely successful. There are now too many of these tigers for zoos to house. In addition to this, other sub-species of tigers have been bred with the Indian tiger creating hybrids that are unsuitable for conservation efforts (Tiger Information Center <www.5tigers.org>, March 2000).

Looking at the changes in the zoo population of Bengal tigers Figure 3.2 shows the success in breeding. From 1989 to 1992 the zoo population of the Indian tiger increased by 127 percent (Table 3.1). The years between 1992 and 1997 show the gradual decline of the zoo population. This is due to limited space in zoos for these large carnivores (Tiger Information Center,<www.5tigers.org>, March 2000).

In comparing the wild populations of Bengal tigers to zoo populations of Bengal tigers, it appears that wild populations of this sub-species seems to be stable, while the zoo populations are in decline.

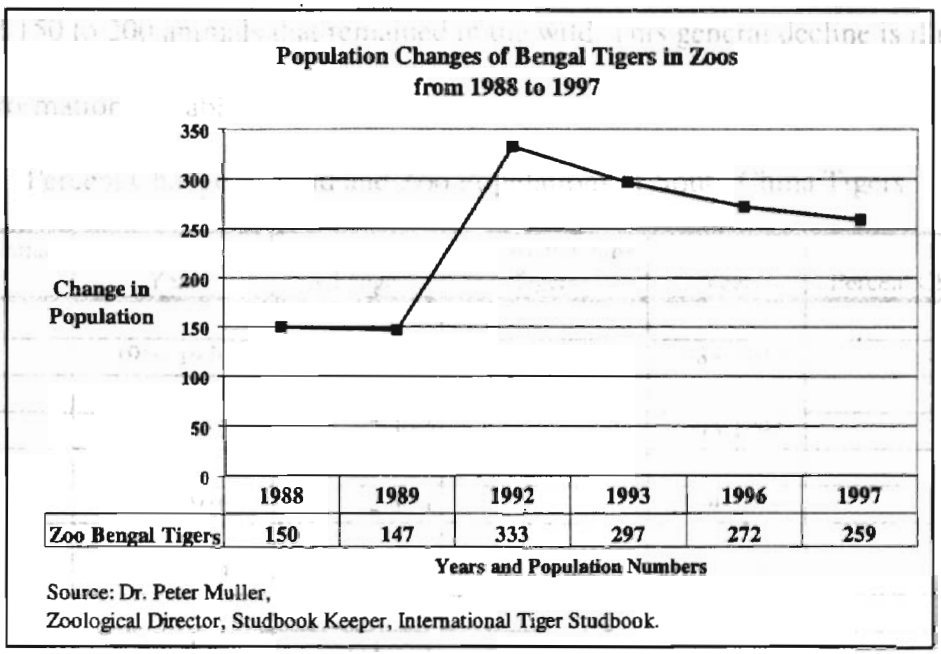

Figure 3.2

By comparing the overall changes within both wild and zoo populations Table 3.1 shows that over the longer term, zoo populations are mirroring wild populations by showing an overall increase over time.

South China Tigers. The South China tiger is the most critically endangered tiger sub-species with estimates ranging from 20 to 30 individuals left in the wild. During the 1950's China promoted an anti-pest campaign against tigers. The government documented the decline of the South China tiger by counting how many skins were reported taken each year (Tilson, et al., 1997). A figure amounting to about 80 skins a

year. In twenty years the number of the South China tigers declined from about 4000 animals in the 1950's to around 1000 animals in the 1970's (Tilson et al. 1997) (Figure 3.3). In 1982 the population estimates for the South China tiger had dwindled to an estimated 150 to 200 animals that remained in the wild. This general decline is illustrated by the information in Table 3.2.

Percent Change in Wild and Zoo Populations of South China Tigers

Wild South China Tigers	Year	Percent Change	Zoo South China Tigers	Year	Percent Change
	1950-1970	-75.00%		1988-1993	-30.77%
	1970-1982	-82.50%		1993-1994	47.22%
	1982-1986	-62.86%		1994-1996	-11.32%
	1986-1993	-15.38%		1996-1997	12.77%
	1993-1998	-54.55%			
Overall change	1950-1998	-99.38%	Overall change	1988-1997	1.92%

Table 3.2

In examining Figure 3.3, the wild population chart of the South China Tiger, shows that these animals have not been able to recover from China's anti-pest campaign and, as a result there are only an estimated 25 tigers left in the wild.

The population of South China tigers in zoos all reside in China. These tigers are descended from 6 wild tigers that were caught about 20 years ago. The ideal situation for these tigers, for genetic diversity, would be the case where 120 captive tigers would have descended from 30 wild-caught tigers. Unfortunately, the last South China tiger that was brought into captivity was about 20 years ago (Tiger Information Center, <www.5tigers.org>, March 2000).

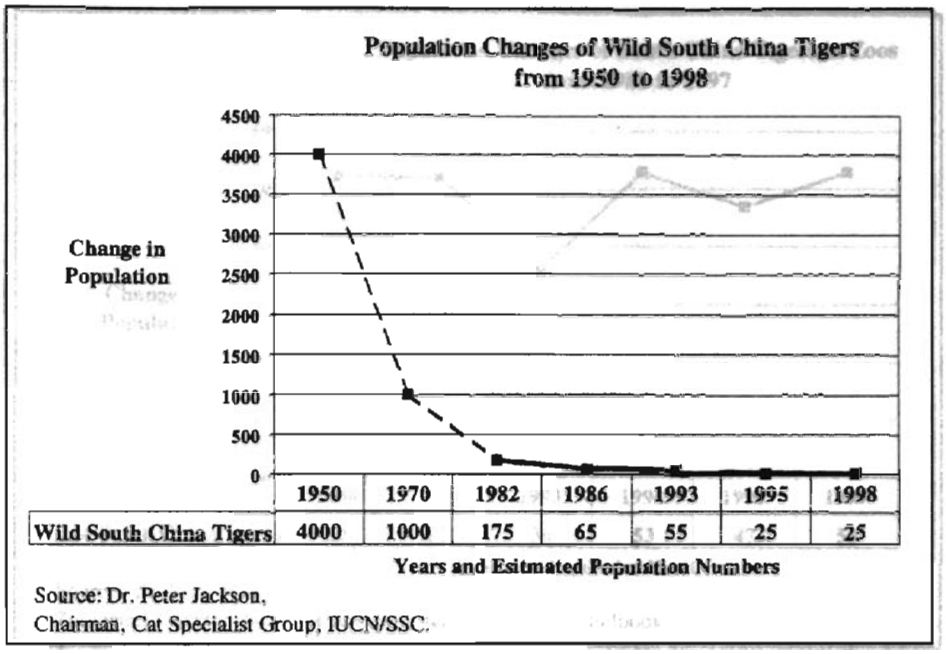

Figure 3.3

The zoo populations of South China tigers appear to be more stable than the wild populations. Figure 3.4 indicates that the zoo population has fluctuated, but was on the rise from 1996 to 1997. This was an increase of about 13 percent (Table 3.2). Although the zoo populations appear to be on the rise this particular sub-species still stands perilously close to extinction. In order to counteract the decline of this sub-species China, joined CITES in 1981. The IUCN was also called in to assess the Chinese Association Zoological Gardens husbandry and medical management operations. The South China Studbook and South China Tiger Masterplan were put into place as a result, to create a conservation breeding program for these tigers (Tiger Information Center, <www.5tigers.org>, March, 2000).

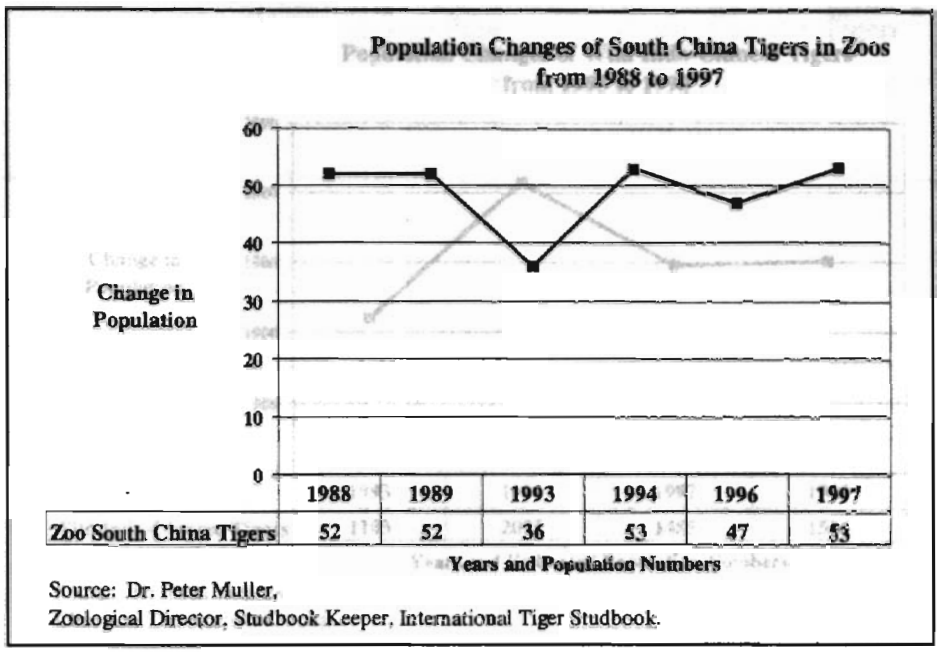

Figure 3.4

Indo-Chinese Tigers. The Indo-Chinese tiger is smaller in size, with darker, shorter and, narrower stripes than its cousin the Bengal tiger. This particular sub-species ranges from Southern China, and Thailand through Malaysia. Because this sub-species has a very extensive range the status of this tiger is very difficult to discern (Tiger Information Center, 2000). The available data for wild populations of Indo-Chinese tigers only goes back to 1993. These tigers increased from an estimated 1103 animals to an estimated 2075 animals between 1993 and 1996, shown in Figure 3.5. This was an increase of 88 percent, as indicated in Table 3.3. Although, the population numbers fell from 1996 to 1997 but appear to have stabilized in 1998.

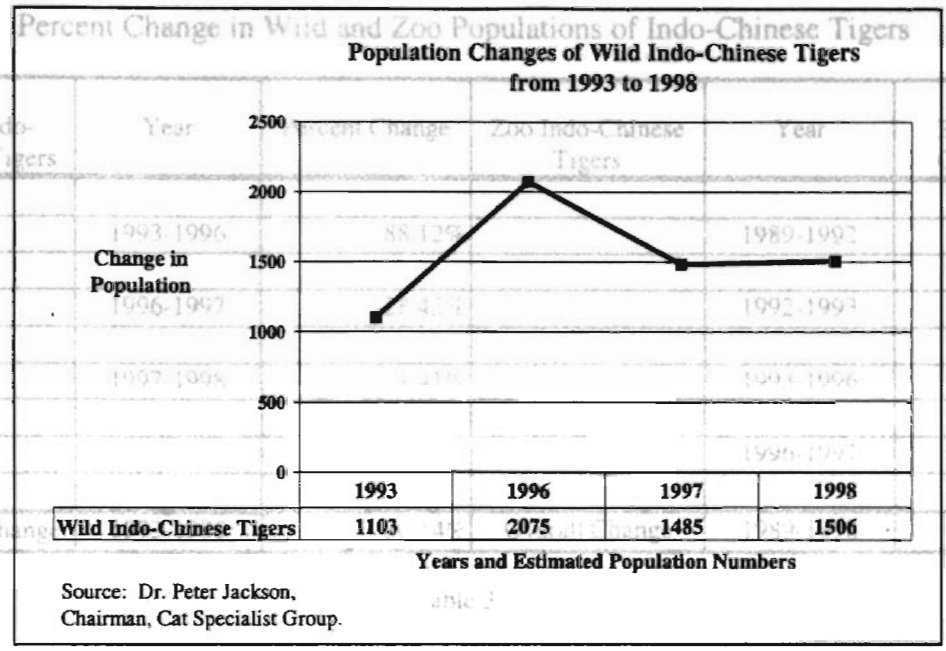
Population Changes of Wild Indo-Chinese Tigers
from 1993 to 1998
Change in Population
2500
2000
1500
1000
500
0
1993
1996
1997
1998
Wild Indo-Chinese Tigers
1103
2075
1485
1506
Years and Estimated Population Numbers
Source: Dr. Peter Jackson,
Chairman, Cat Specialist Group.

Figure 3.5

Percent Change in Wild and Zoo Populations of Indo-Chinese Tigers

Wild Indo-Chinese Tigers	Year	Percent Change	Zoo Indo-Chinese Tigers	Year	Percent Change
	1993-1996	88.12%		1989-1992	254.55%
	1996-1997	-28.43%		1992-1993	-17.95%
	1997-1998	1.41%		1993-1996	3.13%
				1996-1997	-9.09%
Overall Change	1993-1998	36.54%	Overall Change	1989-1998	172.73%

Table 3.3

Figure 3.6 shows that zoo populations of the Indo-Chinese Tigers seem quite low. The data of the population status of these tigers reveals a decline, but according to the Tiger Information Center there was an estimated 60 Indo-Chinese tigers in captivity in Asian and North American zoos (Tiger Information Center, <www.5tigers.org>, March 2000). These numbers in this study reflect only those tigers registered with the International Tiger studbook, and that are reported as living.

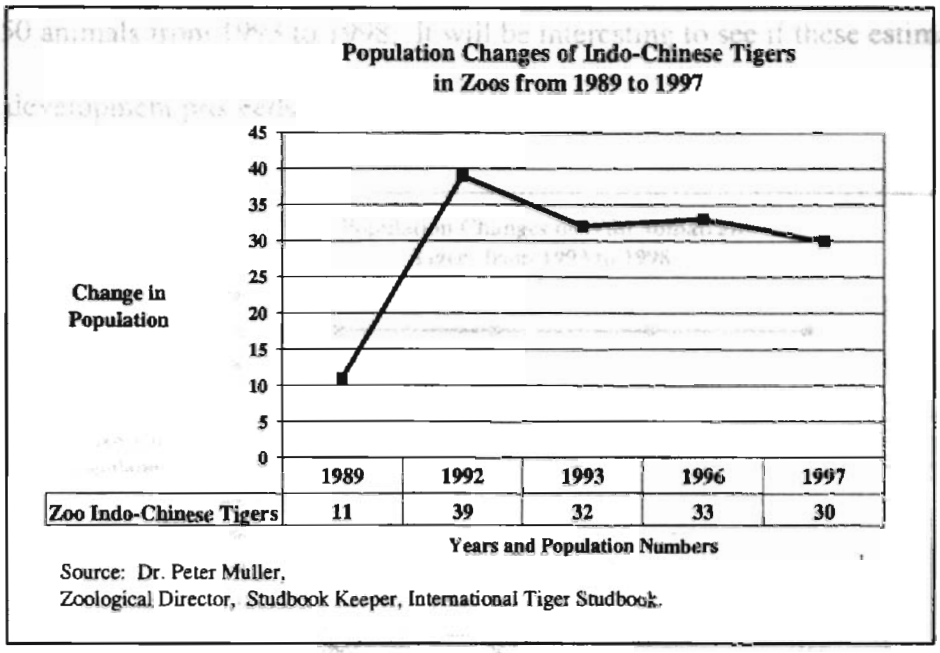

Figure 3.6

Comparing the zoo populations to wild populations of Indo-Chinese tigers the trend indicates that zoo populations have declined somewhat while wild populations have increased slightly. This may be due to increased conservation efforts for these tigers.

Sumatran Tigers. Because of agricultural development in Sumatra, the fragmentation of forests has diminished the Sumatran tiger's habitat. In 1992 an estimated 400 Sumatran tigers were living in five National Parks and two games reserves, according to the Indonesian Department of Forest Protection and Nature Conservation. It was also estimated that possibly another 100 tigers were in unprotected areas that were soon to be converted into agricultural land (Tiger Information Center, <www.5tigers.org>, March 2000). According to the estimated numbers gathered for this study, Sumatran tigers appear to be stable in the wild. Population estimates put these

tigers at 450 animals from 1993 to 1998. It will be interesting to see if these estimates change as development proceeds.

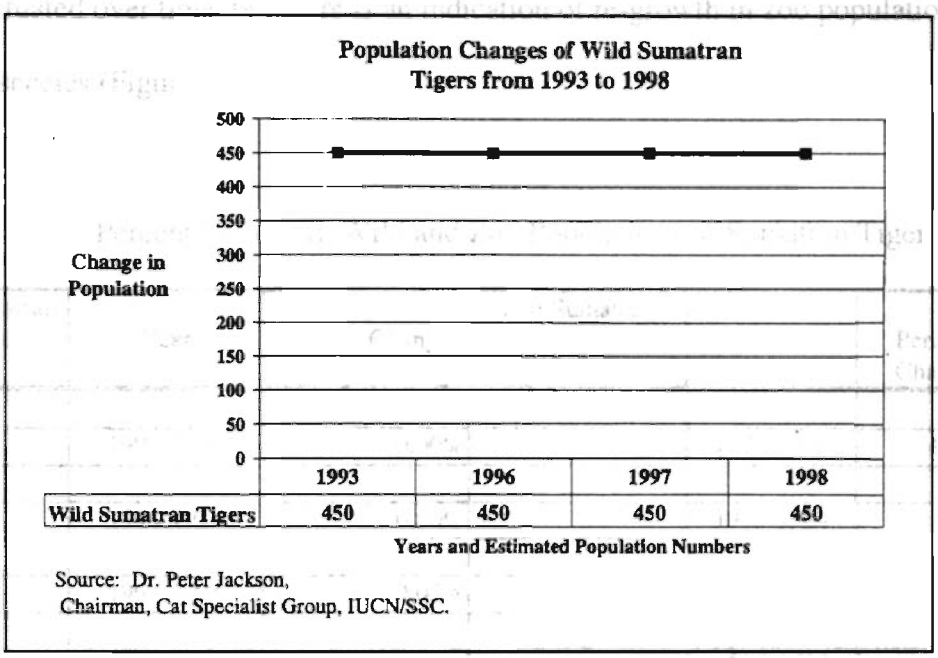

Figure 3.7

The Tiger Information Center website (www.5tigers.org) notes that the state of the Sumatran tiger in zoos is much better than it has been in the past. A conservation program has been developed for this sub-species through the Indonesian Zoological Parks' Association and the Tiger Global Conservation Strategy. The Tiger Global Conservation Strategy is a program designed for the effective management of captive tiger populations in order to successfully utilize these populations for wild tiger conservation. The Tiger GCS also assists in wild tiger conservation through research, conservation management, and conservation education for communities surrounding tiger reserves (Tiger Information Center, <www.5tigers.org>, March 2000). In examining the percent change in zoo populations the population grew approximately 52 percent from

1989 to 1993 (Table 3.4). There was a drop between 1993 and 1996 of 18 percent. From 1996 to 1997 the population rebounded 20 percent. Sumatran tiger populations in zoos have fluctuated over time, but there is an indication of re-growth in zoo populations of this sub-species (Figure 3.8).

Percent Change in Wild and Zoo Populations of Sumatran Tigers

Wild Sumatran Tigers	Year	Percent Change	Zoo Sumatran Tigers	Year	Percent Change
	1993-1996	0.00%		1976-1979	41.59%
	1996-1997	0.00%		1979-1984	-1.88%
	1997-1998	0.00%		1984-1989	5.10%
				1989-1993	51.52%
				1993-1996	-17.60%
				1996-1997	19.90%
Overall Change	1993-1998	0.00%	Overall Change	1976-1997	118.58%

Table 3.4

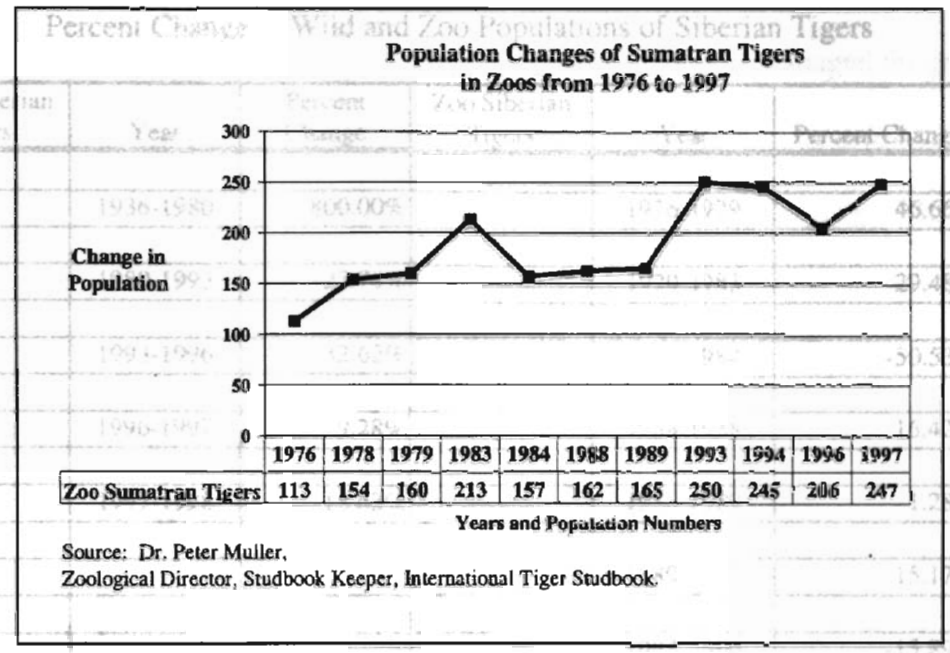

Figure 3.8

Siberian Tigers. Siberian tigers are the largest of all the tiger sub-species. They have survived four wars and two revolutions (Tiger Information Center, <www.5tigers.org>, March, 2000). The population counts for the Siberian tiger are considered to be the most accurate of all the tiger sub-species. The Siberian tiger appears to have made a dramatic comeback over a 44-year period from 1936 to 1980. The population from that point on fluctuated, but there was a decline from 1997 to 1998 shown in Figure 3.9, which represents a decline of around 19 percent (Table 3.5).

Percent Change in Wild and Zoo Populations of Siberian Tigers

Wild Siberian Tigers	Year	Percent Change	Zoo Siberian Tigers	Year	Percent Change
	1936-1980	800.00%		1976-1979	46.66%
	1980-1993	-27.78%		1979-1983	29.48%
	1993-1996	32.62%		1983-1984	-50.53%
	1996-1997	9.28%		1984-1988	16.42%
	1997-1998	-18.68%		1988-1989	1.28%
				1989-1993	15.17%
				1993-1996	-15.89%
				1996-1997	1.18%
Overall Change	1936-1998	666.00%	Overall Change	1976-1997	-20.06%
	1980-1998	-14.89%			

Table 3.5

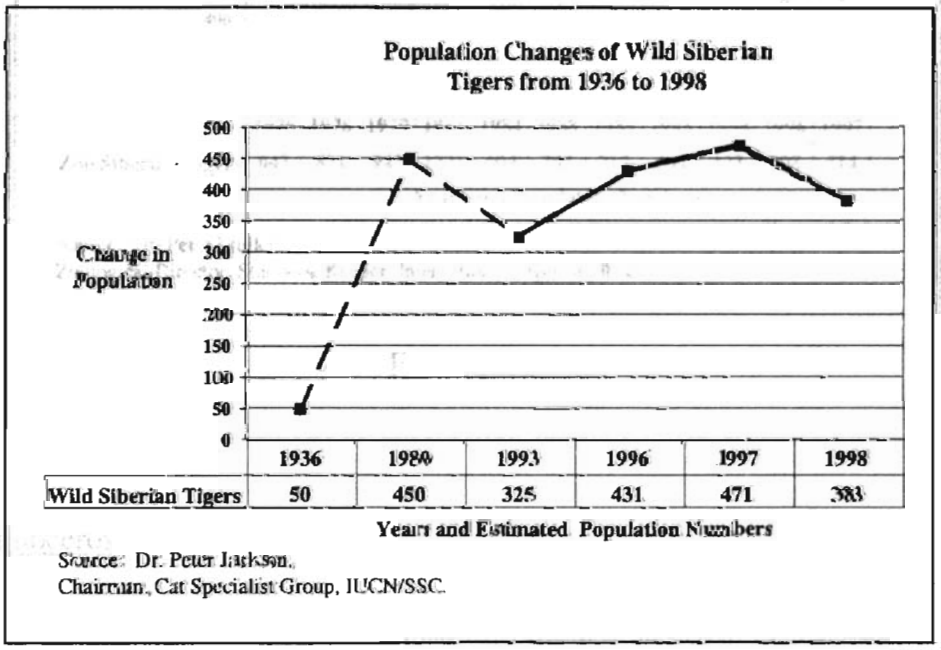

Figure 3.9

The Siberian tigers in zoos have had the largest and longest managed program for any of the tiger sub-species. This sub-species of tiger is considered to be genetically diverse and stable in captivity (Tiger Information Center, <www.5tigers.org>, March, 2000). According to Dr. Kathy-Traylor Holzer, the AZA Amur Regional Studbook Keeper in North America, Siberian tiger populations are being deliberately decreased to allow for needed space for the Sumatran and Indo-Chinese tigers in captivity. As indicated in Figure 3.10 the direction for the population is on the decline.

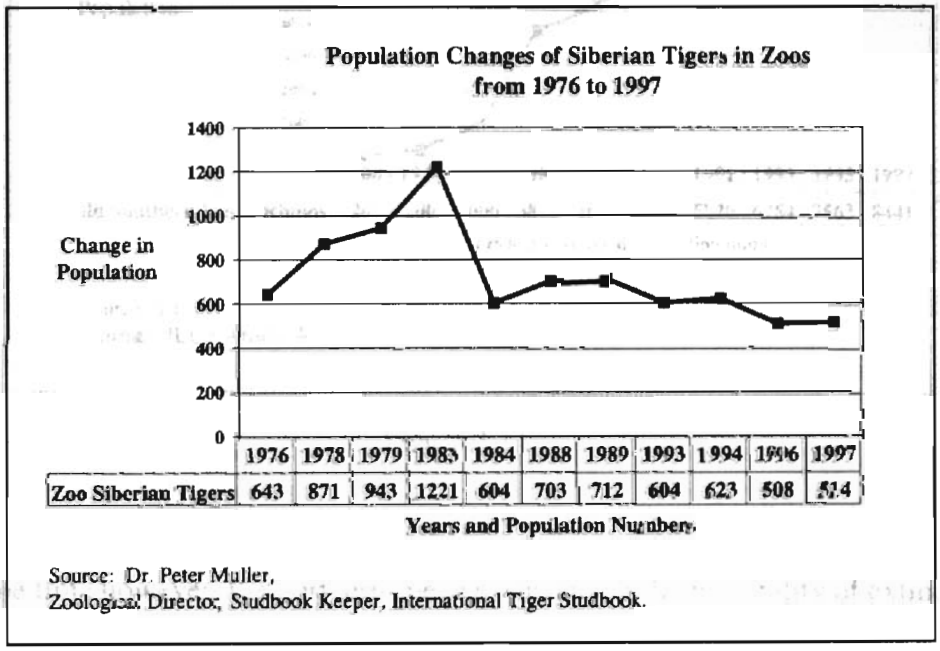

Figure 3.10

White Rhinoceros

There are two subspecies of white rhinoceros on the continent of Africa, the southern white rhinoceros and the northern white rhinoceros. Both subspecies are

considered endangered especially, the northern white rhino. The Southern white rhinoceros was on the verge of extinction at the turn of the 20th century, but by the mid 1980's it had recovered to about 3500 animals (Hillman-Smith, et al., 1986). Figure 3.11 shows the gradual increase of the Southern white rhinoceros, which is still on the increase today.

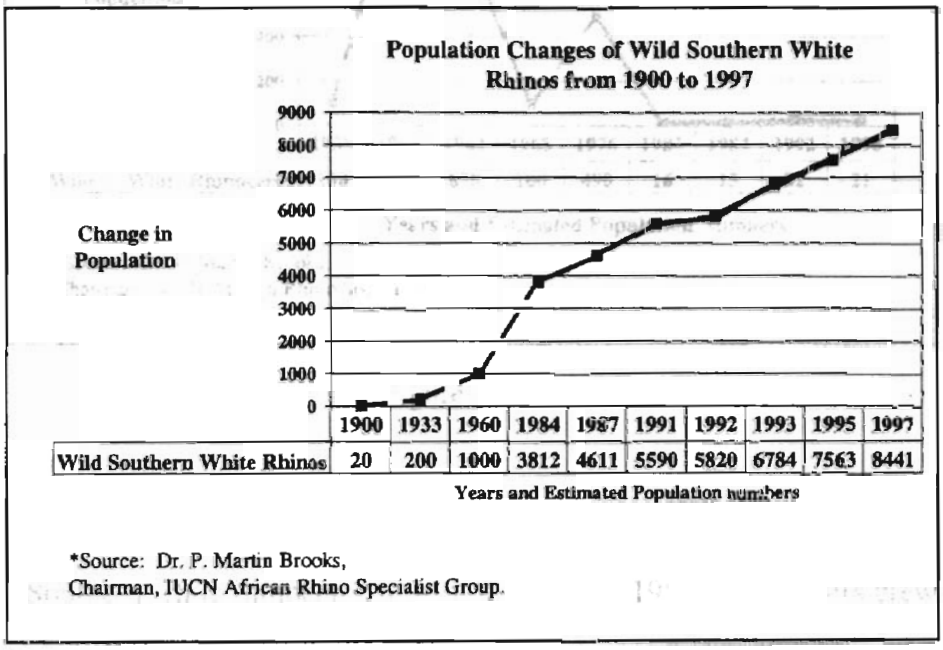

Figure 3.11

At the same time however, the northern species was facing the possibility of extinction. In 1979 it was believed that there were approximately 800 to 1000 animals left in the wild. The estimated numbers dropped by 1981 to around 700 animals and then to less than 50 northern white rhinos in the wild by 1983. This represented a loss of about 80 percent in the northern white rhino population (Hillman-Smith, et al., 1986). In 1982, a paper by Eric L. Edroma (1982) revealed that the white rhinoceros was extinct in Uganda (Edroma, 1982). Figure 3.12 shows the decline of the Northern white rhinoceros over the last 60 years.

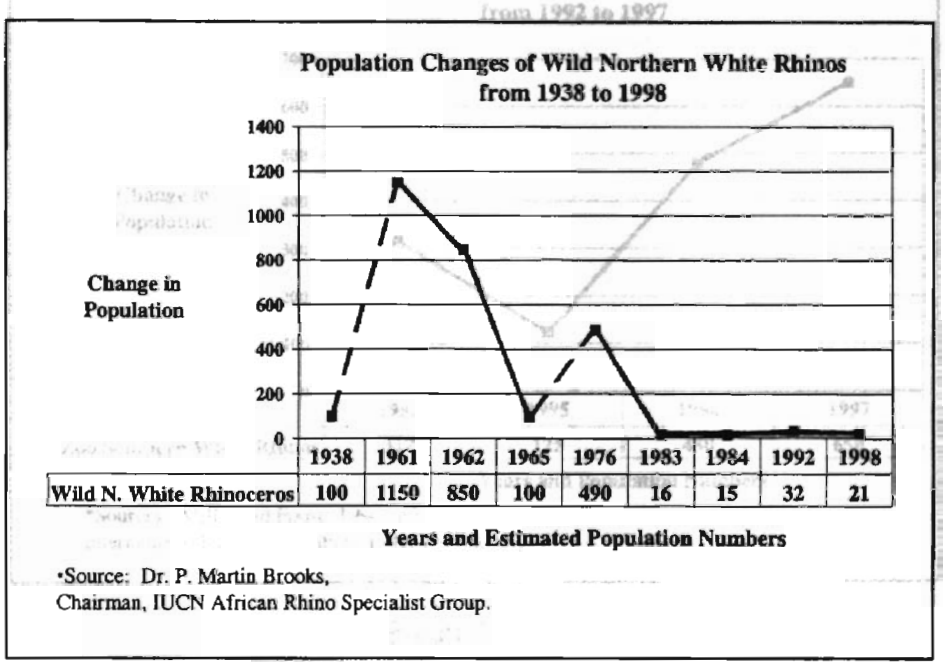

Figure 3.12

The Southern white rhinoceros in zoos declined in 1995 but numbers grew during 1996 and 1997. (Figure 3.13) Between 1996 to 1997 the population increased by 35 percent (Table 3.6). Both wild and zoo populations of this sub-species are on the increase.

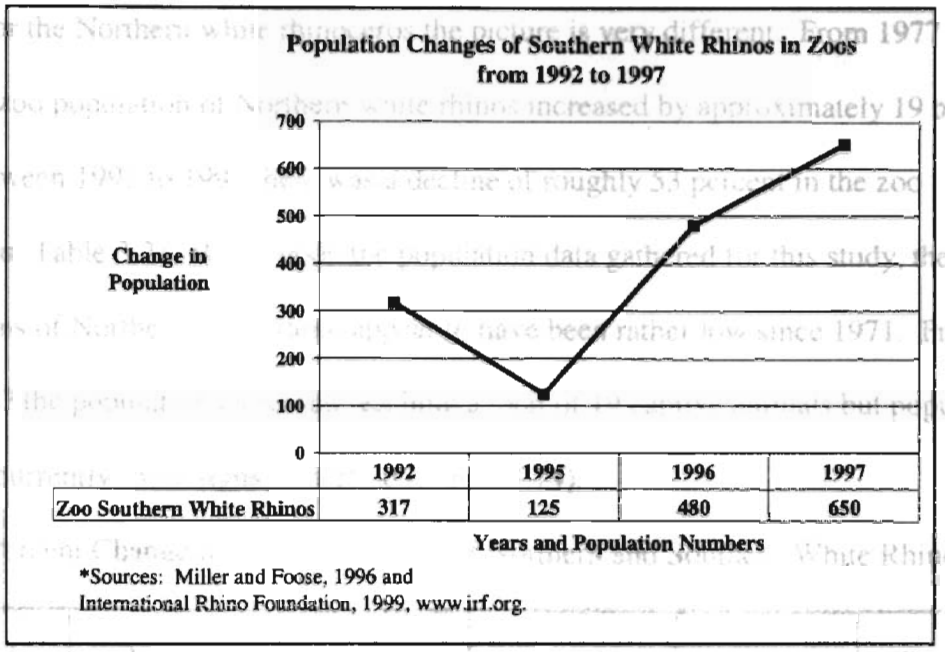

Figure 3.13

Percent Change in Wild Populations for Northern and Southern White Rhinoceros

Wild Northern White Rhinoceros	Years	Percent Change	Wild Southern White Rhinoceros	Years	Percent Change
	1938-1961	1050.00%		1900-1933	900%
	1961-1962	-26.09%		1960-1984	281%
	1962-1965	-88.24%		1987-1991	21%
	1965-1976	390.00%		1993-1995	11%
	1976-1983	-96.73%		1995-1997	12%
	1983-1984	-6.25%			
	1984-1992	113.33%			
	1992-1998	-34.38%			
Overall Change	1938-1998	-79.00%	Overall Change	1900-1997	42105%
	1961-1998	-98.17%		1960-1998	744%

Table 3.6

For the Northern white rhinoceros the picture is very different. From 1977 to 1992 the zoo population of Northern white rhinos increased by approximately 19 percent. Then, between 1992 to 1995 there was a decline of roughly 53 percent in the zoo population (Table 3.7). Based upon the population data gathered for this study, the zoo populations of Northern white rhino appear to have been rather low since 1971. From 1971-1992 the population increased reaching a total of 19 captive animals but population numbers currently show signs of decline (Figure 3.14).

Percent Change in Zoo Populations of Northern and Southern White Rhinoceros

Zoo Northern White Rhino	Years	Percent Change	Zoo Southern White Rhino	Years	Percent Change
	1971-1977	128.57%		1992-1995	-61%
	1977-1992	18.75%		1995-1996	284%
	1992-1995	-52.63%		1996-1997	35%
	1995-1997	0.00%			
Overall Change	1971-1997	28.57%	Overall Change	1992-1997	105%
	1992-1997	-52.63%			

Table 3.7

In comparing zoo and wild populations of these two sub-species wild and zoo populations are on the rise for the Southern white rhinoceros. It appears that both wild and zoo populations of Northern white rhinoceros are in decline and are on the threshold of extinction.

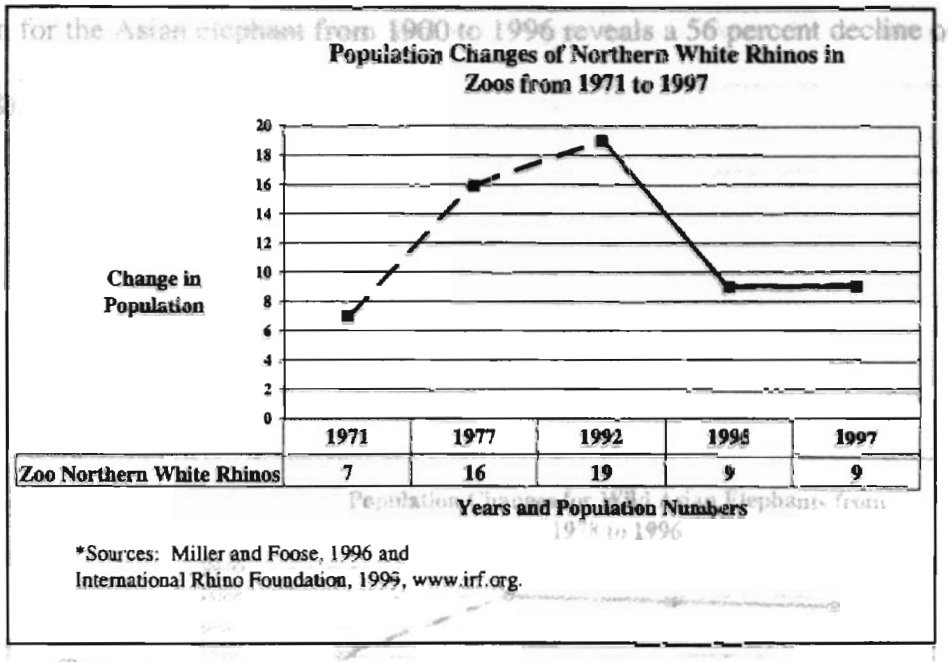

Figure 3.14

Asian Elephants

Unfortunately, the data on Asian elephants was very sparse and difficult to obtain. There was very little information on the zoo populations of Asian elephants, and I was only able to gather one data set.

The population graph for wild Asian elephants reveals very little change during the years from 1978 to 1996 (Figure 3.15). Between 1978 and 1989 there was a 29 percent increase in population (Table 3.8). After that, the population declines 3.27 percent during the period from 1989 to 1996. Changes in population from 1979 to 1996 indicated a 26 percent increase. According to the World Wildlife Fund there were an estimated 100,000 Asian elephants at the turn of the 20th century (World Wildlife Fund <www.panda.org>, August, 1999a). Based upon this number, changes in the overall

population for the Asian elephant from 1900 to 1996 reveals a 56 percent decline overall (Table 3.8).

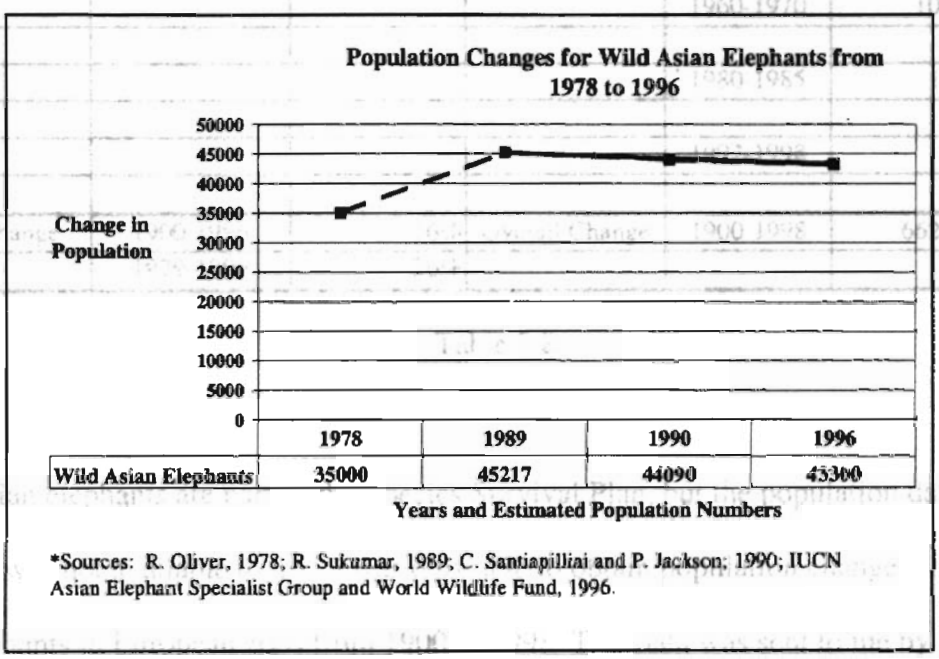

Figure 3.15

Percent Change in Wild and Zoo Populations of Asian Elephants

Wild Elephants	Year	Percent Change	European Zoo Elephants	Year	Percent Change
	1979-1989	29%		1900-1914	175.00%
	1989-1990	-3%		1914-1920	-36.36%
	1990-1996	-0.27%		1920-1930	28.57%
				1960-1970	104.48%
				1980-1985	17.95%
				1997-1998	1.13%
Overall Change	1900-1996	-56%	Overall Change	1900-1998	6625.00%
	1979-1996	26%			

Table 3.8

Asian elephants are part of the Species Survival Plan, but the population data for most zoos was not available to me. I was only able to obtain population changes for Asian elephants in European zoos from 1900 to 1998. This data was sent to me by Dr. Rob Belterman, Animal Records Officer, EEP of the Rotterdam Zoo. Figure 3.16 shows the increase of European zoo populations over time. In 1990 the population peaks at 276 animals. From 1990 to 1995 the population declines and stabilizes around 260 animals. The percent change in the European zoo population from 1900 to 1998 has increased by approximately 6000 percent. According to the Cincinnati zoo website, the Species Survival Plan for Asian elephants includes 132 cows and 22 bulls in North America (Cincinnati Zoo Online, <www.cincy.zoo.org/>, February, 2000).

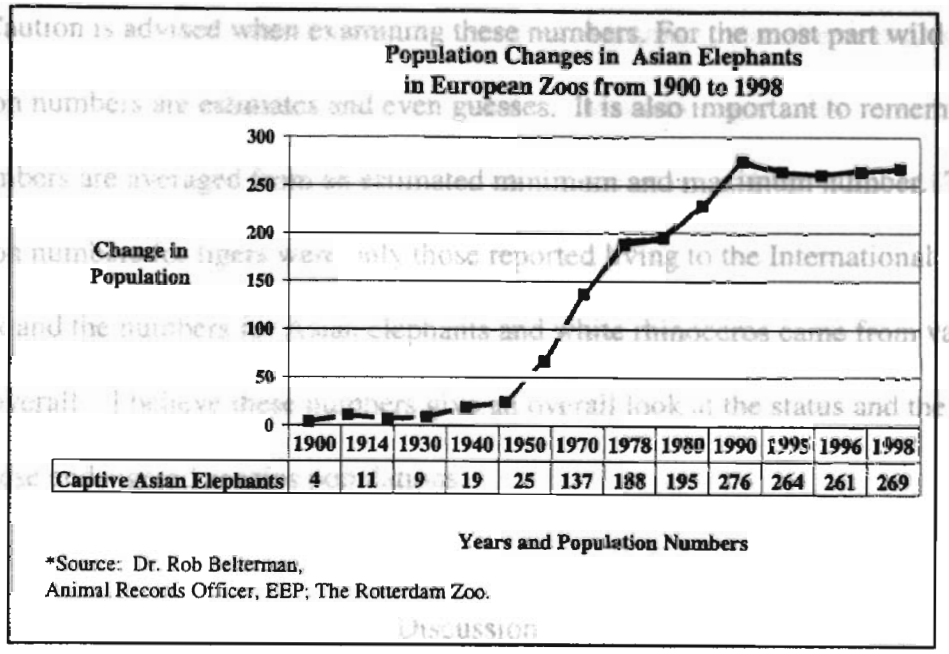

Figure 3.16

Overall Results

The overall results show that zoo populations of endangered species do not necessarily increase as the wild populations decline. In the case of the Northern white rhinoceros both wild and zoo populations appear to be in decline. The numbers for the Southern white rhinoceros in both wild and zoo populations showed that they were increasing. The data for the Bengal tiger indicates the results were in opposition to the hypothesis. The zoo populations were declining while the estimated populations of wild tigers seemed to be increasing or were stable. In the case of the Indo-Chinese tiger the numbers suggested the same scenario as the Bengal tiger with zoo populations in decline and wild populations were increasing or stable.

Caution is advised when examining these numbers. For the most part wild population numbers are estimates and even guesses. It is also important to remember that these numbers are averaged from an estimated minimum and maximum number. The zoo population numbers for tigers were only those reported living to the International Studbook and the numbers for Asian elephants and white rhinoceros came from various sources overall. I believe these numbers give an overall look at the status and the trends within these endangered species populations.

Discussion

In order to understand why these population numbers appear the way they do, we must discuss the reasons why these animals are endangered, and explore their current situation within the wild and within zoos.

Tiger Status

At the turn of the 20th century (1900) about 100,000 tigers roamed the vast region of Asia. This included the areas of Russia, China, Korea, India, and Southeast Asia (Indonesia and Malaysia). Tiger populations have dwindled at an alarming rate over the last 100 years. Three tiger subspecies are now extinct. These include the Bali, Javan and Caspian subspecies. There are five subspecies that remain, and all are critically endangered. The remaining subspecies include the Siberian or Amur tiger, Bengal or Indian tiger, the Sumatran tiger, the Indo-Chinese tiger, and the South China tiger.

In 1995 a Wildlife Conservation Society report estimated that the overall tiger populations in the wild were less than 5000 animals. Many biologists and conservationists believe that this number is much lower and possibly at or near 3000 tigers left in the wild (Matthiessen, 1997).

The estimates for wild populations of tigers are very difficult to obtain. Tigers, which are forest dwelling animals, are very secretive. Many estimates of wild populations come from reported sightings by the local people, from tiger signs such as scrapes and footprints (pugmarks), from calculating the carrying capacity of available habitat, and through guesswork. New methods are being employed to get a more accurate count of wild tiger populations. One method being used is the camera trap. Researchers capture tigers on film and identify them by their unique patterns of stripes (Lynam, et al, 1999).

The causes of this rapid loss in numbers of tigers vary. The main causes are habitat loss, human population growth, and poaching (Tilson, et al., 1997). A growing demand in Asia for tiger parts that are used in traditional Chinese medicine has placed increasing pressure on all subspecies of tiger since 1990. Some experts consider this to be the most critical threat to the survival of tiger populations. Although tigers are protected under Appendix I of the Convention of International Trade of Endangered Species of Wild Fauna and Flora (CITES), the illegal trade in tiger parts persists. Countries such as China, South Korea, and Taiwan all have banned the trade in tiger parts, however China is the number one consumer and exporter of tiger bones and all other tiger parts (Tilson, et al., 1997). During 1990 through 1992 China exported 27 million units of tiger derived medicines to 26 different countries and territories (Tilson, et

al., 1997). Tiger parts are considered cures for many types of ailments ranging from rheumatism to dysentery. Tiger bone itself is believed to be an aphrodisiac and a substance that promotes sexual stamina (United States. Fish and Wildlife Service, 1998b). It is obvious that bans on trade in tiger parts have not stopped the poaching or lessened the demand.

In 1994 the United States the imposed wildlife trade sanctions on Taiwan for illegal trade in tiger and rhinoceros parts (United States. Fish and Wildlife Service, 1998b). It was the first time the U.S. government acted against illegal trade in endangered wildlife (United States. Fish and Wildlife Service, 1998b).

Tigers in Zoos

According to the European Endangered Species Programme (EEP), there are four conservation strategies that tigers in zoos provide towards the survival of the species. This includes, "preserving genetic diversity over time, educating and informing the general public, fund-raising, and information gathering" (Christie, personal communication, 01 September, 1999).

Many tigers in zoos are hybrids and therefore are not used for breeding purposes. Breeding of tigers in zoos is carefully controlled because space in zoos is limited, and tigers need large spacious enclosures. Limits are set on how many cubs are born. Controlled breeding allows cubs to replace the adults who have died. Zoos also have to take into account the most viable genetic pairings for tigers to ensure genetic diversity within zoo populations. These populations contribute to the "genetic reservoir" of tigers to ensure the survival of the species. Currently, there are no plans for the reintroduction

of any tiger subspecies. Many of the problems that are causing tiger populations to dwindle have not been solved or addressed sufficiently to justify the reintroduction of tiger populations in the wild (Christie, personal. comm., 01 September, 1999). A related problem is that many captive-born tigers would not be adapted for reintroduction into the wild. Some programs are considering the possibility of artificial insemination of wild females with unrelated captive males (Christie, personal. communication., 01 September, 1999).

White Rhinoceros Status

According to the International Rhino Foundation the 1999 population of northern white rhinoceros in the wild has dwindled to less than 25 animals. This estimate is 20 percent below the 1994 estimate of 30 to 34 animals (International Rhino Foundation, 1999). This is the last surviving wild population of northern white rhinoceroses in the world (*Ceratotherium simum cottoni*). This particular population lives within the Garamba National Park in the Democratic Republic of Congo. Due to recent civil war within the region, conservationists are very concerned about the status of this last remaining northern white rhino population. According to the IUCN African Rhino Specialist Group, northern white rhinoceros populations have fluctuated greatly from 1935 to 1995. It also noted by the IUCN that these populations of rhinoceros show notable growth in population when they are provided protection (Brooks, Letter to Author, 20 September, 1999).

Reasons for decline in all rhino populations are habitat loss, increasing human population, which in turn causes the increased need for agricultural and urban lands, and

illegal hunting or poaching. As with the tiger, poaching has hastened the decline of the white rhinoceros, and is also considered to be the greatest immediate threat to all rhino populations. Rhino horn, as with tiger parts, are used in traditional Chinese medicine. The powdered rhino horn is believed to cure fevers, nose bleeds and measles. It is also thought that it can help sustain youthful vigor and sexual stamina (United States. Fish and Wildlife Service, 1998a).

All rhinoceros subspecies are protected under CITES. Countries such as Yemen, South Korea, China, and Taiwan all are being threatened with trade sanctions because of alleged violations of CITES agreements (United States. Fish and Wildlife Service, 1998a). In Yemen, for example, the handle of a jambiyya, or dagger worn by men has historically been carved from rhino horns, although this practice is now changing.

White Rhinoceroses in Zoos

Under the Species Survival Program, captive management is designed to maintain rhinoceros populations that are demographically and genetically viable (Miller and Foose, 1996). According to Miller and Foose, the demographics of the rhinoceros population are considered more important than genetic considerations at this point. This approach stresses the need to make sure that there is a captive population of rhinoceroses that is able to maintain itself through reproduction (Miller and Foose, 1996). Genetic considerations are very important as well. The goal is to maintain a captive population of rhinoceroses that retain "90 percent of the average gene diversity that occurs within wild populations over a 100 to 150 year time period" (Miller and Foose, 1996: 24). This equates to about 7 to 10 generations of rhinoceros (Miller and Foose, 1996).

In 1970 and 1971 Heinz-Georg Klos and Reinhard Frese observed that according the current international studbooks at that time, the African rhinos held in captivity had increased by twofold. It was also noted by Klos and Frese that there were a number of white rhinos in captivity that were unregistered due to the lack of cooperation of governments of Japan, and Russia. They had also observed that death rates in white rhinos was very low (Klos and Frese, 1978).

The San Diego Wild Animal Park is considered to have to have the most successful captive-breeding program of rhinos in the world. Since the San Diego Wild Animal Park opened in 1972, there have been 119 births. Eighty-three of these births were southern white rhinos. The park currently is maintaining 27 rhinos, which includes 8 southern white rhinos and 4 northern white rhinos (Robinson, 1998). The Dvur Kralove Zoo in the Czech Republic is currently maintaining five northern white rhinos. These five plus the four in San Diego constitutes the entire captive population of northern white rhinoceros, a total of just nine animals. It is noted by the International Rhino Foundation that the northern white rhinoceros has not been reproducing well in captivity and this gives it the unfortunate distinction of being the most endangered species of all the rhino taxa (International Rhino Foundation,<www.rhinos-irf.org/index.html> January, 1999).

Asian Elephant Status

Estimating the numbers of Asian elephants in the wild also proves very difficult. As with tigers, the Asian elephant is a forest dwelling animal. According to Dr. R.

Sukumar the wide margins between minimum and maximum estimates illustrates the difficulties in surveying wild populations of forest dwelling animals. Dr. Sukumar also indicates that there is a lack of systematic surveys for numerous reasons (Sukumar, 1989). Political situations in some countries have made the task virtually impossible to conduct field surveys to count wild Asian elephant populations (Sukumar, 1994). In the last ten years the World Conservation Union's Asian Elephant Specialist Group along with the World Wildlife Fund have put together a rough estimate of population numbers for the Asian elephant to show the elephants' current distribution and status (Sukumar, 1994). In 1994, estimates of Asian elephant populations were between 34,000 and 56,000 (Tudge, 1994). According to the IUCN Asian Elephant Specialist Group, there is an estimated 38,000 to 51,000 wild Asian elephants today in the wild. More attention has been given to the plight of the African elephant, which has a population of approximately 600,000. The Asian Elephant, with an estimated 15,000 working elephants in captivity combined with the total wild populations of Asian elephants, represents only 10 percent of the total estimated African elephant population (Sukumar, 1994).

Within the Asian Elephant's range, twenty percent of the world's human population reside. It is estimated that with the current rate of human population growth at three percent a year, the human population within the elephant's range will have doubled in 23 years. The forests of Asia, where these animals range, have been seriously depleted. Many Asian countries have cleared their forests to accommodate increasing numbers of people and to expand agricultural land (Kemf and Jackson, 1996. <www.panda.org/resources/publications/species/w-elephants/page1.htm >16, March, 2000). In India only 20 percent of the country's forests remain, and much of this forest

land is degraded and not suitable as Asian elephant habitat. Fragmentation of forests is a serious problem for elephants due to the fact that elephants migrate with food sources as the seasons change (Kemf and Jackson, 1996. <www.panda.org/resources/publications/species/w-elephants/page1.htm >16, March, 2000). This brings the migrating elephants into conflict with communities that have encroached upon their natural habitats and have obstructed their migration routes.

The decline of wild Asian elephants can be attributed not only to habitat loss but also to the removal of elephants from the wild for domestic use. In contrast, African elephant populations have been devastated by ivory poaching (Sukumar, 1994). Captive working elephants are an important aspect to the economy of many Asian countries. They are used within the forestry industry to gain access to areas that are inaccessible to vehicles and are utilized in other domestic tasks. Elephants mature slowly, and spend many years as juveniles. Because of this fact, rather than breed these elephants, mature adults are most often taken from the wild, trained, and then put to work (World Wildlife Fund for Nature, 1996; <www.panda.org>, September, 1999). Other factors involved in the decline of Asian elephants include poaching, loss of genetic diversity, and, disease.

Asian Elephants in Zoos

There are approximately 15,000 captive working Asian elephants in Asia, but according to Victoria Taylor and Trevor B. Poole, very few these captive populations of Asian elephants that are self-sustaining (Taylor and Poole, 1998). These captive-working elephants represent about 21 to 33 percent of the total estimated populations of

Asian elephants around the world (Taylor and Poole, 1998). Populations of Asian elephants in zoos appear to be quite low in comparison. This is due to difficulty in breeding these animals as well as limited space for zoo populations (Schmid, 1998). The Asian elephants in North American zoos are part of the Species Survival Plan. According to the Cincinnati zoo there are approximately 400 Asian elephants in zoos worldwide. (Cinncinati Zoo, <www.cincy.zoo.org/>, February, 2000). Of these, there have only been 67 births of Asian elephants in zoos within North America. Thirty percent of all baby Asian elephants born in captivity did not survive their first year (Fort Worth Zoo, <www.fortworthzoo.com/baby_elephant.html>, April, 2000). One of the biggest problems is maintaining bull elephants in captivity. The male elephant becomes aggressive and dangerous during the musth phases where a fluid is produced on the sides of the males head which is signal to the female that he is ready to mate. Zoos that maintain Asian elephants face many challenges with breeding and up-keep of these captive giants.

Conclusions and Limitations

Again, the definition of an endangered species as defined by the United States Government is "a species (which) is in danger of becoming extinct throughout all or a portion of its range" (United States. Fish & Wildlife Service, 1998a: 2). All the species within this study are endangered, meaning these populations have been and are in decline, and could become extinct in all or part of their natural ranges. The population numbers and graphs suggest that the depending on the endangered species, the conservation of its wild populations, and the management of populations within zoos, all

zoo populations are not increasing and not all wild populations are in decline. Dr. Kathy Traylor-Holzer the AZA Amur Regional Studbook Keeper in North America, suggests that space within zoos is a limitation for captive populations as is a loss of habitat is for wild populations of animals (Traylor-Holzer, personal communication, April, 2000). This indicates that both wild and zoo populations face limitations in population size due to limited space within the habitat or within the zoo. In the case of the Siberian tiger, the zoo populations are deliberately being limited to make space for other sub-species of tiger.

The limitations of this study are important to discuss in order to improve the research on this topic. The biggest limitation of this research was finding good population data. The Asian elephant population data was the most difficult to obtain. Most of the information on Asian elephants came from published books and articles. Another limitation of this particular research is that it only examined three species of mammal populations. Results may prove to be very different for other animals. In a letter I received from Dr. Nick Lindsay of the Zoological Society of London at the Whipsnade Wild Animal Park, it is noted that the species within this study do not benefit from a fully managed breeding program, and the problems associated with these programs. He states that the elephant and rhinoceros have been held in captivity for many years, but have only recently been under managed breeding. He also states that these two particular species are known to be difficult to breed in captivity, and therefore do not represent the value of captive breeding programs. Dr. Lindsay gives the example of the Arabian oryx or the Scimitar horned oryx as better examples of long-term project animals that contain field information of wild population declines (Nick Lindsay,

personal communication, 02 September, 2000). With Dr. Lindsay's suggestions, further research of this topic would prove to be valuable in comparing the status of wild populations of endangered species to the captive breeding populations within zoos.

This research allowed me to examine the issues and difficulties of conservation and management of wild and captive populations of endangered species. I also believe it was valuable in showing the trends in both wild and zoo populations of the selected endangered species. It is my hope that this research helps to address the deficit in research within geography on the topic of animals, and that this will also add to the body of research of endangered species and wildlife population studies.

Chapter IV

Protected Areas and Endangered Species

Protected Areas and Conservation

According to the World Conservation Strategy:

> Preservation of genetic diversity is both a matter of insurance and investment—necessary to sustain and improve agricultural, forestry, and fisheries production, to keep open future options, as a buffer against harmful environmental change, as the raw material for much scientific and industrial innovation—and as a matter of moral principle" (Lucas, 1982: 73).

In 1972 the Third World Congress on National Parks declared that national parks and other protected areas are an indispensable element to conservation (McNeely, 1990). Ecological processes which rely on natural ecosystems are guarded from degradation by maintaining protected areas (McNeely, 1990). These areas are also important for the preservation of biodiversity and genetic variation, which in turn guards against irrevocable loss of the natural ecosystem. They are also valuable for the protection and sustainable use of species of plants and animals. Finally, protected areas create opportunities for scientific research, education, recreation and tourism (McNeely, 1990). The need for protected areas is becoming more important as the human population grows and the demand for natural resources increases. Protected areas are vital to the survival of species under threat from pollution, the alteration of habitats, competition and exploitation of natural resources, and from predation associated with alien species (Pritchard, 1993). The creation and establishment of these areas has proved to be instrumental in protecting endangered species from extinction (Lucas, 1982).

In 1997, the United Nations listed 12,754 areas worldwide as protected. These protected areas are listed by the categories and criteria set up by the IUCN. According to this list there are more than 13.2 square kilometers (five million square miles) of protected area throughout the world, which is equivalent to an area greater than the United States or China. According to the IUCN, protected areas have increased by 3.9 million square kilometers (1,505,798 square miles) since 1993 when the last edition of the UN list was compiled (World Conservation Monitoring Center, <www.wcmc.org.uk> 22, November, 1999). Although this represents a mere 9 percent of the world's land area, the IUCN warns that even this figure may be inflated due to the inclusion of marine protected areas. If marine protected areas are excluded then the percentage of protected area drops to just under 8 percent of the world's land area (World Conservation Monitoring Center,<www.wcmc.org.uk> 22 November, 1999).

Zoos are playing a more important role in the protection of endangered species within protected areas (in-situ conservation) due to the fact that there is an increasing number of endangered species, a lack of space within zoos, and shrinking habitats around the world. It is noted by Michael Hutchins, director of the AZA, that captive breeding programs are becoming impractical (Sunquist, 1995). Zoos are changing their roles and conservation of natural habitats is becoming a very important part of the zoo mission. The majority of endangered species live in developing countries. These countries often lack the resources for protection of species and habitats. Money spent on protection of endangered species has been key to their survival. According to Nigel Leader-Williams of Cambridge University, in 1980 the national wildlife authorities within all the sub-

Saharan countries of Africa had a total budget of 75 million dollars (Sunquist, 1995). The San Diego Zoo, in comparison, had an annual budget of 70 million dollars. Money coming from zoos is making a notable impact on habitat protection and anti-poaching campaigns (Sunquist, 1995).

Data and Methodology

There is a connection between the growth or loss of an endangered species to the amount of protected area within its range countries or regions. The aim of my second hypothesis was to compare protected areas to the wild populations of endangered species and to look at the relationship between these two factors. This is being done in order to determine if in fact protected areas are contributing to the protection of endangered species populations. Data on protected areas was acquired from the World Conservation Monitoring Centre website under the Protected Areas Information Service. The data that was utilized for this project came from the 1997 United Nations List of Protected Areas (www.wcmc.org.uk/protected_areas/data/un_97_list.html). Countries were chosen based upon the selected endangered species range countries. The endangered species include the previously selected species of tiger (all subspecies), white rhinoceros (all subspecies) and Asian elephants (all subspecies).

The World Conservation Commission (IUCN) has divided protected areas into categories based upon management objectives. The IUCN has identified seven categories of protected areas. Five of the seven categories were employed within this study. I excluded marine protected areas because marine species are not being considered in this

study. I also restricted the study to only those categories designated for the protection of wildlife. The definitions for these categories are as follows:

Category Ia is defined as a Strict Nature Reserve. It is an area protected and managed for scientific research. Category Ib is classified as a Wilderness Area. These sites are managed in order to maintain the natural conditions of an area. National Parks fall under Category II. National parks are managed for ecosystem protection and recreation. Many endangered species are protected within national parks, and therefore are included within this study. Category IV is specifically managed for wildlife and is defined as a Habitat/Species Management Area. This is an area that is protected and managed to ensure the maintenance of habitats and the specific requirements of specific species (World Conservation Union, 1994). The final category, Category VI is a managed resource protected area. It is designed as a protected area for the sustainable use of natural ecosystems. This includes game reserves and wildlife as sustainable resources. Since this category is not designed specifically for the protection of wildlife it seemed problematic. As a result I decided to create two data-sets. One would exclude category VI, and the other would include category VI. This was done to determine any differences by the inclusion or exclusion of this category in the amount of protected area per country and the effect it would have on the selected endangered species populations. Table 4.1 summarizes these IUCN categories.

IUCN Protected Area Categories Used in this Study

Category	Type	Description
Ia	Strict Nature Reserve	managed mainly for science.
Ib	Wilderness Area	managed for wilderness protection.
II	National Parks	managed for ecosystem protection and recreation.
IV	Habitat/Species Management Area	managed for conservation through management purposes to ensure maintenance of habitats or to meet the requirements for specific species.
VI	Managed Resource Protected Area	managed for sustainable use of natural ecosystems includes wildlife game Reserves.

Table 4.1

Countries were chosen based upon the range countries or regions of each of the selected endangered species (tiger, white rhinoceros and Asian elephant). For each range country or region, the data was entered by category and number of hectares and calculated into square miles for each protected area listed. Using this data I obtained the percentages of protected area within each country. I treated Sabah and Kalimantan as separate regions because there are Asian elephant populations that range within these two areas. Table 4.2 (See Appendix II.) presents this data including the results of my calculations.

After the data was compiled for each country, data sets were established for each selected endangered species. This included population data and square miles of protected area for each species and sub-species for their respective range country, with and without

calculate the protected area per animal in square miles. This would show the density of the endangered animals per square mile in its range for that year.

Results

The results of calculating protected areas in square miles per animal did not reveal any definite relationship between the amount of protected area and the population of an endangered species. (See Appendix II.) What I did find notable was that the country with the largest amount of protected area had the lowest populations of the endangered species selected for this study. China has the distinction of having three of the five tiger sub-species within its borders. This includes the South China tiger, the Siberian tiger and the Indo-Chinese tiger. The data shows (Table 4.3 a and 4.3 b) China had 243,810 total square miles of protected areas including category VI. This represents 2.54% of the country is protected area. China had the lowest estimated populations of the three tiger sub-species. As a result there are 7,616.06 square miles per Bengal tiger within China's borders. In comparison, India had 54,746 square miles of protected area, which translated into 1.73 percent of the country being protected by IUCN categories. But in contrast, India has the largest tiger populations in Asia. For the Bengal tiger, this represented 17.52 square miles per animal. The results were the same for estimated populations of Asian elephants within China's, and India's borders.

This brings up questions such as how well are these areas protected? And, are these protected areas suitable for sustaining wildlife? This indicates to me that there are clearly other factors to be considered when discussing protected areas and endangered

species populations. The differences I found may be a reflection of different conservation efforts within these countries. Other factors that should be considered include poaching, habitat degradation, migration routes being disrupted and, a major issue for India and China, human population growth.

In comparing the range countries and regions of the selected endangered species, only 12 of the 30 countries and regions maintained protected areas classified as category VI (Table 4.2). Category VI is significant in this study as a type of protected area because it is not specifically designed for species and habitat protection. It is maintained for natural resource use such as logging and big game hunting. Despite this fact a question that arises is whether these areas provide sufficient habitat and endangered species protection, or are they too disturbed by human activities to sustain populations of endangered species? This may depend on the species itself and how well they adapt to disturbed habitats.

Kalimantan, Indonesia, where there are significant populations of Asian elephants had the highest percentage of category VI at just below 9 percent. The significance of this may be that these small regions rely heavily on their natural resources for economic growth, and create protected areas for the sustainable use of these natural resources. The difference in square miles for those countries with and without category VI did not seem to make any significant impact upon the outcome of the data. For example, the Bengal tiger was estimated at 32 tigers within China's borders. China's protected areas totaled 243,810 square miles. This gave each tiger approximately 7,620 square miles in this area. On the other hand in Myannmar, Bengal tigers were estimated to be 177 tigers in 1998. Myannmar only has 620 square miles of protected area. The calculated numbers gives

each tiger 3.50 square miles in this area. For this reason, I believe the numbers are not significant in determining how protected areas are helping maintain wild populations of endangered species.

The region of Kalimantan, Indonesia has the most significant differences between the size of those protected areas with category VI and those without category VI. There is 31,062 square miles of protected area in Kalimantan, which includes category VI. This same region without category VI drops to 12,581 square miles of protected area for Asian elephants. This difference is 18,481 square miles of protected area reserved for the sustainable use of the natural resources in the area, including wildlife. In Kalimantan deforestation is a major problem. It is estimated that 20,934 square miles of tropical forest were logged by the timber companies during 1990 and 1995. Farmers have expanded into these areas where timber companies have cut down trees. At 8.35 percent of the country of Zambia also had a significant percentage of protected area classified as category VI.

Overall, the results for all three species were not particularly revealing due to a lack of good population data for the endangered species selected. All population data for these selected endangered species are estimates rather than census figures. Population data for Asian elephants was the most difficult to acquire. Tigers and white rhino estimated population data was more readily available. In order to better understand the results or lack of results, an examination of the role of protected areas for each endangered species must be considered.

Discussion

Tigers and Protected Areas

Tigers adapt to a wide variety of habitats that range from tropical Asian jungles to the forests of Siberia. (Miquelle, et al., 1999). In the past, tigers populated most of Asia with eight subspecies roaming and inhabiting all of the diverse habitats of the Asian continent and the Asian islands. In the Status and Conservation Action Plan for wild cats published by the IUCN, it has been noted that tigers have very little future outside of protected areas, and are considered to be a threat to the local livestock and to human life (Nowell and Jackson, 1996). The protection of tiger habitats is crucial to the survival of this greatly endangered cat. These cats range in the most densely populated areas of the world and the population is growing at an average of 1.8 percent a year (Nowell and Jackson eds., 1996). In countries such as India, a growing human population, where a high percentage of the population live in poverty, and increased demand for land and natural resources have elevated the pressure put upon forests, grasslands, and coastal and marine ecosystems (MacKinnon, et al, 1999). According to MacKinnon et al (1999), because it ranks at the top of the food chain, the tiger is a good indicator of the status of conservation of natural habitats and wildlife in India (MacKinnon, et al, 1999). India's protected areas cover 14 million hectares (54,031 square miles). However, 4.48 percent of the country is designated as protected. India's protected areas include 75 parks and 421 sanctuaries. Several of these parks are designated and managed as tiger and elephant reserves. These protected areas such as parks, sanctuaries, and areas of contiguous forest

reserves are considered important for the protection of these endangered species (MacKinnon, et al, 1999).

In 1994 with help from the World Bank, India created a new project called the India Eco-Development Project. It is designed to encourage conservation by taking into account the impact that a protected area has on the local population. In order to alleviate the effects associated with limitations of resource use within protected areas upon the local community (MacKinnon, et al 1999). MacKinnon notes that if the project proves to be successful, the Indian government plans to expand the Eco-Development Project to include an additional 100 to 200 protected areas around the country. At this point in time, five of the reserves in the project are tiger reserves and one is an elephant reserve that contains important tiger populations (MacKinnon, et al. 1999). These protected areas included in this project encompass a wide range of habitats from wet evergreen forests to semi-arid grassland and mountain ecosystems (MacKinnon, et al. 1999). These areas are important because they not only protect tiger populations, but also protect other wildlife and plant communities within the protected area. It has also been acknowledged that India's protected areas are important to the conservation of biodiversity on a global scale (MacKinnon, et al. 1999).

In addition to the Eco-Development Project, Project Tiger has been working to address tiger conservation for almost 30 years. This project was instituted in 1972 after the Bengal tiger was recognized as a protected species. The World Wildlife Fund donated one-million dollars in financial assistance for the project. The objective of the project was to maintain a viable population of tigers in India and to preserve natural habitats that were considered to be biologically important to the national heritage of India

(Kumar, <www.cranes.org/PROTIGER.htm>, 03, June, 2000). In the first seven years, 11 reserves were established encompassing approximately 6,100 square miles. Problems arose with the Project in the 1980's. Pressure put upon game wardens and wildlife officials to show growth of tiger populations due to the project resulted in an over-estimation of populations. But, it is acknowledged that counting wild tigers can prove to be a difficult task to undertake. Other problems with the Project Tiger were human/tiger conflicts and, encroachment onto protected areas (Kumar, <www.cranes.org/PROTIGER.htm>, 03, June, 2000).

Despite its difficulties, Project Tiger has shown that saving a key "flagship" species within its habitat can benefit other species, as well as the entire ecosystem of the area (Kumar, <www.cranes.org/PROTIGER.htm>, 03, June, 2000). Other lessons learned by Project Tiger include the need to involve the local people living on the edges of the reserves in the conservation efforts and the need to for ecological sustainable development hence, the Eco-Development Project was created. Overall, Project Tiger has been a success and has provided valuable lessons in conservation efforts.

Asian Elephants and Protected Areas

The Asian Elephant Specialist Group has stated that the conservation of the Asian elephant is not only important to the countries where it ranges but has significance on a global scale. This gives the Asian elephant the status of "flagship species" (Santiapillai and Jackson, 1990). Due to the fact that elephants require large areas to forage and range, the conservation of the elephant through the preservation of its habitat also secures the biological diversity of other animals as well as plants within the region. The loss of

habitat for Asian elephants is best illustrated by the circumstances in India. In the elephant's past, their range covered the entire landscape of India. Today, the elephant is confined to only three percent of the area of that country (Sukumar, 1990).

As with tigers and all endangered species, protected areas are a significant factor in the survival of Asian elephants. Project Elephant, a plan similar to Project Tiger, has identified that the major threats to populations of Asian elephants are loss of habitat, habitat fragmentation, and degradation of forests to where the forest can no longer support elephant populations (Daniel, 1993). As one researcher points out, the populations of elephants living in protected areas, such as national parks or wildlife sanctuaries are not completely secure and protected, due to the fact that home ranges of elephants cover a wide area with different levels of protection status (Daniel, 1993).

The Asian Elephant Action Plan published by the IUCN Asian Elephant Specialist Group, recommends that a system of protected areas should be developed by each country with Asian elephant populations specifically for Asian elephant conservation (Santiapillai and Jackson, 1990). The group also recommends that these areas should provide sanctuaries for elephants from human activities, in addition to maintaining a viable population of elephants. These protected sanctuaries would also be part of a larger "Managed Elephant Range," which would provide room for the migration and the movement of elephants. In "Managed Elephant Ranges" human activities would be allowed but the elephant's needs would take precedence (Santiapillai and Jackson, 1990).

White Rhinoceros and Protected Areas

The Rhino Trust, an organization dedicated to the conservation of the world's rhinos, says that rhino populations can be regarded as a means of determining the health of the habitats in which they live. Field biologists have suggested that through the conservation of land in Africa, approximately 10,000 species or more of mammals, birds, reptiles, amphibians, invertebrates and plants can be supported (The Rhino Trust, <www.rhinotrust.org> December, 1999).

The World Wildlife Fund has been involved in the protection of the white rhino and its habitat for decades. Many projects sponsored by WWF have included the protection of white rhinoceros in national parks and game reserves. Due to the increased poaching in the 1970's "Project Rhino" was launched in 1979 as a fundraising campaign that was committed to rhino conservation (Dublin and Wilson, 1998). Funds collected were then funneled into several rhino conservation projects. Conservation efforts focused on protecting all rhino populations on government and privately run refuges. In 1998 these protected areas retained 48 percent of Kenya's rhino population and 60 percent of Zimbabwe's rhino population (Dublin and Wilson, 1998).

Conclusions and Limitations

Although the results of this examination in comparing amount of protected areas to size of wild populations of endangered species seemed inconclusive, it is obvious that from the investigation into this topic, protected areas are providing valuable habitat for

endangered species populations. I did not come across other studies about the relationship of protected areas and endangered species but believe there must be information about this topic being gathered and discussed by wildlife experts. The counting of animals proves to be a difficult task with no easy method. But, as research continues perhaps more accurate population data can be gathered for further investigation and the role of protected areas can be examined more thoroughly.

Limitations should be considered in order to improve and expand upon such research. The lack of good population data can be considered a significant drawback. This particular research only examined very few populations of animals and their range countries with protected areas designed to sustain them. This research was limited to protected areas that met the IUCN categories. For example, The Democratic Republic of Congo has no protected areas that qualify under the IUCN listing. As this research has shown, a relict population of white rhinoceros are *protected* within the Garamba National Park inside the borders of the Democratic Republic of Congo. This study also did not include changes over time of the increase or decrease in protected areas for each country. This may be a significant factor that needs to be addressed by further research. Due to the lack of data, other methods of statistical analysis were not employed. For example, I had hoped to correlate the size of a protected area to the size of the endangered species populations, showing that countries with more protected areas would have larger populations of the selected endangered species within its borders. The amount of data was too small to do a regression analysis or correlation coefficient.

To maintain an endangered species in the wild, protected areas are becoming more important in conservation efforts. Zoos are now more involved in habitat

conservation by using part of their funds for "in situ" conservation of endangered species. It is recognized by these organizations that it is important to maintain protected areas and habitats not only for endangered species but also for the overall biodiversity of the planet.

Chapter V

Zoos and The African Bias

Zoos

Zoos and aquariums are the most popular and most visited attractions in cities and communities in the United States. One hundred fifty-five million people visited zoos and aquariums in 1993 alone, which exceeded attendance for professional football, baseball, and basketball games combined (Johnston, 1998). Attracting visitors to their facilities is an important aspect to the function of a zoo. In 1993, for example visitors generated 1.2 billion dollars in income for zoos.

There are 165 zoos in the United States (Magin et al. 1994). Many of these zoos specialize in various types of animals and conservation efforts. Zoo exhibits are based upon the mission and goals of the zoo (Bretzfelder, personal communication: 10 June, 2000). The aim of the zoo can fall under one or more of the following categories; education, research, conservation and recreation. Exhibits within a zoo will reflect one or more of these goals. Many zoos will exhibit principally animals that represent the region where the zoo is located. For, example the Arizona Sonoran Desert Museum exhibits species mostly from that surrounding region. The curator of the zoo generally draws up a collection plan that is approved by the director of the zoo (Bretzfelder, personal communication, 10 June, 2000).

Data and Methodology

Zoos have a bias towards the African continent in exhibits and in collections of animals. Zoos show a bias when 40 percent or more of their animals come from the African continent. The goal of hypothesis three is to determine if zoos in the United States have a bias towards the African species in their collection of mammals. An African bias within a zoo may mean that zoos are devoting fewer resources to other species and other parts of the world. An African bias may also reflect the public's desire to see African animals.

Sixty-five of the largest zoos in the United States were selected from the 1998 International Zoo Yearbook based upon acreage, which determined the selection of zoos. Zoos with at least 49 acres were selected with the assumption that the larger the facility the more animals it can accommodate. Three major Texas zoos have 49 acres and because I wanted to include these zoos within my study, 49 acres became the cut-off point. The International Species Information System abstracts were used to count species and sub-species. ISIS is an organization that assists zoos in managing and specimen record keeping of the zoo's animal population and maintains abstracts on species and subspecies for each zoo that is a member. Two zoos were not represented through the International Species Information System and therefore were dropped from the study leaving 63 zoos within the study. If the zoo was not a member then it was impossible to count the number of species and sub-species for that zoo and subsequently was dropped from the survey.

Using the International Species Information System, 1678 species and subspecies of mammals were surveyed. A total of 888 of these species and subspecies were

represented within the 63 zoos surveyed. The species and subspecies ranges were recorded and divided into regions based upon an animal's range. This was done to put species and sub-species into specific regions of the world to determine if they were African in origin. The regions were divided as follows: North America, Central America, South America, Europe, and Africa. Asian species were more difficult to subdivide but were divided as follows: MiddleEast/Southwest Asia, South Asia (India, Sri Lanka, Burma etc.) East Asia (Mongolia, Tibet, Taiwan, Japan, Korea, and China), Southeast Asia (Vietnam, Thailand, Malaysia, and Indonesia), and Russia, which includes all of the former Soviet Union. The Philippines, New Guinea and all other South Pacific islands were classified as Asian-Pacific, while the region of Australia includes Tasmania and New Zealand.

Many species and subspecies had ranges that were very extensive. For example, several species ranges were from North America through South America. These areas were separated into their own regional categories, since the ranges extended into larger areas. To give an example, the Big Brown Bat had a range including Alaska but also had a region extending from Central America to Argentina. This species was classified into an extended regional category known as North America though South America. These extended regions are as follows: Africa and other, Europe and other, Russia and other, Eurasia, East Asia-Southeast Asia, the Arctic, the Arctic and other, the Indian Ocean, Australia-Asia Pacific, North America-South America, North America-Central America, Central America-South America, South America and the Caribbean, South Asia-Southeast Asia, The West Indies, and Worldwide.

This method of dividing species into specific ranges proved to be difficult because the animal's ranges most often did not follow human conceived boundaries. Some species were categorized within one region or another to produce more defined categories and boundaries based upon the researcher's discretion.

For each of the 1678 species and subspecies that were listed by the International Species Information System I recorded a "1" in the column for each zoo that had this species represented within its zoo population. Eight hundred and eighty-eight of these species were represented in 63 zoos surveyed. The other 790 species and sub-species within the ISIS abstracts fell within other U.S. and International zoos not included within this study. The number of mammal species was then added up to obtain a total number of species for each zoo. The number for each regional category was totaled to generate the number of species per region. The total number for each regional category was then divided by the total number of species per zoo. These numbers were then converted into a percentage. See Appendix II.

Results

The criterion I used to establish an African bias was that 40 percent of the mammal zoo population would be African in origin.* I chose 40 percent based upon personal experience in visiting zoos. Fifty percent seemed too large of a percentage for African mammals in zoos.

* The standard way to measure a bias is to count the total number of mammal species worldwide, and calculate the percentage of those that are African. Then by making the same calculations for mammal species in zoos and comparing the results, a bias (over-representation or under-representation) can be detected. Unfortunately, the total number of species for zoos and total number of African species was not forthcoming, I was therefore was unable to use this method.

While my investigation of this topic developed, a more applicable method of measuring a bias was discovered.

Eight of the 63 zoos surveyed had 40 percent or more mammal species with African origins. (See Appendix III.) Ten of these zoos had between 30 and 40 percent of mammal species with African origins. Thirty-four of the zoos fell within the 20 percent to 30 percent range, and only eleven fell below the 20 percent range of mammal species of African origin. The eight zoos with 40 percent or more include the following: Busch Gardens Zoological Park, the Dallas Zoo, Jacksonville Zoological Gardens, Disney's Animal Kingdom, Miami Metro Zoo, North Carolina Zoological Park, St Catherine's Wildlife Center, and the San Diego Wild Animal Park. Busch Gardens with 44 percent, and Disney's Animal Kingdom with 40 percent both are privately owned zoos and both specialize in African ungulates and birds. The Dallas Zoo, the Jacksonville Zoological Gardens, and the Miami Metro Zoo with 41, 40, and 43 percent respectively are all municipally funded zoos. The Dallas Zoo's specialization is their herpetological collection while the Miami Metro Zoo specializes in hoofed animals and cranes. The Jacksonville Zoological Gardens had no specialization listed. Finally, the North Carolina Zoological Park with 41 percent is state-owned and has no specialization listed. San Diego's Wild Animal Park with 41 percent of African mammals represented is a private non-profit zoo. San Diego specializes in ungulates, so the fact that it has a comparatively high percentage of African mammals is not surprising. St. Catherine's Wildlife Center by far had the largest percentage of African mammals with 72 percent, however, the total number of species within the Center was very low and there was no information provided about its specialization.

Acreage did not seem to be a factor affecting whether a zoo had an African bias or not. The acreage of these zoos ranged from 49 acres to 1,182 acres. The largest zoo in the survey was the National Zoological Park in Washington D.C. This zoo has 3,147 acres with only 20 percent of the mammal species represented being of African origin. The largest of the seven zoos considered to have an African bias is the San Diego Wild Animal Park at 1,798 acres. Disney's Animal Kingdom with 500 acres was the second largest of the seven zoos that met the criteria for an African bias. The smallest acreage of the seven zoos was the Jacksonville Zoological Gardens with only 62 acres.

Mammals with an African origin constituted between 20 and 37 percent of mammals at most of the zoos in this study. These zoos were generally municipally funded but funding also included sources such as non-profit. Specialization was also varied and was wide-ranging.

Another Look

In comparison to other regions, African species seemed to have the highest percentages for most of the zoos within the survey. In order to find out how Africa compared to other regions represented, the regions were ranked by the three highest percentages for each zoo. The results were quite dramatic.

In 59 of the 63 zoos surveyed, Africa was one of the three most represented regions. In 55 of the zoos, African mammals represent the highest percentage of species and sub-species. In only four zoos did Africa fail to appear as one of the top three regions represented. (See Appendix III.)

Using my criteria, an African bias was not indicated at all. However, by ranking the top three regions for each zoo by percentage, an African dominance was clearly demonstrated. Some of the limitations of this study are that it did not include birds, reptiles, amphibians or invertebrates. In addition, this evaluation does not include all zoos within the United States. I also do not know what percentage of the world's mammals are African. This bias may be representative of the natural world. At Oklahoma State University, Dr.Tracy Carter, a professor of zoology, has suggested that zoos do have a bias towards African animals and, this study clearly demonstrated many U.S. zoos exhibit African species.

There were only eight zoos with an African bias determined by the criteria set up by this study. Despite this fact, it was obvious that for most zoos, mammal species with African origin were by far more represented than any other region in the world including the South American rainforests. The region with the highest percentage of mammals represented after Africa was South America. Alexandria Zoological Park in Alexandria Louisiana had the highest percentage of South American species and sub-species at 19 percent.

Discussion

As humans and mammals, we generally relate to what is called the charismatic animals such as elephants, large cats and other mammals. Paul I. Ward and colleagues studied the "relationship between the popularity of an exhibit and the body sizes of the animals displayed" (Ward et. al. 1998: 1410). In this study they found there was a trend towards the larger animals being more popular with the public including adults and

children. This is one possible reason that a large percentage of mammal exhibits in zoos tend to be African in origin. In another study by Robert J. Johnston, it was found that the visual characteristics of a zoo exhibit have a significant impact on viewing time of visitors. These characteristics included the naturalism of the exhibit, the level of activity of the animals, and the percentage of time that the animals are visible (Johnston, 1998). Although these aspects may not be directly related to an African bias in zoos, it may indicate how zoos determine the types of exhibits they want to create based on the demand produced by the public. Zoo exhibits may also be determined by the availability of the animals themselves. Some endangered species are restricted to their home country by their governments. These animals may be endangered and may not be available to zoos in the United States. In the case of the Giant Pandas, China loans these animals to zoos such as the San Diego Zoo and the National Zoo in Washington.

It must be noted that the African continent has the largest number of ungulates in the world at approximately 90 species. In addition, there are 45 different species of primates on the continent. Many of these animals are very adaptable to zoo life and, are easily maintained within the zoo. From this fact, the question arises: does this study really reflect an African bias or does it just reflect the natural world? Further research on this issue is probably needed.

Conclusions and Limitations

I believe that this study was able to demonstrate an African dominance, if not an African bias of mammal populations within zoos. The consequences of this are unclear, but only bring up more questions. If there is an African bias, does this represent the

natural world or does this represent the desire for zoos to attract visitors? Attracting visitors is an important aspect to zoos in maintaining their mission statements for education, conservation and the support of these animals in captivity. How zoos decide on exhibits is a factor not closely examined within this particular study. There are animals that may not be available to zoos. What I did notice while conducting the survey was that many Australian species are strictly maintained in Australian zoos. Australia may have strict laws keeping most of these species within their home country. According to Tarren Wagener, the Conservation Science Manager of the Fort Worth Zoo, there are constraints put upon zoos and affect the kinds of exhibits they can have. One such constraint involves the availability of species that zoos can acquire. Many animals such as the endangered Ethiopian wolf are not allowed out of their country. Therefore zoos do not have access to this particular species. Of course, size is a significant factor affecting which animals a zoo can house. Generally speaking the larger the zoo the more flexible it can be in acquiring large and small indoor and outdoor animals.

When creating geographic exhibits, zoos select species that come from the region being represented, such as the Brazilian Tropical Rainforest or Texas Panhandle. Then a variety of animals that represent these regions will be included within the exhibit.

The limitations to be considered by this study are that birds, reptiles, amphibians and invertebrates were not included within the survey. Further research that included these different families might change the dynamics of the outcome. Smaller zoos were also not included within the study, which also might change the results of this study. Overall the results indicated an African bias. The reasons for a bias should be investigated and researched more thoroughly.

Chapter VI

Summary and Conclusions

Overview

This research examined the issues of conservation and management involved with endangered species and zoos. It attempted to compare the wild and zoo populations of selected endangered species, which allowed an examination of the issues and controversies of wild and zoo population management. My research also has attempted to compare protected areas to size of endangered species populations. And finally, I investigated the possibility of an African bias within mammal collections of zoo exhibits. In the following paragraphs I will summarize each chapter and the findings of my research.

Endangered Species: Zoo and Wild Populations

The selected endangered species in this study were *Panthera tigris* (tiger), *Ceratotherium simmum* (white rhinoceros), and *Elephas maximus* (Asian elephant). These animals were selected based upon the initial data available through the World Wildlife Fund. As my research progressed more information became available from various sources.

Hypothesis one states that as populations of endangered species decline in the wild, populations of the same endangered species within zoos have increased. The aim of

hypothesis one is to compare changes in populations of zoo captive endangered species to wild populations of the same endangered species.

Overall Percent Change in Wild and Zoo Populations for Selected Endangered Species

Wild Tigers	Years	Percent Change	Zoo Tigers	Years	Percent Change
Wild Bengal Tigers			Zoo Bengal Tigers		
	1951-1998	96.85%		1988-1997	72.67%
Wild South China Tigers			Zoo South China Tigers		
	1950-1998	-99.38%		1988-1997	1.92%
Wild Siberian Tigers			Zoo Siberian Tigers		
	1936-1998	666.00%		1976-1997	-20.06%
	1980-1998	-14.89%			
Wild Sumatran Tigers			Zoo Sumartran Tigers		
	1993-1998	0.00%		1976-1997	118.58%
Wild Indo-Chinese Tigers			Zoo Indo-Chinese Tigers		
	1993-1998	36.54%		1989-1998	172.73%
Wild Elephants			European Zoo Elephants		
	1900-1996	-56%		1900-1998	6625.00%
	1979-1996	26%			
Wild Northern White Rhinoceros			Wild Southern White Rhinoceros		
	1938-1998	-79.00%		1900-1997	42105%
	1961-1998	-98.17%		1960-1998	744%
Zoo Northern White Rhino			Zoo Southern White Rhino		
	1971-1997	28.57%		1992-1997	105%
	1992-1997	-52.63%			

Table 6.1

The research, indicated that some of these wild populations were increasing. The data also indicated that depending on the endangered species, the conservation of its wild

populations, and the management of populations within zoos, not all zoo populations are increasing and not all wild populations are in decline. The population data for the Bengal tigers indicated the opposite of the proposed hypothesis. The wild populations appeared to be stable and possibly increasing while zoo populations are in decline. White rhinoceros populations suggested that both wild and zoo populations were very low and in decline. Table 6.1 shows percent changes in wild and zoo populations.

Limitations

As with all research limitations are important to consider in order to improve and to continue further research. The most problematic issue for this topic was finding reliable and complete population data. This stems from the problems of counting wild forest dwelling mammals. Although zoo population data was readily more available, the Asian elephant population for both wild and zoos was extremely difficult to find. Much of the population data has come from published books and articles. It was also pointed out to me that results might prove to be different for different animals. Dr. Nick Lindsay of the Zoological Society of London at Whipsnade Wild Animal Park, states that although the elephant and rhinoceros have been held in captivity for many years, it has only been recently that they have been under a fully managed breeding program. They are also difficult to breed in captivity and therefore do not represent the value of captive breeding programs (Lindsay, personal. communication, 02 September, 1999).

Conclusion

Finally, I believe that this research allowed me an opportunity to look closely at the issues and problems of conservation and management of wild and captive populations of endangered species. The research was also able to show the trends in both wild and zoo populations of the selected endangered species. Furthermore, it will contribute to geography's lack of research on animals. I also hope that this research provides a better understanding of the plight of endangered species, and adds valuable information to the research on endangered species and wildlife population studies.

Protected Areas and Endangered Species

Hypothesis two states that there is a connection between growth or loss of an endangered species and the amount of protected area within its range. The aim of this hypothesis was to compare the previously selected endangered species to the amount of protected areas within their range countries to determine the relationship between these two factors. I had hoped to determine if in fact protected areas are contributing to the protection of endangered species populations.

My research on this topic involved looking at populations of the previously selected endangered species and how protected areas are playing a role in their conservation. I gathered data using the World Conservation Monitoring Centre and compared each country's protected areas to the population data of the selected endangered species. I created data sets, which included five categories of the IUCN criteria of protected areas that were relevant to wildlife and habitat protection. Category

VI was problematic because it was not managed specifically for wildlife conservation but for the sustainable use of natural resources, which includes wildlife. Two data sets were created for that reason. One data set with Category VI and one data set without. With the protected area data and the population data, protected area in square miles per animal was calculated.

Unfortunately the results of this research appear to be inconclusive. What was notable was that China has a total of 243,810 square miles of protected areas, which includes Category VI, but for all tiger sub-species and the Asian elephant it had the smallest populations of these endangered species. This raises questions about how effectively these areas are protected. Are these protected areas suitable for sustaining wildlife? Other factors that should be considered when examining the relationship of protected areas and endangered species include differences in conservation efforts, poaching, habitat degradation, migration routes being disrupted, and rates of human population growth.

The differences in protected areas that fell under Category VI and all other categories did not affect the overall result of the outcome. Twelve of the 30 countries and regions had protected areas that qualified as Category VI. Kalimantan, Indonesia and Zambia in Africa had the highest percentages of Category VI protected areas. The significance of this may be that these small regions and countries may rely heavily on their natural resources for economic reasons, and therefore create protected areas based upon sustainable use of these resources. How this affects the conservation and protection of endangered wildlife is a question that remains for further research.

Limitations

The limitations of this particular study are examined to improve the research and gain more knowledge of the topic. One such limitation is the lack of good population data. Another is this study only examined a few populations of animals and their range countries. The protected area data was limited to the IUCN categories and definitions. It did not show change over time for the protected areas. Again, due to the lack of data other methods of statistical analysis were not employed. I had hoped to correlate the amount of protected area to the size of the endangered species population but was not able to because of a lack of sufficient data.

Conclusions

My overall conclusion of this study is that the lack of sufficient data did not provide me with the results I had hoped. Therefore, more in-depth research might provide clearer answers to the questions asked here. What I have learned from investigating this topic is that protected areas are providing valuable habitat for endangered species. In protecting the "flagship species" such as the tiger, white rhino and Asian elephant, other animals and, the entire ecosystem benefit from protection. This protection of flagship species not only provides benefits to the environment on a local scale but also, on a global scale.

Protected areas are an important aspect to conservation of endangered species. With zoos now more involved in the protection of habitats using funds for "in-situ" conservation, many poorer countries will be able to provide protected areas for

conservation of their endangered species and other wildlife. It is recognized by these organizations that creating and maintaining protected areas and habitats for endangered species will also help in preserving the biodiversity of the planet.

Zoos and The African Bias

In this chapter I examined the possibility of zoos having a bias toward the African species within their collection of animals. Hypothesis three states that zoos have a bias towards the African continent in exhibits and their collections of animals. The aim of this hypothesis is to determine if zoos in the United States have a bias towards African species in their collections of animals by surveying mammal species and sub-species for selected zoos.

Why is this important to know? An African bias may mean that zoos are devoting fewer resources to other species and parts of the world that need attention. A bias may also be a reflection of the public's demand to see African animals. It also may be a reflection of the natural world and in this case there would be no bias.

The criterion that was established for an African bias was that of 40 percent of the mammal population would be African in origin. The results based upon these criteria did not reveal an African bias with only eight of the zoos surveyed having 40 percent or more of their mammal species with African origins. When regional categories were ranked for each zoo, 59 of these zoos fell within the top three regions most represented within zoo mammal collections. This indicated to me at least an African dominance within the U.S. zoos surveyed.

Limitations

The biggest limitation for this study is the criteria set by the researcher to measure a bias. A more appropriate way to measure a bias would have been to calculate the total number of mammal species worldwide and based upon this number find the percent of African species from that total. Then by adding up total zoo species in the U.S., and calculating African species as a percent of the total zoo species, I would have two values to compare. If this value is greater or less than the total percentage of African mammal species then a bias is indicated. Unfortunately, for this study this information was not available. I was able to obtain the total number of species worldwide but was unable to obtain the other numbers. Therefore, this is a weakness in this study.

Other limitations that should be considered are that other families of animals and smaller zoos were not included within the survey. Both these factors might change the results of this study.

Conclusions

Although there were problems with this research, I do believe that this study was able to show an African dominance if not a bias within the surveyed zoos. If this represents an African bias the consequences are unclear but bring up more questions for further research. If there is an African bias does this represent the natural world or does this represent a desire for zoos to attract visitors? My overall assessment of this study is that it successfully examined the possibility of the issue of an African bias, and that further research is justified using more applicable methods.

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APPENDIX I

TABLES 1.4 and 1.5

SELECTED ZOOS FOR SURVEY AND EXAMPLE OF ISIS ABSTRACT

Table 1.4

Selected Zoos for Survey

State	City	Zoo	Area in Acres	AZA affiliation
Arizona	Litchfield Park	Wildlife World Zoo	49	Yes
New York	Syracuse	Burnett Park Zoo	49	Yes
Texas	Fort Worth	Fort Worth Zoo	49	Yes
Texas	Houston	Houston Zoological Gardens	49	Yes
Texas	San Antonio	San Antonio Zoological Gardens	49	Yes
Utah	Salt Lake City	Utah's Hogle Zoological Gardens	52	Yes
Kansas	Manhattan	Sunset Zoological Park	54	Yes
Louisiana	New Orleans	Audubon Park and Zoological Garden	54	Yes
Ohio	Cincinnati	Cincinnati Zoo &Botanical Garden	54	Yes
Virginia	Norfolk	Virginia Zoological Park	54	Yes
New Mexico	Albuquerque	Rio Grande Zoological Park	59	Yes
Florida	Jacksonville	Jacksonville Zoological Gardens	62	Yes
Texas	Waco	Cameron Park Zoo	62	Yes
California	Vallejo	Marine World Africa USA	64	Yes
Indiana	Indianapolis	Indianapolis Zoological Park	64	Yes
Oregon	Portland	Metro Washington Park Zoo	64	Yes
Pennsylvania	Pittsburgh	Pittsburgh Zoo	64	Yes
West Virginia	Wheeling	Oglebays Good Children's Zoo	64	Yes
Oklahoma	Tulsa	Tulsa Zoological Park	67	Yes
Wisconsin	Madison	Henry Villas Park Zoo	67	Yes
Missouri	Springfield	Dickerson Park Zoo	69	Yes
Massachusetts	Boston	Franklin Park Zoo	72	Yes
Alabama	Birmingham	Birmingham zoo	74	Yes
Colorado	Colorado Springs	Cheyenne Mountain Zoological Park	74	Yes
Kentucky	Louisville	Louisville Zoological Garden	74	Yes
Texas	Dallas	Dallas Zoo	74	Yes
California	Los Angeles	Los Angeles Zoo	79	Yes
Colorado	Denver	Denver Zoological Gardens	79	Yes
Louisiana	Monroe	Louisiana Purchase Garden and Zoo	79	Yes
Louisiana	Alexandria	Alexandria Zoological Park	82	Yes
Missouri	St. Louis	St. Louis Zoological Park	82	Yes
North Dakota	Bismark	Dakota Zoo	86	Yes
Washington	Seattle	Woodland Park Zoological Gardens	91	Yes
California	San Diego	San Diego Zoological Gardens	99	Yes
Mississippi	Jackson	Jackson Zoological Park	99	Yes
Arkansas	Little Rock	Little Rock Zoo	104	Yes
California	San Francisco	San Francisco Zoological Gardens	109	Yes
Michigan	Detroit	Detroit Zoological Park &Belle Isle Zoo	114	Yes
Georgia	Midway	St. Catherine's Wildlife Survival Center	121	Yes
Arizona	Phoenix	Phoenix zoo	124	Yes
Ohio	Cleveland	Cleveland MetroParks Zoological Park	124	Yes
Nebraska	Omaha	Omaha's Henry Doorly Zoological Gardens	130	Yes
Tennessee	Knoxville	Knoxville Zoological Gardens	140	Yes

Table 1.4
continued

State	City	Zoo	Area in Acres	AZA association
Illinois	Chicago	Chicago Zoological Park	142	Yes
Louisiana	Baton Rouge	Greater Baton rouge Zoo	145	Yes
South Carolina	Columbia	Riverbanks Zoological Park	146	Yes
Missouri	Kansas City	Kansas City Zoological Gardens	173	Yes
Tennessee	Memphis	Memphis Zoo and Aquarium	173	Yes
Indiana	Evansville	Mesker Park Zoo & Botanical Garden	180	Yes
Oklahoma	Oklahoma City	Oklahoma City Zoological Park	188	Yes
Wisconsin	Milwaukee	Milwaukee County Zoological Park	190	Yes
Maryland	Baltimore	Baltimore Zoo	200	Yes
Kansas	Wichita	Sedgewick County Zoo	212	Yes
New York	New York	Bronx Zoo/Wildlife Conservation Park	245	Yes
Florida	Miami	Miami Metro Zoo	257	Yes
Florida	Tampa	Busch Gardens Zoological Park	299	Yes
North Carolina	Asheboro	North Carolina Zoological Park	299	Yes
Ohio	Columbus	Columbus Zoological Gardens	404	Yes
Minnesota	Minneapolis/St Paul	Minnesota Zoological Garden	482	Yes
Florida	Lake Buena Vista	Disney Animal Kingdom	500	Yes
Oregon	Winston	Wildlife Safari	600	Yes
Washington	Eatonville	Northwest Trek Wildlife Park	667	Yes
California	Palm Desert	The Living Desert	1186	Yes
California	San Diego	San Diego Wild Animal Park	1798	Yes
District of Colombia	Washington D.C.	National Zoological Park	3147	Yes
		Total Zoos	65	

**Source: The International Zoo Yearbook, 36th edition.*
Olney,P.J.S. and F.A. Fisken, Eds. 1998. Zoological Society of London.

Table 1.5

Example of ISIS Abstract

PANTHERA TIGRIS (NO SUBSP)
TIGER

Range: SE SIBERIA-JAVA-CAUCASUS

Institution	Males	Females	Unknowns	Births (last 6 months)
AYWAILLE	0	3	0	0
BARRANQUL	3	2	0	0
BEAUVAL	0	2	0	0
BELFAST	1	1	0	0
BELFAST	1	0	0	0
BORAS	2	1	0	0
BROUSSARD	0	2	0	0
CINCINNAT	3	2	0	0
COLOMBO	3	6	0	0
COLUMBUS	1	0	0	0
DISNEY AK	0	6	0	0
DUBBO	1	0	0	0
DUNLAP	2	0	0	0
ESKILSTUN	5	2	0	0
GREENVISC	0	1	0	0
HOUSTON	0	1	0	0
KNOXVILLE	0	3	0	0
KUALA LUM	0	2	0	0
LA FRONTI	2	1	0	4
LEON	1	2	0	0
LISBON	1	2	0	0
LISIEUX Z	4	4	0	1
LOSANGELE	0	1	0	0
MAYAGUEZ	4	7	0	0
METROZOO	1	3	0	0
MILL MOUN	0	1	0	0
MONCTON	1	0	0	0
NASHVILLZ	3	3	0	2
NEUWIED	1	1	0	0
NORFOLK	0	2	0	0
NZP-WASH	1	0	0	0
OAKHILL	1	3	0	0
Table 1.5				

continued				
ORANA	2	0	0	0
Institution	Males	Females	Unknowns	Births (last 6 months)
PARIS ZOO	1	1	0	0
PEAUGRES	1	2	0	0
PERTH	0	1	0	0
PITTSBORO	10	16	0	0
PITTSBORO	1	0	0	0
PRETORIA	1	0	0	0
PRETORIA	2	1	0	0
REDWOOD	3	3	0	0
ROLLING H	1	1	0	0
ROSAMOND	0	1	0	0
SACRAMNTO	2	0	0	0
SALZBURG	0	2	0	0
SAN ANTON	0	2	0	0
SCOTTSBLU	1	1	0	0
SYDNEY	1	0	0	0
THOIRY	5	6	0	0
TORONTO	0	1	0	0
TOUROPARC	1	2	0	0
WILD WRLD	1	0	0	0
YULEE	1	1	0	0
Totals	76	105	0	7

Source: International Species Information System website: www.worldzoo.org

Protected Area Data for Selected Range Countries

Table 4.2

Country	Total Area of Country or Area in Sq. Miles	Percentage Of Protected Areas without category VI	Percentage of Protected Areas Category VI Only	Total Percentage Protected Area	Area Protected in Square Miles	Area Protected Sq. miles Category VI	Total Area Protected in Square Miles
Bangladesh	144,000	0.22%	0%	0.22%	322	0	322
Bhutan	46,620	0.86%	0%	0.86%	3,851	0	3,851
Botswana	57,500	7.05%	0%	7.05%	40,511	0	40,511
Brunei	5,765	7.70%	0%	7.70%	444	0	444
Cambodia	181,035	4.52%	0%	4.52%	8,186	0	8,186
China	9,597,000	2.20%	0.34%	2.54%	211,489	32,321	243,810
Congo (former Zaire)	905,365	0.00%	0.00%	0.00%	0	0	0
India	3166830	1.73%	0%	1.73%	54,746	0	54,746
Indonesia	1,919,445	3.76%	2.90%	6.66%	72,127	55,649	127,776
Kenya	582,645	3.32%	0.64%	3.96%	13,491	3,708	17,200
Laos PDR	236,800	0.00%	4.49%	4.49%	0	10,638	10,638
Malaysia	332,965	1.59%	0%	1.59%	5,294	0	5,294
Mozambique	784,755	0.03%	0%	0.03%	25,422	0	25,422
Myanmar	678,030	0.09%	0%	0.09%	620	0	620
N.Korea	98,445	0.14%	0%	0.14%	135	0	135
S. Korea	122,310	0.58%	0%	0.58%	715	0	715
Namibia	824,295	4.58%	0.28%	4.86%	37,749	2,316	40,065
Nepal	141,415	3.04%	0.43%	3.47%	4,297	614	4,911
Russian Federation	17,075,400	1.17%	0%	1.17%	199,297	0	199,297
S. Africa	1,184,825	2.18%	0.01%	2.19%	25,789	75	25,864
Sri Lanka	65,610	5.07%	0%	5.07%	3,326	0	3,326
Sudan	2,505,815	1.33%	1%	1.89%	33,252	13,921	47,173
Sumatra	182,860	7.84%	0%	7.84%	14,335	0	14,335
Swaziland	17,365	0.78%	0.55%	1.33%	136	96	232
Thailand	514,000	4.97%	0%	4.97%	25,552	0	25,552

Table 4.2 continued.

Country	Total Area of Country or Area in Sq. Miles	Percentage Of Protected Areas without category VI	Percentage of Protected Areas Category VI Only	Total Percentage Protected Area	Area Protected in Square Miles	Area Protected Sq. miles Category VI	Total Area Protected in Square Miles
Vietnam	329,565	1.16%	0%	1.16%	3,838	0	3,838
Zambia	752,615	3.26%	8.35%	11.61%	24,540	62,843	87,383
Zimbabwe	390,310	2.69%	1.90%	4.59%	10,498	7,430	17,928
Sabah	28,417	4.69%	0%	4.69%	1,334	0	1,334
Kalimantan	208,286	6.04%	8.87%	14.91%	12,581	18,481	31,062

*Source: Data obtained from the 1997 United Nations List of Protected Areas from the World Conservation Union website: <www.wcmc.org/uk>

Protected Area per Tiger by Range Country Based on IUCN Categories

Table 4.3a

Sub-species	Country	Total Area Protected in Square Miles (includes Category VI)	Population Estimate	Protected area in square miles per animal	Year
Bengal Tiger	Bangladesh	322	389	0.83	1993
		322	380	0.85	1996
		322	380	0.85	1997
		322	362	0.89	1998
	Bhutan	3,851	35	110.03	1993
		3,851	145	26.56	1996
		3,851	145	26.56	1997
		3,851	145	26.56	1998
	China	243,810	no data		1993
		243,810	32	7,619.06	1996
		243,810	32	7,619.06	1997
		243,810	32	7,619.06	1998
	India	54,746	3500	15.64	1993
		54,746	3125	17.52	1996
		54,746	3125	17.52	1997
		54,746	3125	17.52	1998
	Myannmar	620	177	3.50	1998
	Nepal	4,911	200	24.56	1993
		4,911	200	24.56	1996
		4,911	215	22.84	1997
		4,911	95	51.69	1998
Siberian Tiger	China	243,810			1993
		243,810	16	15,238.13	1996
		243,810	16	15,238.13	1997
		243,810	32	7,619.06	1998
	Russia	199,297	325	613.22	1993
		199,297	175	1,138.84	1996
		199,297	445	447.86	1997
		199,297	350	569.42	1998

Sources: Peter Jackson, Chairman, Cat Specialist Group, IUCN/SSC.
Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website <www.wcmc.org/uk>.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Tiger by Range Country Based on IUCN Categories

Table 4.3a continued.

Sub-species	Country	Total Area Protected in Square Miles (includes Category VI)	Population Estimate	Protected area in square miles per animal	Year
S. China Tiger	China	243,810	55	4,432.91	1993
		243,810	25	9,752.40	1996
		243,810	25	9,752.40	1997
		243,810	25	9,752.40	1998
Sumatran	Sumatra	14,335	450	31.86	1993
		14,335	450	31.86	1996
		14,335	450	31.86	1997
		14,335	450	31.86	1998
Indo-Chinese	Cambodia	8,186	present		1993
		8,186	150	54.57	1996
		8,186	150	54.57	1997
		8,186	225	36.38	1998
	China	243,810	no data		1993
		243,810	35	6,966.00	1996
		243,810	35	6,966.00	1997
		243,810	35	6,966.00	1998
	Laos	10,638	present		1993
			present		1996
			present		1997
			present		1998
	Malaysia	5,294	550	9.63	1993
		5,294	625	8.47	1996
		5,294	625	8.47	1997
		5,294	500	10.59	1998
	Myannmar	620	present		1993
		620	present		1996
		620	present		1997
		620	170	3.65	1998
	Thailand	25,552	303	84.33	1993
		25,552	425	60.12	1996
		25,552	425	60.12	1997
		25,552	375	68.14	1998
	Vietnam	3,838	250	15.35	1993
		3,838	250	15.35	1996
		3,838	250	15.35	1997
		3,838	200	19.19	1998

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Tiger by Range Country Based on IUCN Categories

Table 4.3b

Sub-species	Country	Total Area Protected in Square Miles (without Category VI)	Population Estimate	Protected area in square miles per animal	Year
Bengal Tiger	Bangladesh	322	389	0.83	1993
		322	380	0.85	1996
		322	380	0.85	1997
		322	362	0.89	1998
	Bhutan	3,851	35	110.03	1993
		3,851	145	26.56	1996
		3,851	145	26.56	1997
		3,851	145	26.56	1998
	China	211,489	no data		1993
		211,489	32	6,609.03	1996
		211,489	32	6,609.03	1997
		211,489	32	6,609.03	1998
	India	54,746	3,500	15.64	1993
		54,746	3,125	17.52	1996
		54,746	3,125	17.52	1997
		54,746	3,125	17.52	1998
	Myanmar	620	177	3.50	1998
	Nepal	4,297	200	21.49	1993
		4,297	200	21.49	1996
		4,297	215	19.99	1997
		4,297	95	45.23	1998
Siberian Tiger	China	211,489			1993
		211,489	16	13,218.06	1996
		211,489	16	13,218.06	1997
		211,489	32	6,609.03	1998
	Russia	199,297	325	613.22	1993
		199,297	175	1,138.84	1996
		199,297	445	447.86	1997
		199,297	350	569.42	1998

Sources: Peter Jackson, Chairman, Cat Specialist Group, IUCN/SSC.
Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. <www.wcmc.org/uk>.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Tiger by Range Country Based on IUCN Categories

Table 4.3b continued

Sub-species	Country	Total Area Protected in Square Miles (without Category VI)	Population Estimate	Protected area in square miles per animal	Year
S. China Tiger	China	211,489	55	3,845.25	1993
		211,489	25	8,459.56	1996
		211,489	25	8,459.56	1997
		211,489	25	8,459.56	1998
Sumatran	Sumatra	14,335	450	31.86	1993
		14,335	450	31.86	1996
		14,335	450	31.86	1997
		14,335	450	31.86	1998
Indo-Chinese	Cambodia	8,186	present		1993
		8,186	150	54.57	1996
		8,186	150	54.57	1997
		8,186	225	36.38	1998
	China	211,489	no data		1993
		211,489	35	6,042.54	1996
		211,489	35	6,042.54	1997
		211,489	35	6,042.54	1998
	Laos	0	present		1993
			present		1996
			present		1997
			present		1998
	Malaysia	5,294	550	9.63	1993
		5,294	625	8.47	1996
		5,294	625	8.47	1997
		5,294	500	10.59	1998
	Myanamar	620	present		1993
		620	present		1996
		620	present		1997
		620	170	3.65	1998
	Thailand	25,552	303	84.33	1993
		25,552	425	60.12	1996
		25,552	425	60.12	1997
		25,552	375	68.14	1998
	Vietnam	3,838	250	15.35	1993
		3,838	250	15.35	1996
		3,838	250	15.35	1997
		3,838	200	19.19	1998

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Asian Elephant by Range Country Based on IUCN Categories

Table 4.4a

Sub-species	Country	Total Area Protected in Square Miles (includes Category VI)	Population Estimate	Protected area in square miles per animal	Year
Elephas maximus	Indian Sub-continent				
	(includes, India, Nepal,	63,830	12,500	5.11	1979
	Bhutan and Bangladesh)	63,830	19,589	3.26	1989
		63,830	20,010	3.19	1990
		63,830	22,172	2.88	1996
	Myanmar (Burma)	620	5,000	0.12	1979
		620	8,000	0.08	1989
		620	6,500	0.10	1990
		620	5,500	0.11	1996
	China	243,810	100	2,438.10	1979
		243,810	165	1,477.64	1989
		243,810	225	1,083.60	1990
		243,810	300	812.70	1996
	Thailand	25,552	3,500	7.30	1979
		25,552	3,737	6.84	1989
		25,552	1,650	15.49	1990
		25,552	2,250	11.36	1996
	Indonesia	127,776	no data		1979
		127,776	3,800	33.63	1989
		127,776	4,200	30.42	1990
		127,776	3,500	36.51	1996

Sources: Oliver, Robert; 1978.
Sukumar, R.; 1989.
Santiapillai, C. and Peter Jackson; 1990.
World Wildlife Fund International and IUCN Asian Elephant Specialist Group.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. <www.wcmc.org/uk>.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Asian Elephant by Range Country Based on IUCN Categories

Table 4.4a continued.

Sub-species	Country	Total Area Protected in Square Miles (includes Category VI)	Population Estimate	Protected area in square miles per animal	Year
Elephas maximus	Laos and Vietnam	14,476	4,250	3.41	1979
		14,476	4,250	3.41	1989
		14,476	4,250	3.41	1990
		14,476	3,350	4.32	1996
	Kalimantan, Indonesia	31,062			1979
		31,062			1989
		31,062	300	103.54	1990
		31,062			1996
	Sabah, Malaysia	1,334	2,000	0.67	1979
		1,334	1,250	1.07	1989
		1,334	1,250	1.07	1990
		1,334	1,250	1.07	1996
	Sumatra	14,335	300	47.78	1979
		14,335	3,800	3.77	1989
		14,335	3,900	3.68	1990
		14,335	no data		1996
	Malaysia	5,294	4,500	1.18	1979
		5,294	1,900	2.79	1989
		5,294	900	5.88	1990
		5,294	900	5.88	1996
	Sri Lanka	3,326	3,000	1.11	1979
		3,326	3,000	1.11	1989
		3,326	2,950	1.13	1990
		3,326	2,750	1.21	1996

Sources: Oliver, Robert; 1978.
Sukumar, R.; 1989.
Santiapillai, C. and Peter Jackson; 1990.
World Wildlife Fund International and IUCN Asian Elephant Specialist Group.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. < www.wcmc.org/uk>.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Asian Elephant by Range Country Based on IUCN Categories

Table 4.4b

Sub-species	Country	Total Area Protected in Square Miles (not including Cat. VI)	Population Estimate	Protected area in square miles per animal	Year
Elephas maximus	Indian Sub-continent				
	(includes, India, Nepal,	63,216	12,500	5.06	1979
	Bhutan and	63,216	19,589	3.23	1989
	Bangladesh)	63,216	20,010	3.16	1990
		63,216	22,172	2.85	1996
	Myanmar (Burma)	620	5,000	0.12	1979
		620	8,000	0.08	1989
		620	6,500	0.10	1990
		620	5,500	0.11	1996
	China	211,489	100	2,114.89	1979
		211,489	165	1,281.75	1989
		211,489	225	939.95	1990
		211,489	300	704.96	1996
	Thailand	25,552	3,500	7.30	1979
		25,552	3,737	6.84	1989
		25,552	1,650	15.49	1990
		25,552	2,250	11.36	1996
	Indonesia	72,127	no data		1979
		72,127	3,800	18.98	1989
		72,127	4,200	17.17	1990
		72,127	3,500	20.61	1996

Sources: Oliver, 1978.
Sukumar, R.; 1989.
Santiapillai, C. and Peter Jackson; 1990.
World Wildlife Fund International and IUCN Asian Elephant Specialist Group.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. <www.wcmc.org/uk>.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Asian Elephant by Range Country Based on IUCN Categories

Table 4.4b continued.

Sub-species	Country	Total Area Protected in Square Miles (not including Cat. VI)	Population Estimate	Protected area in square miles per animal	Year
Elephas maximus	Laos and Vietnam	3,838	4,250	0.90	1979
		3,838	4,250	0.90	1989
		3,838	4,250	0.90	1990
		3,838	3,350	1.15	1996
	Kalimantan, Indonesia	12,581			1979
		12,581			1989
		12,581	300	41.94	1990
		12,581			1996
	Sabah, Malaysia	1,334	2,000	0.67	1979
		1,334	1,250	1.07	1989
		1,334	1,250	1.07	1990
		1,334	1250	1.07	1996
	Sumatra	14,335	300	47.78	1979
		14,335	3,800	3.77	1989
		14,335	3,900	3.68	1990
		14,335	no data		1996
	Malaysia	5,294	4,500	1.18	1979
		5,294	1,900	2.79	1989
		5,294	900	5.88	1990
		5,294	900	5.88	1996
	Sri Lanka	3,326	3,000	1.11	1979
		3,326	3,000	1.11	1989
		3,326	2,950	1.13	1990
		3,326	2,750	1.21	1996

Sources: Oliver, Robert; 1978.
Sukumar, R.; 1989.
Santiapillai, C. and Peter Jackson; 1990.
World Wildlife Fund International and IUCN Asian Elephant Specialist Group.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation. Union website. <www.wcmc.org/uk>

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Rhinoceros by Range Country Based on IUCN Categories

Table 4.5a

Sub-species	Country	Total Area Protected in Square Miles (includes Category VI)	Population Estimate	Protected area in square miles per animal	Year
Northern White Rhino	Sudan	47,173	400	117.93	1981
		47,173	25	1,886.92	1999
	Congo (Former Zaire)	0	300	0.00	1981
		0	25	0.00	1999
Southern White Rhino	Botswana	40,511	60	675.18	1981
		40,511	23	1,761.35	1999
	Ivory Coast	0	no data		1981
			4	0.00	1999
	Kenya	17,200	no data		1981
		17,200	137	125.55	1999
	Mozambique	25,422	40	635.55	1981
		25,422	no data		1999
	Namibia	40,065	15	2,671.00	1981
		40,065	141	284.15	1999
	South Africa	25,864	2,500	10.35	1981
		25,864	7,913	3.27	1999
	Swaziland	232	60	3.87	1981
		232	50	4.64	1999
	Zambia	87,383	6	14,563.83	1981
		87,383	6	14,563.83	1999
	Zimbabwe	17,928	180	99.60	1981
		17,928	167	107.35	1999

Sources: Dr. P. Martin Brook, Chairman, IUCN African Rhino Specialist Group (AFRSG) 1999.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. www.wcmc.org/uk.

*Population estimates are averaged from a minimum and maximum population estimate.

Protected Area per Rhinoceros by Range Country Based on IUCN Categories

Table 4.5b

Sub-species	Country	Total Area Protected in Square Miles (not including Cat. VI)	Population Estimate	Protected area in square miles per animal	Year
Northern White Rhino	Sudan	33,252	400	83.13	1981
		33,252	25	1,330.08	1999
	Congo (Former Zaire)	0	300	0.00	1981
		0	25	0.00	1999
Southern White Rhino	Botswana	40,511	60	675.18	1981
		40,511	23	1,761.35	1999
	Ivory Coast	0	no data		1981
			4	0.00	1999
	Kenya	13,491	no data		1981
		13,491	137	98.47	1999
	Mozambique	25,422	40	635.55	1981
			no data		1999
	Namibia	37,749	15	2,516.60	1981
		37,749	141	267.72	1999
	South Africa	25,789	2,500	10.32	1981
		25,789	7,913	3.26	1999
	Swaziland	136	60	2.27	1981
		136	50	2.72	1999
	Zambia	24,540	6	4,090.00	1981
		24,540	6	4,090.00	1999
	Zimbabwe	10,498	180	58.32	1981
		10,498	167	62.86	1999

Sources: Dr. P. Martin Brook, Chairman, IUCN African Rhino Specialist Group (AFRSG) 1999.

Protected Area data from the 1997 U.N. List of Protected Areas from the World Conservation Union website. <www.wcmc.org/uk>

*Population estimates are averaged rom a minimum and maximum population estimate.

APPENDIX III

TABLES 5.1-5.3

PERCENTAGE OF SPECIES AND SUB-SPECIES PER ZOO FOR 1998 AND ZOO RANKINGS

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1

Zoos	Alexandria Zoological Park	Audubon Park and Zoological Garden	Baltimore Zoo	Birmingham zoo	Bronx Zoo/Wildlife Conservation Park	Burnett Park Zoo	Busch Gardens Zoological Park	Cameron Park Zoo	Cheyenne Mountain Zoological Park
City/State	Alexandria	New Orleans, LA	Baltimore	Birmingham	New York	Syracuse NY	Tampa	Waco	Colorado Springs
State	Louisiana	Louisiana	Maryland	Alabama	New York	New York	Florida	Texas	Colorado
Regions	Number of Species and Sub-species								
Africa	9%	21%	31%	28%	21%	14%	44%	31%	28%
Africa and other	2%	1%	3%	1%	2%	2%	0%	0%	0%
Arctic	0%	0%	2%	0%	1%	0%	0%	0%	1%
Arctic and other	2%	0%	0%	0%	0%	0%	0%	0%	0%
Asia	0%	0%	1%	0%	0%	0%	0%	0%	0%
Asia-Pacific	0%	1%	0%	0%	1%	0%	0%	0%	0%
Australia	4%	1%	2%	2%	1%	2%	3%	0%	0%
Australia-Asia Pacific	0%	0%	0%	0%	1%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Alexandria Zoological Park	Audubon Park and Zoological Garden	Baltimore Zoo	Birmingham zoo	Bronx Zoo/Wildlife Conservation Park	Burnett Park Zoo	Busch Gardens Zoological Park	Cameron Park Zoo	Cheyenne Mountain Zoological Park
City/State	Alexandria	New Orleans, LA	Baltimore	Birmingham	New York	Syracuse NY	Tampa	Waco	Colorado Springs
State	Louisiana	Louisiana	Maryland	Alabama	New York	New York	Florida	Texas	Colorado
Regions	Number of Species and Sub-species								
E. Asia-SE Asia	0%	0%	2%	1%	2%	0%	0%	0%	1%
Indian Ocean	0%	0%	0%	0%	1%	0%	0%	0%	0%
MiddleEast/S.W.Asia	0%	3%	2%	1%	3%	5%	0%	8%	3%
N. America	14%	9%	10%	6%	6%	16%	0%	12%	11%
N. America-S. America	7%	4%	1%	5%	1%	3%	3%	0%	1%
N. America-Central America	2%	2%	0%	1%	1%	0%	0%	0%	0%
N. America and other	0%	0%	0%	0%	0%	2%	0%	0%	0%
Russia	0%	0%	0%	0%	0%	2%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Alexandria Zoological Park	Audubon Park and Zoological Garden	Baltimore Zoo	Birmingham zoo	Bronx Zoo/Wildlife Conservation Park	Burnett Park Zoo	Busch Gardens Zoological Park	Cameron Park Zoo	Cheyenne Mountain Zoological Park
City/State	Alexandria	New Orleans, LA	Baltimore	Birmingham	New York	Syracuse NY	Tampa	Waco	Colorado Springs
State	Louisiana	Louisiana	Maryland	Alabama	New York	New York	Florida	Texas	Colorado
Regions	Number of Species and Sub-species								
S. America	19%	12%	7%	8%	14%	6%	8%	4%	9%
S. Asia	5%	2%	5%	5%	5%	8%	3%	0%	5%
S. Asia-SE. Asia	4%	3%	0%	5%	3%	3%	6%	4%	3%
SE Asia	4%	5%	1%	1%	9%	5%	3%	4%	5%
West Indies	0%	0%	0%	0%	0%	0%	0%	0%	0%
Worldwide	0%	2%	2%	1%	1%	5%	0%	0%	0%
Total Number of Mammals Species per Zoo	57	91	94	88	182	64	36	26	76

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Chicago Zoological Park	Cincinnati Zoo &Botanical Garden	Cleveland MetroParks Zoological Park	Columbus Zoological Gardens	Dakota Zoo	Dallas Zoo	Denver Zoological Gardens	Detroit Zoological Park &Belle Isle Zoo	Dickerson Park Zoo	Disney Animal Kingdom
City/State	Chicago	Cincinnati	Cleveland	Columbus	Bismark	Dallas	Denver	Detroit	Springfield	Tampa
State	Illinois	Ohio	Ohio	Ohio	N. Dakota	Texas	Colorado	Michigan	Missouri	Florida
Regions										
Africa	23%	25%	24%	23%	4%	41%	25%	24%	29%	40%
Africa and other	2%	2%	1%	1%	0%	4%	0%	1%	0%	2%
Arctic	1%	1%	1%	0	0	0	1%	2%	0%	0%
Arctic and other	0%	0%	0%	0%	0%	0%	1%	0%	2%	0%
Asia	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Asia-Pacific	1%	1%	1%	1%	0%	0%	0%	1%	0%	0%
Australia	3%	2%	2%	6%	2%	2%	1%	1%	3%	3%
Australia-Asia Pacific	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Chicago Zoological Park	Cincinnati Zoo &Botanical Garden	Cleveland MetroParks Zoological Park	Columbus Zoological Gardens	Dakota Zoo	Dallas Zoo	Denver Zoological Gardens	Detroit Zoological Park &Belle Isle Zoo	Dickerson Park Zoo	Disney Animal Kingdom
City/State	Chicago	Cincinnati	Cleveland	Columbus	Bismark	Dallas	Denver	Detroit	Springfield	Tampa
State	Illinois	Ohio	Ohio	Ohio	N. Dakota	Texas	Colorado	Michigan	Missouri	Florida
Regions										
E. Asia-SE Asia	1%	1%	1%	1%	0%	1%	0%	0%	0%	1%
Indian Ocean	1%	0%	1%	0%	0%	0%	0%	0%	0%	1%
MiddleEast/S.W.Asia	2%	2%	2%	2%	2%	3%	2%	5%	3%	2%
N. America	7%	4%	2%	12%	35%	4%	7%	5%	11%	2%
N. America-S. America	2%	3%	1%	2%	4%	1%	1%	2%	2%	1%
N. America-Central America	1%	0%	1%	1%	0%	1%	0%	0%	3%	2%
N. America and other	1%	0%	1%	1%	2%	0%	1%	0%	0%	0%
Russia	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Chicago Zoological Park	Cincinnati Zoo &Botanical Garden	Cleveland MetroParks Zoological Park	Columbus Zoological Gardens	Dakota Zoo	Dallas Zoo	Denver Zoological Gardens	Detroit Zoological Park &Belle Isle Zoo	Dickerson Park Zoo	Disney Animal Kingdom
City/State	Chicago	Cincinnati	Cleveland	Columbus	Bismark	Dallas	Denver	Detroit	Springfield	Tampa
State	Illinois	Ohio	Ohio	Ohio	N. Dakota	Texas	Colorado	Michigan	Missouri	Florida
Regions										
S. America	11%	8%	15%	9%	7%	7%	13%	7%	8%	10%
S. Asia	2%	6%	3%	8%	0%	0%	5%	5%	2%	3%
S. Asia-SE. Asia	1%	2%	3%	3%	0%	0%	2%	2%	5%	3%
SE Asia	4%	9%	12%	3%	0%	3%	6%	5%	3%	4%
West Indies	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Worldwide	2%	1%	1%	2%	2%	1%	0%	2%	3%	1%
Total Number of Mammals Species per Zoo	162	194	164	108	57	107	141	83	66	105

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Fort Worth Zoo	Franklin Park Zoo	Greater Baton Rouge Zoo	Henry Villas Park Zoo	Houston Zoological Gardens	Indianapolis Zoological Park	Jackson Zoological Park	Jacksonville Zoological Gardens	Kansas City Zoological Gardens	Knoxville Zoological Gardens
City/State	Fort Worth	Boston	Baton Rouge	Madison	Houston	Indianapolis	Jackson	Jacksonville	Kansas City	Knoxville
State	Texas	Massachusetts	Louisiana	Wisconsin	Texas	Indiana	Mississippi	Florida	Missouri	Tennessee
Regions										
Africa	31%	29%	35%	21%	24%	22%	28%	40%	35%	25%
Africa and other	3%	2%	2%	0%	2%	0%	1%	1%	1%	1%
Arctic	0%	1%	0%	1%	0%	2%	0%	0%	0%	0%
Arctic and other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asia	0%	0%	0%	0%	0%	2%	0%	0%	1%	0%
Asia-Pacific	0%	0%	0%	0%	1%	0%	0%	1%	1%	0%
Australia	4%	4%	3%	3%	1%	6%	0%	0%	5%	0%
Australia-Asia Pacific	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Fort Worth Zoo	Franklin Park Zoo	Greater Baton Rouge Zoo	Henry Villas Park Zoo	Houston Zoological Gardens	Indianapolis Zoological Park	Jackson Zoological Park	Jacksonville Zoological Gardens	Kansas City Zoological Gardens	Knoxville Zoological Gardens
City/State	Fort Worth	Boston	Baton Rouge	Madison	Houston	Indianapolis	Jackson	Jacksonville	Kansas City	Knoxville
State	Texas	Massachusetts	Louisiana	Wisconsin	Texas	Indiana	Mississippi	Florida	Missouri	Tennessee
Regions										
E. Asia-SE Asia	1%	1%	0%	0%	1%	0%	0%	0%	1%	0%
Indian Ocean	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MiddleEast/S.W.Asia	1%	4%	3%	4%	2%	6%	3%	4%	3%	4%
N. America	8%	8%	5%	13%	5%	2%	5%	7%	3%	9%
N. America-S. America	0%	4%	3%	0%	3%	0%	1%	4%	1%	0%
N. America-Central America	0%	0%	0%	0%	1%	0%	3%	1%	2%	1%
N. America and other	0%	1%	0%	0%	0%	2%	0%	0%	0%	1%
Russia	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Fort Worth Zoo	Franklin Park Zoo	Greater Baton Rouge Zoo	Henry Villas Park Zoo	Houston Zoological Gardens	Indianapolis Zoological Park	Jackson Zoological Park	Jacksonville Zoological Gardens	Kansas City Zoological Gardens	Knoxville Zoological Gardens
City/State	Fort Worth	Boston	Baton Rouge	Madison	Houston	Indianapolis	Jackson	Jacksonville	Kansas City	Knoxville
State	Texas	Massachusetts	Louisiana	Wisconsin	Texas	Indiana	Mississippi	Florida	Missouri	Tennessee
Regions										
S. America	1%	7%	8%	9%	13%	14%	13%	7%	11%	6%
S. Asia	6%	1%	7%	3%	2%	0%	6%	2%	4%	9%
S. Asia-SE. Asia	3%	0%	2%	4%	1%	0%	3%	0%	0%	1%
SE Asia	8%	0%	3%	1%	7%	2%	6%	3%	3%	1%
West Indies	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Worldwide	0%	2%	2%	1%	3%	8%	1%	0%	3%	3%
Total Number of Mammals Species per Zoo	71	83	118	67	149	51	78	103	111	69

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Little Rock Zoo	Los Angeles Zoo	Louisiana Purchase Garden and Zoo	Louisville Zoological Garden	Memphis Zoo and Aquarium	Mesker Park Zoo & Botanical Garden	Miami Metro Zoo	Milwaukee County Zoological Park	Minnesota Zoological Garden
City/State	Little Rock	Los Angeles	Monroe	Louisville	Memphis	Evansville	Miami	Milwaukee	Minneapolis/St. Paul
State	Arkansas	California	Louisiana	Kentucky	Tennessee	Indiana	Florida	Wisconsin	Minnesota
Regions									
Africa	18%	25%	37%	27%	30%	25%	43%	25%	3%
Africa and other	1%	1%	0%	1%	2%	0%	1%	2%	1%
Arctic	0%	1%	0%	1%	1%	0%	0%	1%	0%
Arctic and other	0%	1%	0%	0%	0%	0%	0%	0%	0%
Asia	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asia-Pacific	0%	0%	1%	0%	1%	0%	1%	1%	0%
Australia	2%	5%	1%	3%	1%	5%	5%	2%	0%
Australia-Asia Pacific	1%	1%	1%	0%	1%	1%	0%	1%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Little Rock Zoo	Los Angeles Zoo	Louisiana Purchase Garden and Zoo	Louisville Zoological Garden	Memphis Zoo and Aquarium	Mesker Park Zoo & Botanical Garden	Miami Metro Zoo	Milwaukee County Zoological Park	Minnesota Zoological Garden
City/State	Little Rock	Los Angeles	Monroe	Louisville	Memphis	Evansville	Miami	Milwaukee	Minneapolis/St. Paul
State	Arkansas	California	Louisiana	Kentucky	Tennessee	Indiana	Florida	Wisconsin	Minnesota
Regions									
E. Asia-SE Asia	1%	0%	0%	0%	1%	0%	0%	0%	1%
Indian Ocean	0%	0%	0%	1%	0%	0%	0%	0%	0%
MiddleEast/S.W.Asia	0%	1%	0%	3%	1%	1%	4%	1%	1%
N. America	8%	8%	1%	4%	2%	3%	1%	12%	21%
N. America-S. America	3%	2%	1%	3%	3%	1%	1%	1%	4%
N. America-Central America	1%	3%	2%	0%	1%	1%	0%	0%	4%
N. America and other	0%	0%	0%	1%	0%	0%	0%	1%	0%
Russia	1%	0%	0%	0%	0%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Little Rock Zoo	Los Angeles Zoo	Louisiana Purchase Garden and Zoo	Louisville Zoological Garden	Memphis Zoo and Aquarium	Mesker Park Zoo & Botanical Garden	Miami Metro Zoo	Milwaukee County Zoological Park	Minnesota Zoological Garden
City/State	Little Rock	Los Angeles	Monroe	Louisville	Memphis	Evansville	Miami	Milwaukee	Minneapolis/St. Paul
State	Arkansas	California	Louisiana	Kentucky	Tennessee	Indiana	Florida	Wisconsin	Minnesota
Regions									
S. America	16%	13%	10%	9%	8%	12%	1%	12%	4%
S. Asia	2%	3%	7%	1%	5%	13%	5%	1%	8%
S. Asia-SE. Asia	2%	1%	4%	4%	3%	3%	5%	2%	4%
SE Asia	8%	5%	7%	8%	7%	4%	5%	2%	10%
West Indies	0%	0%	1%	0%	1%	0%	0%	0%	0%
Worldwide	2%	0%	0%	3%	3%	3%	0%	3%	0%
Total Number of Mammals Species per Zoo	90	154	81	74	153	77	94	138	73

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	National Zoological Park	North Carolina Zoological Park	Northwest Trek Wildlife Park	Oglebay's Good Children's Zoo	Oklahoma City Zoological Park	Omaha's Henry Doorly Zoological Gardens	Phoenix zoo	Pittsburgh Zoo	Rio Grande Zoological Park
City/State	Washington D.C.	Asheboro	Eatonville	Wheeling	OK	Omaha	Phoenix	Pittsburgh	Albuquerque
State	District of Columbia	N. Carolina	Washington	W. Virginia	Oklahoma	Nebraska	Arizona	Pennsylvania	New Mexico
Regions									
Africa	20%	41%	0%	6%	32%	24%	20%	23%	17%
Africa and other	1%	3%	0%	0%	2%	2%	4%	2%	3%
Arctic	0%	3%	0%	0%	0%	1%	0%	1%	3%
Arctic and other	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asia	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asia-Pacific	2%	0%	0%	0%	0%	0%	0%	1%	0%
Australia	2%	0%	0%	0%	2%	1%	2%	1%	5%
Australia-Asia Pacific	1%	0%	0%	0%	1%	0%	0%	0%	2%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	National Zoological Park	North Carolina Zoological Park	Northwest Trek Wildlife Park	Oglebay's Good Children's Zoo	Oklahoma City Zoological Park	Omaha's Henry Doorly Zoological Gardens	Phoenix zoo	Pittsburgh Zoo	Rio Grande Zoological Park
City/State	Washington D.C.	Asheboro	Eatonville	Wheeling	OK	Omaha	Phoenix	Pittsburgh	Albuquerque
State	District of Columbia	N. Carolina	Washington	W. Virginia	Oklahoma	Nebraska	Arizona	Pennsylvania	New Mexico
Regions									
E. Asia-SE Asia	1%	0%	0%	0%	1%	1%	0%	1%	0%
Indian Ocean	0%	0%	0%	0%	0%	0%	0%	0%	0%
MiddleEast/S.W. Asia	1%	3%	0%	3%	4%	1%	3%	2%	2%
N. America	10%	17%	63%	15%	1%	9%	15%	6%	17%
N. America-S. America	2%	4%	2%	9%	2%	2%	1%	3%	0%
N. America-Central America	0%	0%	5%	0%	0%	1%	2%	1%	0%
N. America and other	0%	0%	0%	3%	0%	1%	0%	1%	0%
Russia	1%	0%	0%	0%	0%	0%	0%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	National Zoological Park	North Carolina Zoological Park	Northwest Trek Wildlife Park	Oglebay's Good Children's Zoo	Oklahoma City Zoological Park	Omaha's Henry Doorly Zoological Gardens	Phoenix zoo	Pittsburgh Zoo	Rio Grande Zoological Park
City/State	Washington D.C.	Asheboro	Eatonville	Wheeling	OK	Omaha	Phoenix	Pittsburgh	Albuquerque
State	District of Columbia	N. Carolina	Washington	W. Virginia	Oklahoma	Nebraska	Arizona	Pennsylvania	New Mexico
Regions									
S. America	12%	1%	0%	15%	9%	14%	15%	9%	7%
S. Asia	5%	0%	0%	6%	5%	5%	1%	2%	10%
S. Asia-SE. Asia	3%	0%	0%	0%	5%	3%	1%	2%	3%
SE Asia	8%	0%	0%	6%	6%	7%	3%	7%	3%
West Indies	0%	0%	0%	0%	0%	1%	1%	1%	0%
Worldwide	0%	0%	0%	3%	1%	1%	3%	0%	0%
Total Number of Mammals Species per Zoo	153	70	41	34	109	155	112	162	60

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Riverbanks Zoological Park	San Antonio Zoological Gardens	San Diego Wild Animal Park	San Diego Zoological Gardens	San Francisco Zoological Gardens	Sedgewick County Zoo	St. Catherine's Wildlife Survival Center	St. Louis Zoological Park	Sunset Zoological Park	The Living Desert
City/State	Colombia	San Antonio	San Diego	San Diego	San Francisco	Wichita	Georgia	St. Louis	Manhattan	Palm Desert
State	S. Carolina	Texas	California	California	California	Kansas	Georgia	Missouri	Kansas	California
Regions										
Africa	23%	34%	41%	24%	24%	19%	72%	25%	15%	26%
Africa and other	3%	4%	2%	0%	2%	0%	0%	2%	0%	9%
Arctic	3%	1%	0%	0%	1%	0%	0%	1%	2%	0%
Arctic and other	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
Asia	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Asia-Pacific	2%	2%	1%	1%	0%	1%	0%	0%	0%	0%
Australia	0%	4%	1%	3%	4%	2%	0%	3%	4%	0%
Australia-Asia Pacific	2%	0%	0%	0%	0%	0%	0%	1%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Riverbanks Zoological Park	San Antonio Zoological Gardens	San Diego Wild Animal Park	San Diego Zoological Gardens	San Francisco Zoological Gardens	Sedgewick County Zoo	St. Catherine's Wildlife Survival Center	St. Louis Zoological Park	Sunset Zoological Park	The Living Desert
City/State	Colombia	San Antonio	San Diego	San Diego	San Francisco	Wichita	Georgia	St. Louis	Manhattan	Palm Desert
State	S. Carolina	Texas	California	California	California	Kansas	Georgia	Missouri	Kansas	California
Regions										
E. Asia-SE Asia	2%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Indian Ocean	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MiddleEast/S.W. Asia	2%	3%	4%	3%	2%	4%	6%	2%	2%	8%
N. America	2%	2%	1%	4%	8%	10%	0%	6%	9%	20%
N. America-S. America	0%	1%	0%	1%	3%	4%	0%	1%	4%	7%
N. America-Central America	2%	0%	0%	0%	2%	0%	0%	1%	0%	1%
N. America and other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Russia	0%	1%	2%	2%	0%	0%	0%	1%	0%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Riverbanks Zoological Park	San Antonio Zoological Gardens	San Diego Wild Animal Park	San Diego Zoological Gardens	San Francisco Zoological Gardens	Sedgewick County Zoo	St. Catherine's Wildlife Survival Center	St. Louis Zoological Park	Sunset Zoological Park	The Living Desert
City/State	Colombia	San Antonio	San Diego	San Diego	San Francisco	Wichita	Georgia	St. Louis	Manhattan	Palm Desert
State	S. Carolina	Texas	California	California	California	Kansas	Georgia	Missouri	Kansas	California
Regions										
S. America	14%	12%	4%	6%	9%	18%	0%	10%	9%	0%
S. Asia	3%	3%	7%	5%	3%	3%	6%	2%	13%	0%
S. Asia-SE. Asia	2%	3%	1%	1%	2%	2%	0%	2%	0%	0%
SE Asia	5%	3%	5%	9%	5%	2%	0%	6%	0%	0%
West Indies	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%
Worldwide	2%	0%	0%	1%	2%	2%	0%	0%	4%	0%
Total Number of Mammals Species per Zoo	65	155	174	301	119	105	18	151	46	76

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Tulsa Zoological Park	Utah's Hogle Zoological Gardens	Virginia Zoological Park	Wildlife Safari	Wildlife World Zoo	Woodland Park Zoological Gardens
City/State	Tulsa	Salt Lake	Norfolk	Winston	Litchfield Park	Seattle
State	Oklahoma	Utah	Virginia	Oregon	Arizona	Washington
Regions						
Africa	16%	23%	21%	28%	32%	29%
Africa and other	3%	3%	2%	2%	1%	1%
Arctic	3%	1%	0%	2%	0%	0%
Arctic and other	0%	0%	0%	2%	0%	0%
Asia	0%	0%	0%	0%	0%	0%
Asia-Pacific	0%	0%	0%	0%	1%	1%
Australia	2%	2%	2%	3%	6%	3%
Australia-Asia Pacific	0%	0%	0%	0%	1%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Tulsa Zoological Park	Utah's Hogle Zoological Gardens	Virginia Zoological Park	Wildlife Safari	Wildlife World Zoo	Woodland Park Zoological Gardens
City/State	Tulsa	Salt Lake	Norfolk	Winston	Litchfield Park	Seattle
State	Oklahoma	Utah	Virginia	Oregon	Arizona	Washington
Regions						
E. Asia-SE Asia	0%	1%	0%	0%	0%	0%
Indian Ocean	0%	0%	0%	0%	0%	0%
MiddleEast/S.W.Asia	2%	4%	3%	5%	2%	1%
N. America	18%	16%	7%	13%	3%	10%
N. America-S. America	3%	2%	5%	3%	2%	2%
N. America-Central America	1%	2%	0%	0%	1%	0%
N. America and other	0%	0%	0%	0%	0%	0%
Russia	0%	0%	0%	0%	1%	0%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percentage of Species and Sub-species per Zoo by Region for 1998

Table 5.1 continued.

Zoos	Tulsa Zoological Park	Utah's Hogle Zoological Gardens	Virginia Zoological Park	Wildlife Safari	Wildlife World Zoo	Woodland Park Zoological Gardens
City/State	Tulsa	Salt Lake	Norfolk	Winston	Litchfield Park	Seattle
State	Oklahoma	Utah	Virginia	Oregon	Arizona	Washington
Regions						
S. America	10%	11%	17%	2%	13%	10%
S. Asia	1%	4%	0%	6%	3%	5%
S. Asia-SE. Asia	1%	2%	2%	2%	1%	1%
SE Asia	5%	1%	2%	0%	3%	7%
West Indies	0%	0%	0%	0%	0%	0%
Worldwide	3%	2%	7%	3%	0%	0%
Total Number of Mammals	97	113	58	64	127	110

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percent of African Species and Sub-species per Zoo for 1998

Table 5.2

Zoo	State	Funding	Specialty	Acreage	Percent African species and subspecies	Africa and other regions	African plus other
Alexandria Zoological Park	Louisiana	Municipal	none listed	82	9%	2%	11%
Audubon Zoological Park	Louisiana	Audubon inst.	none listed	54	21%	1%	22%
Baltimore Zoo	Maryland	non-profit	black footed penguins	200	31%	3%	34%
Birmingham Zoo	Alabama	Municipal w/aid	none listed	74	28%	1%	29%
Bronx Wildlife Conservation Park	New York	Zoological Soc.	linking in situ w/ ex situ breeding	245	21%	2%	23%
Burnett Park Zoo	New York	Municipal w/aid	cold adapted wildlife, elephants	49	14%	2%	16%
Busch Gardens Zoological Park	Florida	Private	African ungulates and birds	299	44%	0%	44%
Cameron Park Zoo	Texas	Municipal	none listed	62	31%	0%	31%
Cheyenne Mountain Zoological Park	Colorado	non-profit	primates, large felids, ungulates	74	28%	0%	28%
Chicago Zoological Park	Illinois	Zoological Soc.	Tropical World Habitat, Africa	142	23%	2%	25%
Cincinnati Zoo & Botanical Garden	Ohio	Municipal	insects, amphibians, great apes	54	25%	2%	27%
Cleveland Metroparks Zoological Park	Ohio	Municipal w/ aid	none listed	124	24%	1%	25%
Columbus Zoological Gardens	Ohio	Municipal	none listed	404	23%	1%	24%
Dakota Zoo	N. Dakota	Zoological Soc.	North American Fauna	86	4%	0%	4%
Dallas Zoo	Texas	Municipal w/aid	herpetolotgical collection	74	41%	4%	45%
Denver Zoological Gardens	Colorado	non-profit	primates, large felids, ungulates	79	25%	0%	25%
Detroit Zoological Park & Belle Isle Zoo	Michigan	Municipal w/aid	penguins, great apes, amphibians	114	24%	1%	25%
Dickerson Park Zoo	Missouri	Municipal w/aid	Asian elephants, cheetah, maned wolf	69	29%	0%	29%
Disney Animal Kingdom	Florida	Private	African ungulates and birds	500	40%	2%	42%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percent of African Species and Sub-species per Zoo for 1998

Table 5.2 continued.

Zoo	State	Funding	Specialty	Acreage	Percent African species and sub-species	Africa and other regions	African plus other
Fort Worth Zoo	Texas	Municipal w/aid	none listed	49	31%	3%	34%
Franklin Park Zoo	Massachusetts	Zoological Soc.	Tropical Forest Species	72	29%	2%	31%
Greater Baton Rouge Zoo	Louisiana	Municipal	none listed	145	35%	2%	37%
Henry Villas Park Zoo	Wisconsin	Municipal w/aid	none listed	67	21%	0%	21%
Houston Zoological Gardens	Texas	Municipal	none listed	49	24%	2%	26%
Indianapolis Zoological Park	Indiana	non-profit	none listed	64	22%	0%	22%
Jackson Zoological Park	Mississippi	Municipal	none listed	99	28%	1%	29%
Jacksonville Zoological Gardens	Florida	Municipal	none listed	62	40%	1%	41%
Kansas City Zoological Gardens	Missouri	Municipal	great apes, African birds, black rhinos	173	35%	1%	36%
Knoxville Zoological Gardens	Tennessee	Municipal	red pandas, reptiles, S. white rhinos	140	25%	1%	26%
Little Rock Zoo	Arkansas	Municipal	none listed	104	18%	1%	19%
Los Angeles Zoo	California	Municipal w/aid	California condor recovery program	79	25%	1%	26%
Louisiana Purchase Garden and Zoo	Louisiana	non-profit	gunenons, lemurs, fishing cats	79	37%	0%	37%
Louisville Zoological Garden	Kentucky	Municipal w/aid	none listed	74	27%	1%	28%
Memphis Zoo and Aquarium	Tennessee	Municipal	none listed	173	30%	2%	32%
Mesker Park Zoo & Botanical Garden	Indiana	Municipal	mixed species hoofstock	180	25%	0%	25%
Miami Metro Zoo	Florida	Municipal	hoofed animals and cranes	257	43%	1%	44%
Milwaukee County Zoological Park	Wisconsin	Municipal w/aid	none listed	190	25%	2%	27%
Minnesota Zoological Garden	Minnesota	Municipal	Asian Tropics, N. Hemisphere	482	3%	1%	4%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percent of African Species and Sub-species per Zoo for 1998

Table 5.2 continued.

Zoo	State	Funding	Specialty	Acreage	Percent African species and sub-species	Africa and other regions	African plus other
National Zoological Park	District of Col.	Zoological Soc.	none listed	3,147	20%	1%	21%
North Carolina Zoological Park	N. Carolina	State w/aid	none listed	299	41%	3%	44%
Northwest Trek Wildlife Park	Washington	Municipal	native animals of NW United States	667	0%	0%	0%
Oglebeys Good Chidren's Zoo	W.Virginia	Municipal	Children's Zoo	64	6%	0%	6%
Oklahoma City Zoological Park	Oklahoma	non-profit	none listed	188	32%	2%	34%
Omaha's Henry Doorly Zoological Gardens	Nebraska	Zoological Soc.	wild cattle, large carnivores	130	24%	2%	26%
Phoenix Zoo	Arizona	Private w/aid	desert animals	124	20%	4%	24%
Pittsburgh Zoo	Pennsylvania	Municipal w/aid	elephants, great apes, coral, child. Zoo	64	23%	2%	25%
Albuquerque Biological Park (Rio Grande)	New Mexico	Municipal w/aid	none listed	59	17%	3%	20%
Riverbanks Zoological Park	S. Carolina	Municipal w/ aid	rare primates	146	23%	3%	26%
San Antonio Zoological Gardens	Texas	Zoological Soc.	antelopes, waterfowl, whooping crane	49	34%	4%	38%
San Diego Wild Animal Park	California	Private/non profit	ungulates	1,798	41%	2%	43%
San Diego Zoological Gardens	California	Private/non profit	Chinese animals, hornbills, koalas,	99	24%	0%	24%
San Francisco Zoological Gardens	California	Municipal w/aid	primates, felids	109	24%	2%	26%
Sedgewick County Zoo	Kansas	County owned	none listed	212	19%	0%	19%
St. Catherine's Wildlife Center	Georgia	no info	no info	121	72%	0%	72%
St. Louis Zoological Park	Missouri	Municipal w/aid	none listed	82	25%	2%	27%
Sunset Zoological Park	Kansas	Municipal w/aid	none listed	54	15%	0%	15%
The Living Desert	California	Private/non profit	desert animals, and plants from N. America, Africa & MiddleEast	1,182	26%	9%	35%
Tulsa Zoological Gardens	Oklahoma	Municipal w/aid	zoo/museum combination	67	16%	3%	19%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Percent of African Species and Sub-species per Zoo for 1998

Table 5.2 continued.

Zoo	State	Funding	Specialty	Acreage	Percent African species and subspecies	Africa and other regions	African plus other
Utah's Hogle Zoological Gardens	Utah	Zoological Soc.	none listed	52	23%	3%	26%
Virginia Zoological Park	Virginia	Private/non profit	none listed	54	21%	2%	23%
Wildlife Safari	Oregon	Private/non profit	cheetah	600	28%	2%	30%
Wildlife World Zoo	Arizona	Private	birds, hoofed animals	49	32%	1%	33%
Woodland Park Zoological Gardens	Washington	Municipal w/aid	none listed	91	29%	1%	30%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3

Zoos	Alexandria Zoological Park		Audubon Park and Zoological Garden		Baltimore Zoo		Birmingham zoo	
City/State	Alexandria		New Orleans, LA		Baltimore		Birmingham	
State	Louisiana		Louisiana		Maryland		Alabama	
	Regions		Regions		Regions		Regions	
	S. America	19%	Africa	21%	Africa	31%	Africa	28%
	N. America	14%	S. America	12%	N. America	10%	S. America	8%
	Africa	9%	N. America	9%	S. America	7%	N. America	6%
Zoos	Bronx Zoo/Wildlife Conservation Park		Burnett Park Zoo		Busch Gardens Zoological Park		Cameron Park Zoo	
City/State	New York		Syracuse NY		Tampa		Waco	
State	New York		New York		Florida		Texas	
	Regions		Regions		Regions		Regions	
	Africa	21%	N. America	16%	Africa	44%	Africa	31%
	S. America	14%	Africa	14%	S. America	8%	N. America	12%
	SE Asia	9%	S. Asia	8%	S. Asia-SE. Asia	6%	MiddleEast/S.W. Asia	8%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	Cheyenne Mountain Zoological Park		Chicago Zoological Park		Cincinnati Zoo &Botanical Garden		Cleveland MetroParks Zoological Park	
City/State	Colorado Springs		Chicago		Cincinnati		Cleveland	
State	Colorado		Illinois		Ohio		Ohio	
	Regions		Regions		Regions		Regions	
	Africa	28%	Africa	23%	Africa	25%	Africa	24%
	N. America	11%	S. America	11%	SE Asia	9%	S. America	15%
	S. America	9%	N. America	7%	S. America	8%	SE Asia	12%
Zoos	Columbus Zoological Gardens		Dakota Zoo		Dallas Zoo		Denver Zoological Gardens	
City/State	Columbus		Bismark		Dallas		Denver	
State	Ohio		N. Dakota		Texas		Colorado	
	Regions		Regions		Regions		Regions	
	Africa	23%	N. America	35%	Africa	41%	Africa	25%
	N. America	12%	S. America	7%	S. America	7%	S. America	13%
	S. America	9%	Europe	5%	Africa and other	4%	N. America	7%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	Detroit Zoological Park & Belle Isle Zoo		Dickerson Park Zoo		Disney Animal Kingdom		Fort Worth Zoo	
City/State	Detroit		Springfield		Tampa		Fort Worth	
State	Michigan		Missouri		Florida		Texas	
	Regions		Regions		Regions		Regions	
	Africa	24%	Africa	29%	Africa	40%	Africa	31%
	S. America	7%	N. America	11%	S. America	10%	SE Asia	8%
	E. Asia	6%	S. America	8%	SE Asia	4%	N. America	8%
Zoos	Franklin Park Zoo		Greater Baton Rouge Zoo		Henry Villas Park Zoo		Houston Zoological Gardens	
City/State	Boston		Baton Rouge		Madison		Houston	
State	Massachusetts		Louisiana		Wisconsin		Texas	
	Regions		Regions		Regions		Regions	
	Africa	29%	Africa	35%	Africa	21%	Africa	24%
	N. America	8%	S. America	8%	N. America	13%	S. America	13%
	S. America	7%	S. Asia	7%	S. America	9%	SE Asia	7%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	Indianapolis Zoological Park		Jackson Zoological Park		Jacksonville Zoological Gardens		Kansas City Zoological Gardens	
City/State	Indianapolis		Jackson		Jacksonville		Kansas City	
State	Indiana		Mississippi		Florida		Missouri	
	Regions		Regions		Regions		Regions	
	Africa	22%	Africa	28%	Africa	40%	Africa	35%
	S. America	14%	S. America	13%	S. America	7%	S. America	11%
	Worldwide	8%	SE Asia	6%	N. America	7%	Australia	5%
Zoos	Knoxville Zoological Gardens		Little Rock Zoo		Los Angeles Zoo		Louisiana Purchase Garden and Zoo	
City/State	Knoxville		Little Rock		Los Angeles		Monroe	
State	Tennessee		Arkansas		California		Louisiana	
	Regions		Regions		Regions		Regions	
	Africa	25%	Africa	18%	Africa	25%	Africa	37%
	S. Asia	9%	S. America	16%	S. America	13%	S. America	10%
	N. America	9%	SE Asia	8%	N. America	8%	SE Asia	7%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	Louisville Zoological Garden		Memphis Zoo and Aquarium		Mesker Park Zoo & Botanical Garden		Miami Metro Zoo	
City/State	Louisville		Memphis		Evansville		Miami	
State	Kentucky		Tennessee		Indiana		Florida	
	Regions		Regions		Regions		Regions	
	Africa	27%	Africa	30%	Africa	25%	Africa	43%
	S. America	9%	S. America	8%	S. Asia	13%	SE Asia	5%
	SE Asia	8%	SE Asia	7%	S. America	12%	S. Asia-SE. Asia	5%
Zoos	Milwaukee County Zoological Park		Minnesota Zoological Garden		National Zoological Park		North Carolina Zoological Park	
City/State	Milwaukee		Minneapolis/St. Paul		Washington D.C.		Asheboro	
State	Wisconsin		Minnesota		District of Columbia		N. Carolina	
	Regions		Regions		Regions		Regions	
	Africa	25%	N. America	21%	Africa	20%	Africa	41%
	S. America	12%	SE Asia	10%	S. America	12%	N. America	17%
	N. America	12%	S. Asia	8%	N. America	10%	N. America-S. America	4%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	Northwest Trek Wildlife Park		Oglebay's Good Children's Zoo		Oklahoma City Zoological Park		Omaha's Henry Doorly Zoological Gardens	
City/State	Eatonville		Wheeling		OK		Omaha	
State	Washington		W. Virginia		Oklahoma		Nebraska	
	Regions		Regions		Regions		Regions	
	N. America	63%	S. America	15%	Africa	32%	Africa	24%
	N. America-Central America	5%	N. America	15%	S. America	9%	S. America	14%
	N. America-S. America	2%	N. America-S. America	9%	SE Asia	6%	N. America	9%
Zoos	Phoenix zoo		Pittsburgh Zoo		Rio Grande Zoological Park		Riverbanks Zoological Park	
City/State	Phoenix		Pittsburgh		Albuquerque		Colombia	
State	Arizona		Pennsylvania		New Mexico		S. Carolina	
	Regions		Regions		Regions		Regions	
	Africa	20%	Africa	23%	N. America	17%	Africa	23%
	S. America	15%	S. America	9%	Africa	17%	S. America	14%
	N. America	15%	SE Asia	7%	S. Asia	10%	SE Asia	5%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	San Antonio Zoological Gardens		San Diego Wild Animal Park		San Diego Zoological Gardens		San Francisco Zoological Gardens	
City/State	San Antonio		San Diego		San Diego		San Francisco	
State	Texas		California		California		California	
	Regions		Regions		Regions		Regions	
	Africa	34%	Africa	41%	Africa	24%	Africa	24%
	S. America	12%	E. Asia	9%	SE Asia	9%	S. America	9%
	Africa and other	4%	S. Asia	7%	S. America	6%	N. America	8%
Zoos	Sedgewick County Zoo		St. Catherine's Wildlife Survival Center		St. Louis Zoological Park		Sunset Zoological Park	
City/State	Wichita		Midway		St. Louis		Manhattan	
State	Kansas		Georgia		Missouri		Kansas	
	Regions		Regions		Regions		Regions	
	Africa	19%	Africa	72%	Africa	25%	Africa	15%
	S. America	18%	S. Asia	6%	S. America	10%	S. Asia	13%
	N. America	10%	MiddleEast/ S.W.Asia	6%	SE Asia	6%	S. America	9%

Sources: International Zoo Yearbook, Vol. 36 and The International Species Information System.

Zoos Ranked by Percent and Region of Species and Sub-species

Table 5.3 continued.

Zoos	The Living Desert		Tulsa Zoological Park		Utah's Hogle Zoological Gardens		Virginia Zoological Park	
City/State	Palm Desert		Tulsa		Salt Lake		Norfolk	
State	California		Oklahoma		Utah		Virginia	
	Regions		Regions		Regions		Regions	
	Africa	26%	N. America	18%	Africa	23%	Africa	21%
	N. America	20%	Africa	16%	N. America	16%	S. America	17%
	Africa and other	9%	S. America	10%	S. America	11%	Worldwide	7%

Zoos	Wildlife Safari		Wildlife World Zoo		Woodland Park Zoological Gardens	
City/State	Winston		Litchfield Park		Seattle	
State	Oregon		Arizona		Washington	
	Regions		Regions		Regions	
	Africa	28%	Africa	32%	Africa	29%
	N. America	13%	S. America	13%	S. America	10%
	S. Asia	6%	Australia	6%	N. America	10%

Sources: International Zoo Yearbook, Vol. 35 and The International Species Information System.

VITA

Cecile Marie Valastro

Candidate for the Degree of

Master of Science

Thesis: A COMPARISON OF ZOOS AND SELECTED ENDANGERED SPECIES POPULATIONS FROM A GEOGRAPHICAL PERSPECTIVE

Major Field: Geography

Biographical:

Personal Data: Born in Houston, Texas, on November 2, 1964, the daughter of Salvatore Valastro Jr., and Dolores Nabors.

Education: Graduated from A.N. McCallum High School, Austin, Texas in May 1983; Received a Bachelor of Arts degree in Anthropology from Texas A&M University, College Station, Texas in May 1994. Completed requirements for the Master of Science degree with a major in Geography at Oklahoma State University in July, 2000.

Experience: Laboratory Assistant, Department of Anthropology Pollen lab; Research Assistant, U.S. Department of Agriculture, ARS, AWPMRU; Teaching Assistant, Department of Geography, Oklahoma State University.

Professional Membership: Golden Key National Honor Society, Gamma Theta Upsilon.