The Effects of Land and Water Use on Threatened Migratory Species
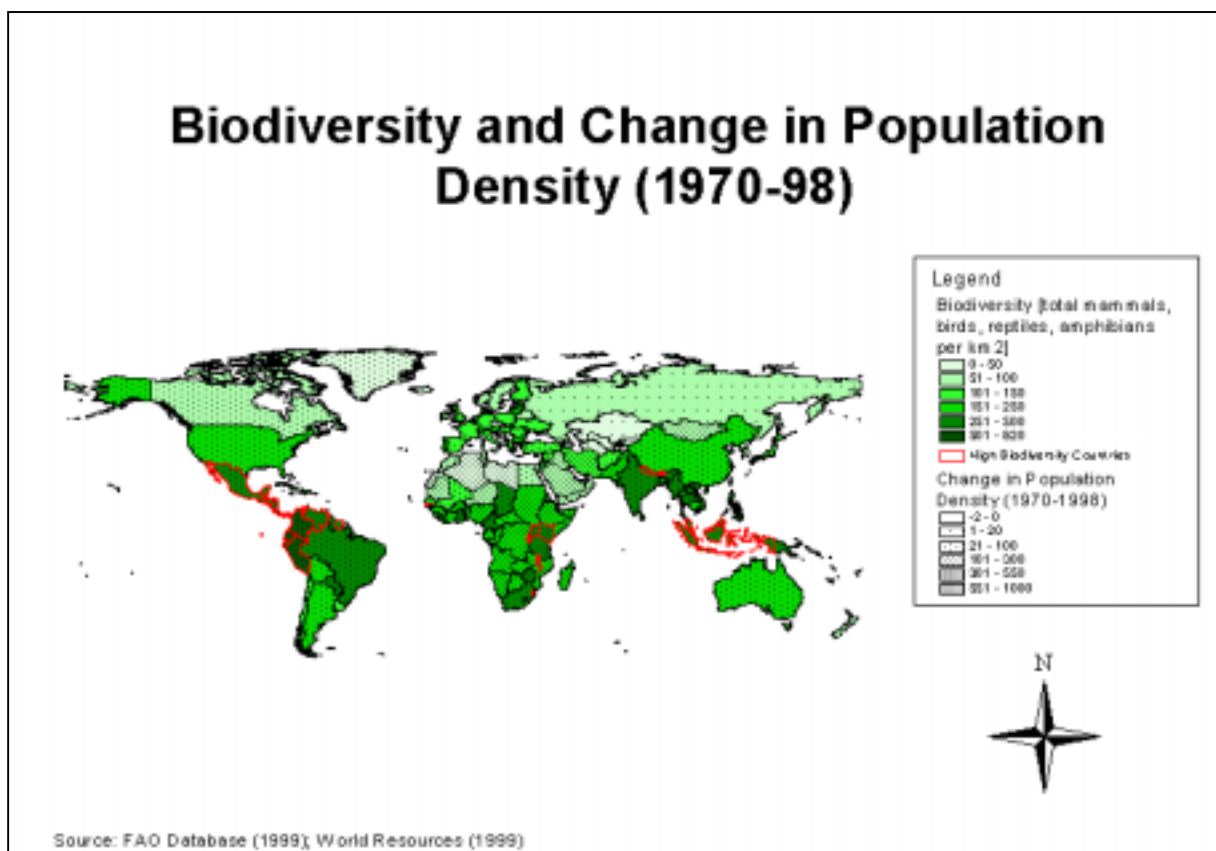
Internship Report

Julia Kaps

Bonn, December 13, 1999

Center for Development Research
Walter-Flex-Str. 3
53113 Bonn

1 Introduction: Biodiversity Loss

Species extinction and temporary loss of biodiversity are elemental parts of the world's history. The past two centuries, however, have seen an increasing rate of extinction due to the global population explosion and the resulting ever growing need for land and resources. Human expansion and its consequences have resulted in an extinction rate 1000 to 10000 times higher than the historical rate (Wilson, 1988). For the next century, this would mean a projected loss of 20 to 50 percent of the world's species.

Unfortunately, many countries with a large biodiversity also have extremely high population growth rates. Map 1 shows global biodiversity expressed in the total of mammals, birds, reptiles, and amphibians found per 10000km^2, as well as the change in population density from 1970 to 1998.

Biodiversity and Change in Population Density (1970-98)

Legend

Biodiversity (total mammals, birds, reptiles, amphibians per km 2)

- 0 - 50
- 51 - 100
- 101 - 150
- 151 - 250
- 251 - 500
- 501 - 820

High Biodiversity Countries

Change in Population Density (1970-1998)

- -2 - 0
- 1 - 20
- 21 - 100
- 101 - 300
- 301 - 550
- 551 - 1000

Source: FAO Database (1999); World Resources (1999)

The 25 highest biodiversity countries, outlined in red in Map 1, are grouped in Table 1. Their biodiversity, percentage of threatened species, and the change in population density from 1970-98 are listed.

	Country	Biodiversity [species/ 10000km^2]	threatened species [%]	change in population density [%] (1970-98)
1	Bhutan	353	10	89
2	Honduras	361	5	137
3	Gambia	373	2	165
4	Nepal	373	16	102
5	El Salvador	377	2	68
6	Malaysia	383	23	97
7	Mexico	384	32	89
8	Kenya	387	19	152
9	Nicaragua	387	4	126
10	Burundi	398	3	84
11	Malawi	402	4	129
12	Singapore	408	4	68
13	Suriname	410	4	11
14	Venezuela	438	14	117
15	Swaziland	460	2	127
16	Belize	471	2	87
17	Guatemala	472	4	106
18	Uganda	477	6	110
19	Indonesia	484	52	72
20	Rwanda	484	3	77
21	Peru	502	24	88
22	Colombia	675	15	81
23	Panama	688	5	84
24	Costa Rica	690	5	122
25	Ecuador	817	11	104

Table 1: Biodiversity, threatened species, and change in population density
Source: FAO Database (1999); World Resources (1999)

Over the past 28 years, the mean increase of population density for these countries was 100 percent while the mean of threatened species is 11 percent. Since high population density is naturally associated with intensive land and water usage, the population increase has and will put great pressure on valuable ecosystems, such as tropical forests or wetlands, and their resident species.
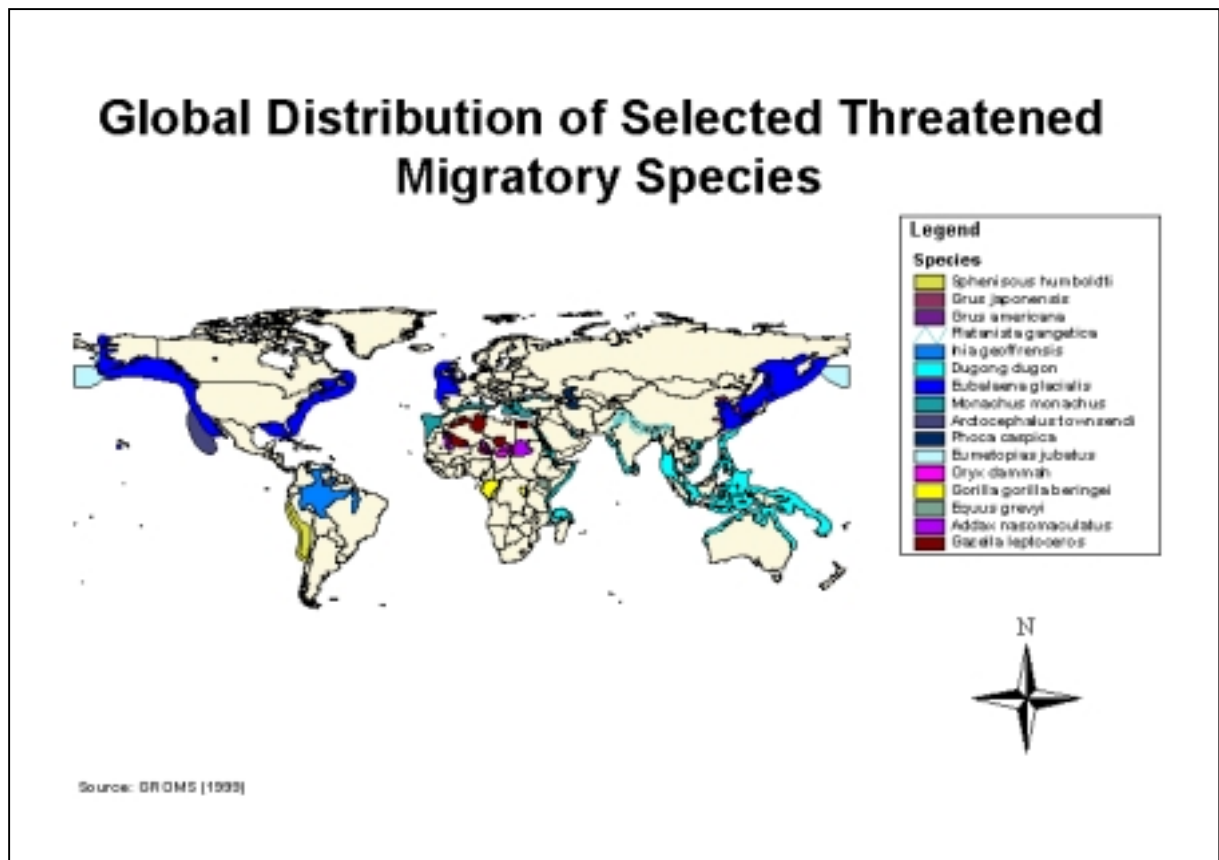

2 Migratory Species

All species are affected by mankind in one way or another. However, migratory species are especially vulnerable to threat by humans and their various forms of land and water use. By nature, migratory species inhabit not one but several habitats at different times. They are, therefore, at risk in their breeding and wintering grounds, as well as on their migration routes and in their resting places. This makes them more vulnerable to endangerment than many non migratory species which remain in a single habitat. Furthermore, migratory species are more difficult to protect. Their crossing of international borders during migration calls for international protection as well as protection on a national level. Unfortunately, on an international level difficulties often arise when it comes to reaching agreements on the necessity or the form of protection for endangered species.

To investigate the effects of land and water use on migratory species, several species were selected from the GROMS (Global Register of Migratory Species) database. They are representatives from land, air, and sea from all continents and are listed in Table 2.

Latin name	English name
Spheniscus humboldti	Humboldt penguin
Grus americana	Whooping crane
Grus japonensis	Red-crowned crane
Eubalena glacialis	Northern right whale
Platanista gangetica	Ganges river dolphin
Inia geoffrensis	South American river dolphin
Phoca caspica	Caspian seal
Monachus monachus	Mediterranean monk seal
Arctocephalus townsendi	Guadalupe fur seal
Dugong dugon	Sea cow
Addax nasomaculatus	Addax
Oryx dammah	Scimitar-horned oryx
Equus grevyi	Grevy's zebra
Gorilla gorilla beringei	Mountain gorilla

Table 2: Select migratory species
Source: GROMS (1999)

Map 2 shows the global distribution of these GROMS species.

In order to examine the causes of endangerment for the selected migratory species, an assessment of human land and water use and their consequences must be made.

3 Land and Water Use

There are different forms of land and water use, all of which can affect and even threaten species. One can differentiate between types of usage that directly affect a species, such as hunting or fishing, and other types which affect a species more indirectly by altering its environment. The latter comprises agriculture, forestry, fishery, industry, urban development, and tourism. Habitats are altered or destroyed, thereby making them less or no longer suitable for the affected species.

The obvious consequences of land and water use, such as the conversion of a natural habitat for human purposes, are usually accompanied by secondary forms of threat. In most cases, a conversion equals habitat loss. Sometimes, if the habitat is still inhabitable, it simply amounts to degradation.

A side effect of any form of land or water use is disturbance. This can lead to less successful breeding or hindrance in the hunt for prey. Another large problem is pollution. It can render habitats uninhabitable or cause disease in affected populations. Livestock farming not only claims land for grazing, thereby shrinking the size of a species' habitat. It can also induce competition for grazing land and watering places, thereby creating stress and forcing the species to move to less ideal areas. Fishery has very unique side effects. Not only has overfishing of the world's seas decreased the amounts of available prey for many marine animals, but entanglement in fishing nets and long lines and consequent drowning has become a leading cause of death amongst marine mammals.

Individually, these numerous forms of land and water use are threats for endangered species. However, generally they do not appear isolatedly so that most species are affected by multiple factors, making their protection more and more difficult. In the case of migratory species, this problem is even more dramatic since the alleviation of threat in one habitat does not guarantee survival. To protect a migratory species there must be threat reduction in all of its quarters: breeding and wintering grounds, as well as on the migration routes and in resting areas.

4 Causes of Endangerment

There seem to be two main causes of endangerment to the selected species from the GROMS database: hunting and habitat degradation or loss. The former is more easily noticeable, directly decimating species numbers. The second is a more indirect threat which can stem from numerous sources. Hunting can be divided into commercial hunting and hunting on a smaller scale, whereas this latter form can have several objectives: subsistence hunting for meat and leather or sport and trophy hunting.

Commercial hunting was, until recently, the main threat to most endangered marine mammals. Until the 1860s, whaling fleets in the northern Atlantic greatly decimated Northern right whale (*Eubalena glacialis*) populations. After that time, hunting this particular whale ceased to be profitable since the population had become so small. The current population is about 2000 individuals compared to over 80000 once found in the Atlantic. In spite of protection through IWC (International Whaling Commission), recovery has been slow due to the long gestation period of over one year as well as long intervals between calves which can be as long as six years (http://www.whales.magna.com.au/DISCOVER/RIGHT/rightg.htm). Today, the main threat to the Northern right whale is collision with vessels which accounts for approximately one third of all deaths (http://www.vineyard.er.usgs.gov/rwdoc/index.htmg).

The Guadalupe fur seal (*Arctocephalus townsendi*) is also a victim of commercial hunting. Thought to be extinct in 1928, it was rediscovered in 1954. Perhaps 6000 individuals remain

on the rocky beaches of the Isla Guadalupe off the coast of Baja California. Today, this fur seal is protected but the small population and resulting slim genetic variety have caused a genetic bottleneck. Inbreeding may result in lower birth rates or in weaker pups (http://www. wcmc.org.uk/ species/ data/species_sheets/guadalup.htm).

Another motive for hunting arises when species are seen as competitors. This is the case for the Mediterranean monk seal (*Monachus monachus*) and the Steller's sea lion (*Eumetobias jubatus*). The latter is found on exposed rocky beaches in the Pacific ocean and the Sea of Japan. Afraid of less fish catch, fishermen deliberately kill the sea lions. Many individuals drown entangled in fishing nets. Those that escape this fate are faced with a reduced food supply due to overfishing. Stress due to less food and disturbance from humans has lead to outbreak of disease in several populations thereby increasing concern for this species (http://www.wcmc.org.uk/species/data/species_ sheets/stellers.htm).

As in the case of many marine animals, the main cause of decline in the populations of the Humboldt penguin (*Spheniscus humboldti*) was hunting. In the 19th century, sailors hunted this bird for sport. Egg collection also reduced population size and the harvesting of valuable guano caused disturbance to many breeding populations. Today, the Humboldt penguin is threatened by food reduction, entanglement in fishing gear, and pollution through oil spills. The El Niño of 1982-83 caused an additional reduction of 65 percent in the Peruvian population when the warm currents caused fish schools to move to colder waters (http://www.bagheera.com/inthewild/van_anim_penguin.htm). Hundreds of penguins died of starvation.

The Caspian seal (*Phoca caspica*) is not only affected by hunting but by habitat degradation as well. These are the two leading causes of endangerment for migratory species. Approximately half a million seals inhabit sandbanks and exposed ice surfaces in the Caspian Sea. Up to 65000 seals are harvested annually (http://www.wcmc.org.uk/species/data/species_ sheets/caspian.htm). Like the Steller's sea lion, this seal is faced with the reduction of prey due to overfishing and entanglement in fishing nets. However, the degradation of the Caspian Sea ecosystem may pose the greatest risk in the future. The Sea is bordered by Iran and by former states of the Soviet Union, some of which are in political turmoil and all of which are not fully developed. Necessary legislation and funds for the protection of valuable ecosystems are often lacking. In addition, the area is rich in oil and projects are already in action or planned for the construction of pipelines which may put even more pressure on the Caspian seal and its environment.

The sea cow (*Dugong dugon*) which ranges from Eastern Africa to Vanuatu is another sea mammal threatened by habitat destruction and a reduced food supply. It feeds on sea grass meadows which are found in shallow tropical and sub-tropical waters. These under water meadows have been disappearing due to pollution from coastal run-off, eutrophication, and mechanical damage from motorized vessels (http://www.gbrmpa.gov.au/corp_site/info_ services/publications/what_is_a_dugong.html). Lastly, sea cows are especially vulnerable to collision with vessels which can result in lethal injuries because they like to float in shallow waters.

Most land species are affected less by hunting and more so by habitat degradation. An exception to this rule are several North African artiodactyls which have experienced sharp declines in numbers due to hunting in the past three decades. The addax (*Addax nasomaculatus*) is hunted for meat and leather, whereas the slender-horned gazelle (*Gazella leptoceros*) is shot mostly for its horns (http://www.animalinfo.org/species.htm). The pressure on these gazelles has come up quite recently, coinciding with the use of motorized vehicles and modern firearms for hunting. The scimitar-horned oryx (*Oryx dammah*) is also affected by this relatively new form of hunting. However, in its case the reduction of its habitat seems to be the more pressing cause for concern. Overgrazing by livestock and destruction of tree

cover have altered the oryx's natural habitat. It is listed as critically endangered with less than 200 individuals left roaming the region between Sahara and Sahel (http://www.animal info.org/species/artiperi/oryxdamm.htm).

Grevy's zebra (*Equus grevyi*) has also become recently affected by habitat destruction (http://www.wcmc.org.uk/species/data/species_sheets/grevy's.htm). It can be found in Ethiopia and in some protected areas in northern Kenya. Unlike in the case of the oryx's habitat, the zebra's has not solely been altered through livestock. Intensive and unregulated tourism has lead to habitat degradation in several Kenyan parks. In addition, the tourists can cause disturbance in breeding areas sometimes restricting access to watering sites. However, the initial cause for decline in the zebra's numbers was the great demand for its hides in the 1970s making it a veritable "fashion victim" (http://www.animalinfo.org/species/artiperi/ equugrev.htm).

The Ganges river dolphin (*Platanista gangetica*) and the South American river dolphin (*Inia geoffrensis*) are both examples of water mammals threatened by the alteration of their habitat rather than by hunting. Dams in the Ganges River system prevent migration and communication between populations (http://www.animaldiversity.ummz.umich.edu/accounts/ platanista/p._gangetica.html). In the future, this may lead to genetic bottlenecks when populations becomes too small. In the Southern American river systems, construction of hydroelectric power plants have also separated populations, thereby creating the same genetic risk. In addition, these plants have influenced the distribution of fish, diminishing the dolphin's prey (http://www. animaldiversity.ummz.umich.edu/accounts/i._geoffrensis.html).

The whooping crane (*Grus americana*) is another species severely threatened by the loss of habitat (http://www.npwrc.usgs.gov/resource/distr/BIRDS/Cranes/grusamer.htm). Today, there are an estimated 200 cranes left. This species is an ideal example of the vulnerability of migrating species. It faces habitat loss in both its wintering and in its nesting grounds. In the United States and Canada the conversion of wetlands, which are important nesting grounds for the whooping crane, into agricultural land have caused a sharp decline in the crane population. Wintering areas along the Atlantic and Gulf coasts have also been converted to make room either for agriculture or human settlements. Increased human presence in these areas have caused additional threats such as pollution and disturbance. The whooping crane is extremely vulnerable to disturbance which seems to directly affect their breeding success. On top of this, collision with power and utility lines during migration are quite common (http://wcmc.org.uk/species/data/species_sheets/whoopcra.htm).

The whooping crane's Asian cousin, the red-crowned crane (*Grus japonensis*), faces similar problems. It inhabits extensive and deep wetlands of Eastern Asia. These wetlands have been increasingly turned into agriculturally used land leaving the cranes with less habitat and more vulnerable to disturbance. Overfishing has reduced the available amount of prey and pesticides from farming have led to the poisoning (http:///www.npwrc.usgs.gov/resource/ distr/BIRDS/Cranes/grusjapo.htm).
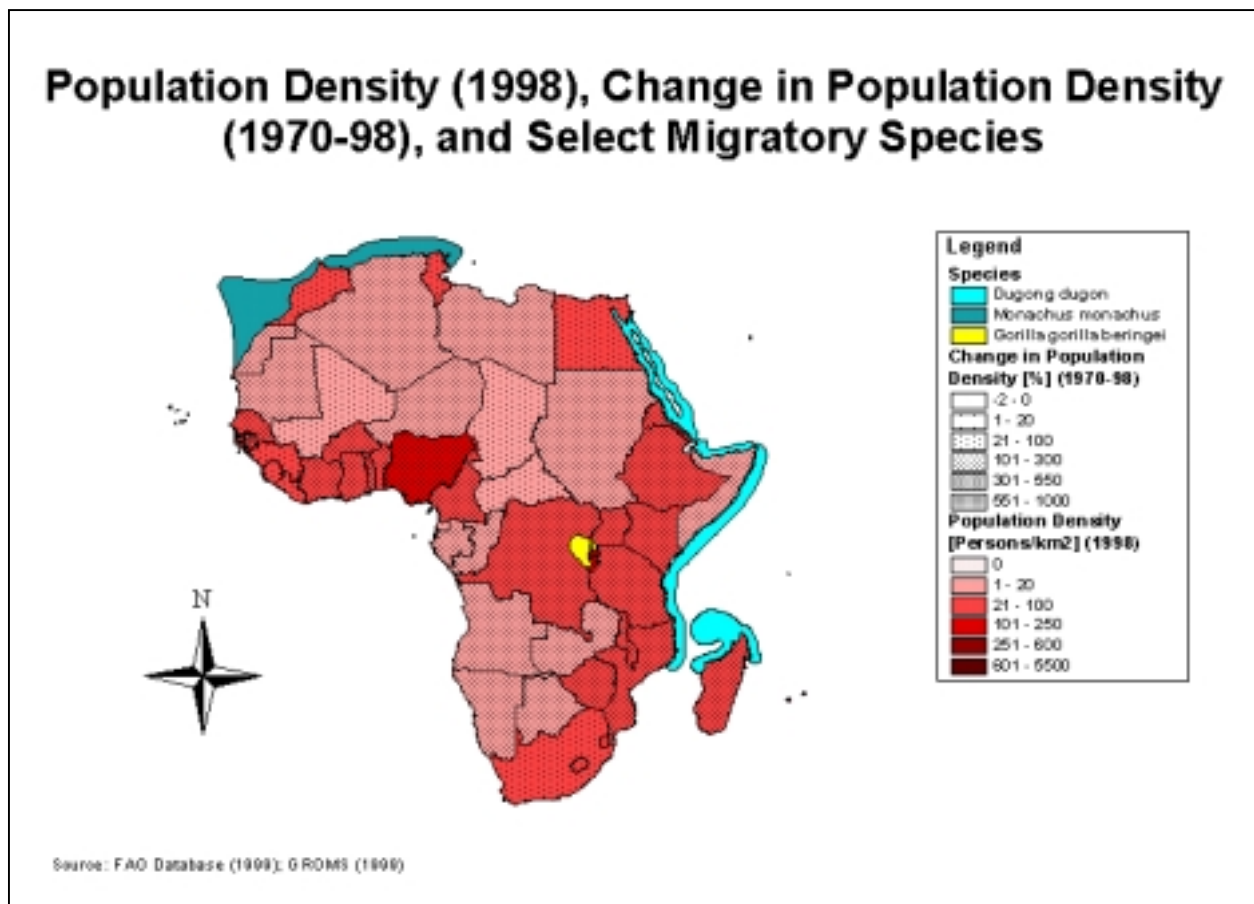
Lastly, this leaves the mountain gorilla (*Gorilla gorilla beringei*). This primate is a resident of the country triangle of Rwanda, Uganda, and the Democratic Republic of Congo. Its mountainous habitat of montane and riverine forest has been partially converted into the Parc National des Volcans creating a sanctuary for the remaining 600 or so individuals. Until the advent of civil war in Rwanda, the gorillas were well protected and tourism brought enough revenue to maintain the park. The war, though it claimed the lives of only two gorillas, has put increasing pressure on this species. Refugees cut firewood for fuel and poaching has become less well monitored. In addition, all three countries have enormous population growth rates creating the need for more space for agricultural use and settlements (http://www.wcmc.org.uk/species/data/ species_sheets/gorilla.htm).

5 Africa: Dynamic Changes in Land and Water Use

In order to better understand the causes of threat to migratory species, the dynamic changes of several forms of land and water use were investigated for the period between 1970 and today. The change in population density (1970-98), agriculturally used land (1970-97), livestock density (1970-99), and fish catch (1970-96) indicate where actual and potential threats for migratory species may lie. The dynamic comparison was restricted to Africa due to the numerous species from the GROMS database native to this continent.

5.1 Population Density

Over the past 28 years, the mean population density increase for the African continent was 113 percent, 21 percent higher than the mean global increase. Even so, population density varies greatly from country to country. The Saharan and Sahelian countries average less than 15 persons per km^2, whereas in Rwanda or Burundi, for example, more than 230 persons crowd one square kilometer. Nonetheless, for migratory species, this enormous population increase must translate into less available habitat due to new and expanding human settlements and activities. In Map 3, population density (1998), population density change (1970-98), and affected species are portrayed.

Source: FAO Database (1998); GROMS (1998)

The mountain gorilla (habitat: yellow) is native to countries with very high population density increases. The Democratic Republic of Congo has the highest increase of 142 percent, followed by Uganda (110%) and Rwanda (77%). However, Congo has the lowest density of only 21 persons per km^2, followed by Uganda with 87 persons per km^2, and Rwanda with 251
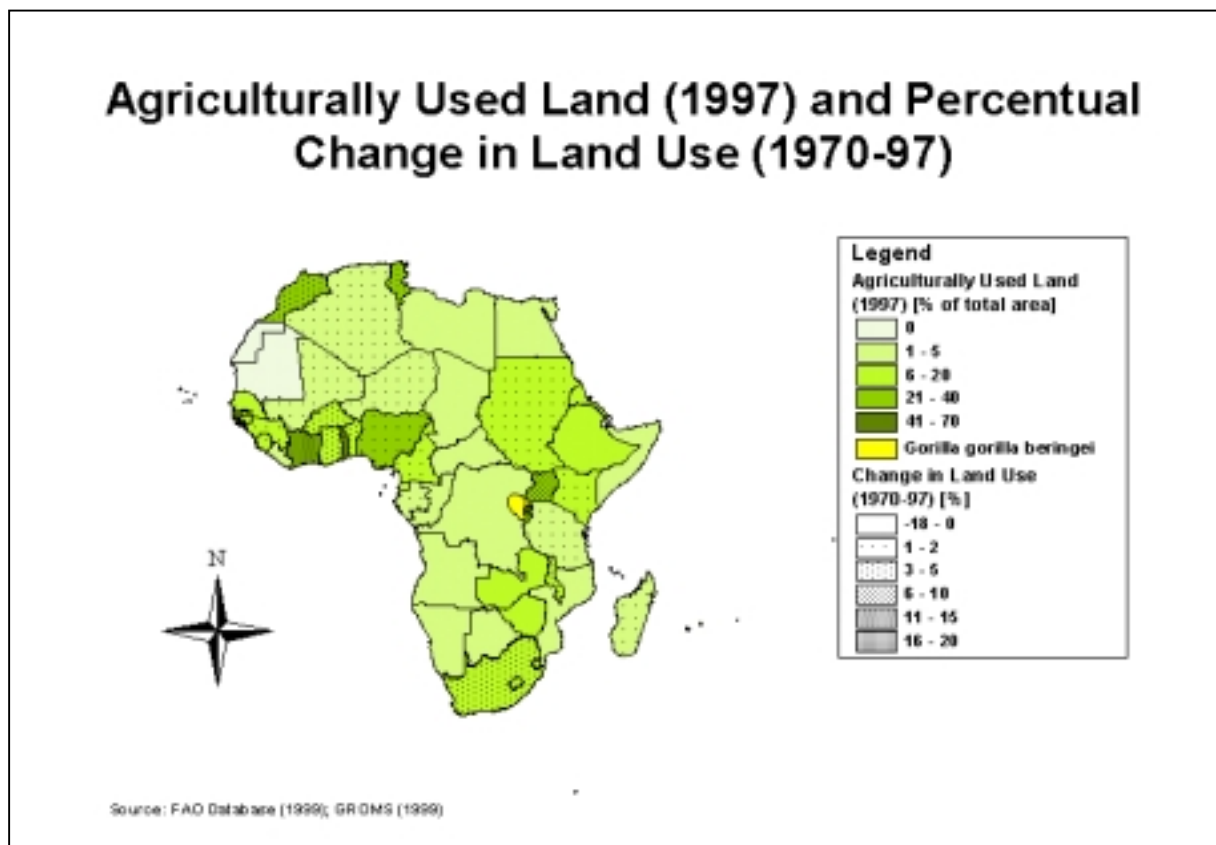
persons per km^2. This means that more and more land must be converted to accommodate the ever growing population which has and will result in the loss of gorilla habitat.

The sea cow, although not a land habitant, also faces growing pressures from population increase. Native to the East African coast it ranges (habitat: turquoise) from Egypt to Mozambique and Madagascar. The sea cow must cope with population increases which are usually especially pronounced along coastlines. This, in turn, is accompanied by more pollution, boat traffic, and disturbance all of which are potentially threatening factors to the sea cow. An influx of tourists along the East African coast may also play a harmful role. Unfortunately, there is not sufficient data for tourism intensity and growth available at this time.

Another sea mammal, the Mediterranean monk seal, has suffered greatly under the pressures of population increase. North African countries with remaining monk seal populations (habitat: gray-green) all have population density increases of over 80 percent. Like in Eastern Africa, this causes more pollution and disturbance. These seals are extremely sensitive to disturbance and have been affected by the growing tourism industry along the Mediterranean coast. They are not only subjected to a larger human presence, but to more noise from motorized vessels as well. This has left them with very little undisturbed and isolated habitat where they can effectively breed and nurse.
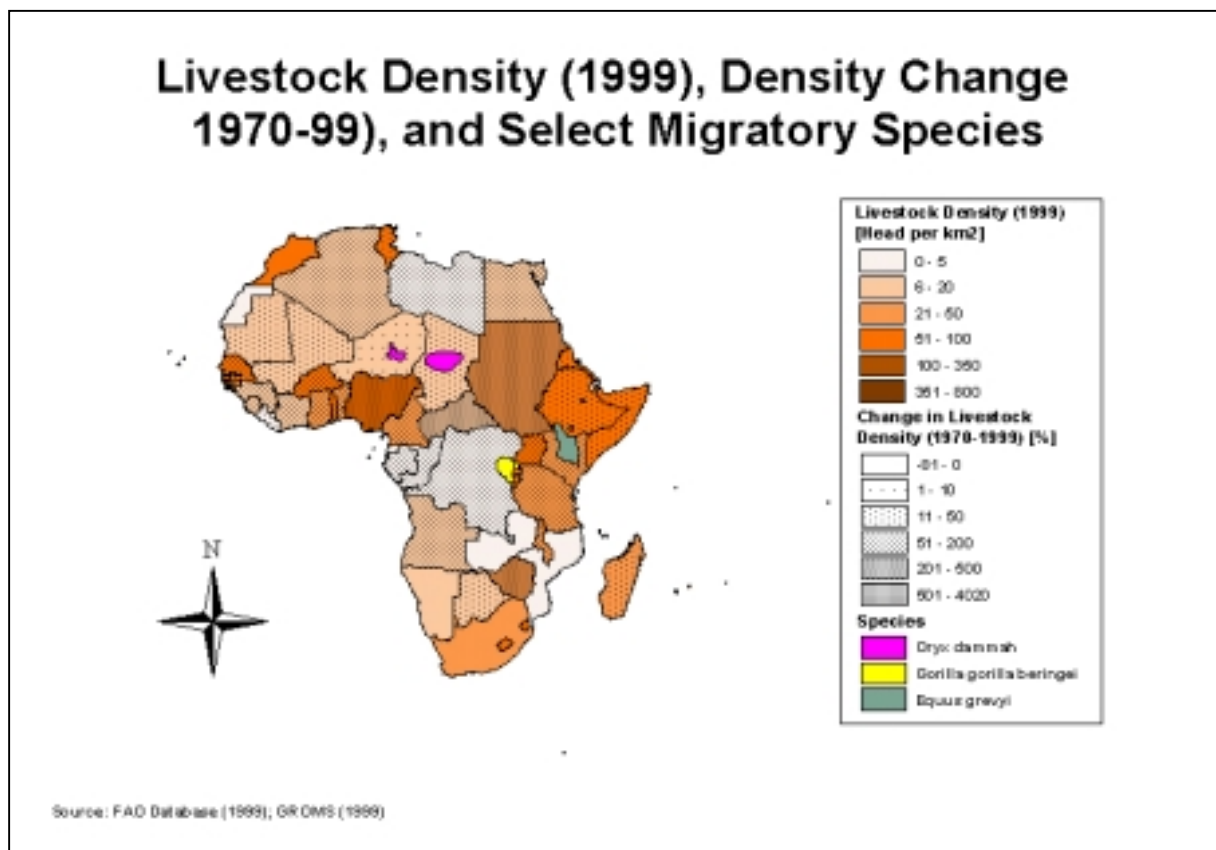
5.2 Agriculture

In 1997, the average of agriculturally used land worldwide was 16 percent. For Africa, this figure lies at 12 percent, a number quite high considering the vast desert expanses covering this continent. On a global level, the increase in agriculturally used land over the past 27 years (1970-97) was one percent, while the increase for Africa was two percent. Most African countries did not show any increase; however, this was compensated by several countries with increases of over five percent. Map 4 shows agriculturally used land (1997), change in agriculturally used land (1970-97), and select migratory species.

The country triangle home to the mountain gorilla (habitat: yellow) showed significant increases in land use for agricultural purposes. Forty-four percent of Rwanda's area are used agriculturally with an increase of 17 percent. Uganda also showed a substantial increase of 8 percent with 28 percent of its area used for agricultural purposes. Solely Congo did not increase the percentage of agriculturally used land over the past years while just three percent of its area are used for this purpose. This puts an enormous pressure on the gorilla's habitat in the two former countries. Forests must be cleared in order to gain agriculturally suitable land. Additionally, the scores of refugees in camps in Congo have intensified this pressure. Firewood is cut for fuel, thereby accelerating the rate of habitat loss, and encroaching human settlements cause disturbance to the primates.

5.3 Livestock

The past 29 years have seen a large growth in livestock density (total of camels, cattle, goats, horses, pigs, and sheep per km^2). On a global level, the average increase amounted to 119 percent, while in Africa it was 87 percent. Map 5 shows livestock density (1999), change in livestock density (1970-1999), and select migratory species.

Approximately 34 heads of livestock are held per km^2 in Africa. This number seems small in comparison with 71 head per km^2 worldwide. However, an increase of 87 percent must have necessitated the conversion of land into grazing area. Wild animals would need to compete with livestock for grassland and water accessibility.

This is the case for Grevy's zebra. Although both Ethiopia and Kenya do not have very high livestock density increases, 20 and 60 percent respectively, there have been growing difficulties for zebras to access watering places. The scimitar-horned oryx has also felt pressure from higher livestock density. Now only found in Niger and Chad, countries with low livestock density of 11 percent and increase of 2 and 45 percent respectively, this

artiodactyl is threatened by habitat degradation through overgrazing. In addition, tree cover which the oryx uses for resting has been largely destroyed. The mountain gorilla's habitat has had to withstand growing livestock density. With increases of three (Congo), 52 (Uganda), and 69 (Rwanda) percent, land must have been made available for grazing.

5.4 Fishery

While the world's marine fishing nations have produced a fish catch 222 percent larger in 1996 than in 1970, African fishing nations increased their total catch by 322 percent. Such an increase involves more vessels as well as more fishing nets and lines. Heavier shipping traffic causes more disturbance and increases the likelihood of collision with marine animals. More fishing gear raises the risk of entanglement and a larger fish catch leaves less prey for marine animals.

The sea cow is threatened by heavier boat traffic. Not only is there a higher risk of collision, disturbance is increased, more pollution is caused, and mechanical damage to sea grass meadows may be more pronounced. East African countries have increased their fish catch by 170 percent (Table 3). This heightens the possibility of entanglement in fishing gear.

Country	Total marine catch [Mt] 1970	Total marine catch [Mt] 1996	% change in marine fish catch from 1970 to 1996	Species
Morocco	244637	744374	204	M. monachus
Algeria	24600	102963	319	M. monachus
Tunisia	21634	72600	236	M. monachus
Libya	5500	34400	525	M. monachus
Egypt	25400	104517	311	D. dugon
Sudan	800	4000	400	D. dugon
Ethiopia	14900	1642	-89	D. dugon
Somalia	5000	14250	185	D. dugon
Kenya	7600	3990	-48	D. dugon
Tanzania	19500	38561	98	D. dugon
Madagascar	11000	70531	541	D. dugon
Mozambique	16100	10033	-38	D. dugon

Table 3: Total marine fish catch 1970 and 1996 [Mt] and change in catch [%]
Source: FAO database (1999)

The Mediterranean monk seal is similarly affected by boat traffic, disturbance, and fishing gear. However, in its home countries the fish catch has increased by 321 percent (Table 3). This greatly affects the amount of available prey. In the past, this seal has become the victim of deliberate killings by fishermen.

5.5 Hunting

Unfortunately, there is not sufficient data or statistics on hunting. Therefore, it is impossible to detect an increase in hunting activity or more prey. Nonetheless, it is certain that several migrating species have become endangered due to hunting. Grevy's zebra, for instance, only became endangered because it was hunted for its hides which were very fashionable in the 1970s. The addax and the slender-horned gazelle are both endangered due to hunting. This threat has only surfaced recently with the advent of modern firearms and the use of motorized vehicles. Nomads, military personnel, and oil surveyors hunt these species for meat, leather, horns, or just for sport. The slender-horned gazelle, once one of the most common Saharan

gazelles, now numbers only about 5000. The addax numbers even less at around 250 to 500. Lastly, the critically endangered scimitar-horned oryx is also threatened by hunting under modern conditions. It is estimated that less than 200 individuals remain. The war in Rwanda has left mountain gorillas less protected and, therefore, made them easier prey for poachers and pet traders who try to sell gorilla infants. Often, entire gorilla families are slaughtered to catch a single infant.

6 Summary

This overview has attempted to clarify the causes of endangerment of migratory species. It seems that the leading threats are hunting and population dependent activities. Hunting does not seem to be population dependent since no significant increase due to population growth can be detected. Several species, like most whales and several pinnipeds, are endangered because they were once hunted commercially and have since not been able to recover. Other species are killed deliberately for fear of competition. Finally, as in the case of several North African artiodactyls, endangerment arrived with the advent of modern firearms and motorized vehicles.

All in all, the real culprit seems to be population growth. Not only does higher population density call for more land for human settlements. It also increases all activities associated with daily life as well as recreation. In order to satisfy growing demand for food and other resources, agricultural production, livestock production, and fishery must increase their yield. Consequently, land must be converted for crops or grazing, shipping traffic is increased, more fishing nets are used, and pollution and disturbance become more and more noticeable. One or all of these factors affect any given migratory species at any time in any of their habitats. The influences wrought on by these factors can range from minor habitat changes, like the construction of a power pole, to complete habitat destruction.

7 Future Threats

In the future, there will be continuing demand for more land and resources, thereby intensifying threats to migratory species. In all likelihood, more species will gain endangered status while others become extinct. The projected average annual population growth rate for Africa is 2.6 percent. This is well above the projected global growth rate of 1.6 percent. Table 4 shows the projected annual growth rates for those African countries that are home to the selected migratory species.

Country	average annual rate of change of population in % (1995-2000)	Species
Algeria	2.3	M. monachus, A. nasomaculatus, G. leptocerus
Chad	2.63	O. dammah, A. nasomaculatus, G. leptoceros
Dem. Rep. Congo	2.57	G. g. beringei
Egypt	1.89	G. leptoceros, D. dugon
Eritrea	3.78	D. dugon
Ethiopia	2.45	E. grevyi, D. dugon
Kenya	2	E. grevyi, D. dugon
Libya	2.42	G. leptoceros, M. monachus
Madagascar	2.97	D. dugon
Mali	2.44	A. nasomaculatus, G. leptoceros
Mauritania	2.73	A. nasomaculatus, G. leptoceros
Morocco	1.76	M. monachus
Mozambique	2.48	D. dugon
Niger	3.19	O. dammah, A. nasomaculatus, G. leptoceros
Rwanda	7.71	G. g. beringei
Somalia	4.16	D. dugon
Sudan	2.05	A. nasomaculatus, G. leptoceros, D. dugon
Tanzania	2.27	D. dugon
Tunisia	1.39	G. leptoceros, M. monachus
Uganda	2.8	G. g. beringei
Western Sahara	3.38	M.monachus

Table 4: Projected annual population growth rates (1995-2000) [%]
Source: World Population Prospects: The 1998 Revision,
Vol. I: *Comprehensive Tables (UN Publications)*

Once again, Rwanda stands out amongst all other countries. The unusually high population growth rate of 7.71 percent foretells growing pressure on the mountain gorilla's habitat and on the species itself. The same can be said of all other selected species, considering that the lowest growth rate is 1,39 percent in Tunisia. Unless population growth rates are curbed, pressure from increased land, water, and resource use will prove too great for some species and many others will become endangered.

8 Measures for Future Protection

The key to the protection of the migratory species examined, as well as other species, is the reduction of population growth. This would hopefully reduce future conversion of land, the use of resources, and all of their side-effects, thereby leaving endangered species with more habitat. Another important step would be the creation of more protected areas, in which all human activities are either banned or strictly regulated. Better enforced or new legislation for the protection of migratory species may also be an important step for conservation.
In order to protect the scimitar-horned oryx or the addax, for instance, stricter protection must be enforced since existing laws are extremely lax. Unfortunately, this would prove to be extremely difficult, considering the vast expanses these species cover. In the case of the Northern right whale or other marine mammals, regulation of shipping traffic would be the best measure to prevent deadly collisions. However, this can only be attempted once

researchers can determine the location of critical nursing and breeding habitats. Better regulation of tourism in Kenyan parks may help ensure the survival of Grevy's zebra. Similar measures could help create sanctuaries for the shy Mediterranean monk seal. This could help this species recover from its critically endangered status. Unfortunately, the mountain gorilla does not face bright prospects: a rapidly growing population, increased agriculture and livestock density, and no visible change regarding these factors in the near future. Hopefully, better understanding of the causes of endangerment will help save some of these species from extinction.

9 Outlook

In the future, a more detailed study of the causes of endangerment will be possible. GROMS will continue adding new species to its register. This will broaden the field of study and will most likely present new forms of threat to migratory species. However, much more detailed assessment of the threats to these species could be made if there would be more information available. For instance, critical areas could be described more accurately if population or agricultural statistics would be available on a regional level, rather than on a country level. Additional data, such as world tourism intensity or hunting statistics, will also enable a more accurate portrayal of threatening factors.

10 Literature

Anonym (1997). Biodiversität und Tourismus - Konflikte und Lösungsansätze an den Küsten der Weltmeere. Bundesamt für Naturschutz. Springer Verlag, Heidelberg.

Bailey, R. G. (1996). Ecosystem Geography. Springer, New York.

Barbier, E. B., Acreman, M., Knowler, D. (1997). Economic Valuation of Wetlands - A Guide for Policy Makers and Planners. Ramsar Convention Bureau.

FAO (Food and Agriculture Organization) Database: http://www.apps.fao.org/cgi-bin/nph-db.pl

Global Registry of Migratory Species (GROMS): http://www.biologie.uni-freiburg.de/data/riede/groms.html

http://animaldiversity.ummz.umich.edu/accounts/inia/i._geoffrensis.html (updated: 8.2.96; viewed 17.11.9)

http://animaldiversity.ummz.umich.edu/accounts/platanista/p._gangetica.html (updated: 8.2.96; viewed: 17.11.9)

http://whales.magna.com.au/DISCOVER/RIGHT/rightg.html (updated: ?; viewed: 16.11.99)

http://www.animalinfo.org/species/artiperi/addanaso.htm (updated: July 99; viewed: 16.11.99)

http://www.animalinfo.org/species/artiperi/equugrev.htm (updated: July 99; viewed: 16.11.99)

http://www.animalinfo.org/species/artiperi/gazelept.htm (updated: Nov 99; viewed: 16.11.99)

http://www.animalinfo.org/species/artiperi/oryxdamm.htm (updated: May 99; viewed: 16.11.99)

http://www.bagheera.com/inthewild/van_anim_gorilla.htm (updated: 7.2.96; viewed: 16.11.99)

http://www.bagheera.com/inthewild/van_anim_monkseal.htm (updated: 07.02.1996; viewed: 16.11.1999)

http://www.bagheera.com/inthewild/van_anim_penguin.htm (updated: 07.02.96; viewed: 16.11.99)

http://www.gbrmpa.gov.au/corp_site/info_services/publications/What_is_a_dugong.html (updated: 16.11.99; viewed: 18.11.99)

http://www.marwell.org.uk/anim-1.htm (updated: January 99; viewed: 16.11.99)

http://www.npwrc.usgs.gov/resource/distr/BIRDS/Cranes/grusamer.htm (updated: ?; viewed: 16.11.99)

http://www.npwrc.usgs.gov/resource/distr/BIRDS/Cranes/grusjapo.htm (updated: ?; viewed: 16.11.99)

http://www.un.org/Depts/unsd/social/poptn.htm (updated: ?; visited: 9.12.99)

http://www.vineyard.er.usgs.gov/rwdoc/index.html (updated: ?; viewed: 6.12.99)

http://www.wcmc.org.uk/species/data/species_sheets/caspian.htm (updated: 13.05.98; viewed: 16.11.99)

http://www.wcmc.org.uk/species/data/species_sheets/gorilla.htm (updated: 13.05.98; viewed: 16.11.99)

http://www.wcmc.org.uk/species/data/species_sheets/grevy's.htm (updated: 13.05.98; viewed: 17.11.1999)

http://www.wcmc.org.uk/species/data/species_sheets/guadalup.htm (updated: 13.05.98; viewed: 16.11.99)

http://www.wcmc.org.uk/species/data/species_sheets/medmonk.htm (updated: 13.05.1998; viewed: 16.11.1999)

http://www.wcmc.org.uk/species/data/species_sheets/stellers.htm (updated: 13.05.98; viewed: 16.11.99)

http://www.wcmc.org.uk/species/data/species_sheets/whoopcra.htm (updated: 13.5.98; viewed: 16.11.99)

International Union for the Conservation of Nature (IUCN): http://www.iucn.org

Pearce, D., Moran, D. (1994). The Economic Value of Biodiversity. Earthscan Publications Ltd., London.

Storch, V., Welsch, U. (1997). Systematische Zoologie. Gustav Fischer Verlag, Stuttgart.

Vorlaufer, K. (1996). Tourismus in Entwicklungsländern - Möglichkeiten und Grenzen einer nachhaltigen Entwicklung durch Fremdenverkehr. Wissenschaftliche Buchgesellschaft, Darmstadt.

Wall, G. (1997). Is Ecotourism Sustainable? Environmental Management 21. 483-491.

Wells, M. P. (1997). Economic Perspectives on Nature Tourism, Conservation and Development. Environment Department Papers No. 55. The World Bank.

Wilson, E. O. (1988). Biodiversity. National Academy Press, Washington.

World Conservation Monitoring Centre (WCMC): http://www.wcmc.org.uk

World Resources Intsitute (WRI): http://www.wri.org