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Patterns of Zootherapy Use in Cross River State, Nigeria and Implications for Human and  
Ecological Health

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## ABSTRACT

**Introduction and Objectives:** Traditional medicine continues to be a critical part of healthcare systems globally, and especially in developing countries that lack access to allopathic medical centers. Zootherapy - the use of wild animals to prevent, treat, and cure physical, psychological, spiritual, and social ailments - is an understudied aspect of traditional medicine but one that has critical human and ecological health consequences as a major pathway for human-environment interaction. In the present study, we analyze data on zootherapies from Cross River, Nigeria to assess (1) what animals are most used and what zootherapeutic animals are at high conservation risk, (2) what illness categories and diseases or symptoms are most treated with zootherapy, and (3) what theories of healing drive the zootherapies of Cross River.

**Results:** We report the use of 41 types of animals in 214 distinct zootherapies to treat 68 diseases or symptoms across 18 categories of illness. The conservation status of 12 of these animal species are threatened, and therefore should be prioritized in conservation interventions to replace their zootherapeutic use with non-threatened wild, or domestic, species. Participants reported the use of zootherapy most often for health promotion, musculoskeletal, unknown, parasites, toxins, and infectious agents, and respiratory or nervous system related ailments, shedding light on the health needs of this community that are not met by allopathic care. Finally, 66 of the zootherapies are founded on a theory of healing in African traditional medicine including “like cures like”, mythological or cultural conceptions, and sympathetic healing.

**Conclusions:** We conclude that while zootherapy, and traditional medicine generally, is a critical force for achieving universal healthcare coverage in Nigeria, certain zootherapies may pose significant human or ecological health risks and should therefore be targeted for replacement

with culturally sensitive, viable options. These replacement options can be better informed by the analysis we provide of the theories behind zotherapies in Cross River, Nigeria to produce successful public health and conservation outcomes.

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## **INTRODUCTION**

### **Role and Importance of Zootherapy in Cross River, Nigeria**

Traditional medicine (TM), which uses nature-derived substances to prevent, treat, and cure physical, mental, social, and spiritual ailments, is a staple of healthcare for people in Africa, and is critical to achieving universal healthcare coverage, especially in rural communities with limited access to allopathic medical centers (Zhang, 2018a; Romero-Daza, 2002; Ataudo, 1985). In Nigeria specifically, TM is an integral aspect of the sociocultural system and is more accessible, affordable, and acceptable to Nigerians than allopathic care (Soewu & Ayodele, 2009; Soewu & Adekanola, 2011; Marshall, 1998; Ataudo, 1985; Izugbara et al., 2005). Nigerian TM is especially well accepted for psychiatric, orthopedic, maternal, and child health problems (Oyeneye, 1985; Izugbara et al., 2005; Kpobi & Swartz, 2018). Additionally, a study from Burkina Faso, also in West Africa, found that TM use is high for illnesses like typhoid fever, sickle cell, meningitis, epilepsy, jaundice, and mental or psychiatric illness, however illnesses like malaria, respiratory illness, and unknown fevers were unlikely to be treated with TM (Pouliot, 2011). Even though 75-80% of Nigerians utilize TM in their healthcare seeking practices, TM has not yet been incorporated into the national official healthcare system (Gamaniel et al., 2005; Alves & Rosa, 2007).

Zootherapy, or the use of animals and animal products to prevent, treat, and cure ailments, is an important part of traditional medical treatments that has not been as thoroughly studied as the use of plants in TM (Lev, 2003; Alves & Rosa, 2005; Alves et al., 2013). For



instance, the WHO's TM program focuses on medicinal plants and acupuncture, but notably ignores the role of zotherapy (Zhang, 1996). Also, in their argument on using TM to achieve universal healthcare coverage, Akerele only identifies medicinal plants – but not zotherapy – to be the most useful and effective contributor for medical systems (Akerele, 1987).

A lack of studies on zotherapy has led to an underestimation of their cultural, ecological, and economic importance. One major reason for the lack of these studies is the clandestine nature of the practice, and so informants may be resistant to provide researchers with information (Alves et al., 2013). However, since zotherapy is a frequent mode of interaction between humans and their environments, it is critical to understand zotherapy in the context of ecological and human health alike, as zotherapies may present risks to, for example, the conservation of endangered species or zoonotic spillover events (Alves & Rosa, 2005; Friant et al., 2022; Thomas-Walters et al., 2020; Alves et al., 2013). In the present study, we explore the various zotherapies of Cross River, Nigeria – including the conservation status of animals used, the illness categories and specific diseases or symptoms most treated with zotherapy, and theories of healing behind these zotherapies – to inform our understanding of the complex and varied interactions between people and their environment, and the effects these interactions can have on the ecological health and human health of an area.

### **Theories of Healing**

Traditional medicine and zotherapy in Africa is highly variable across different ecological zones and cultural groups, and so it is important not to over-generalize these practices; however there are common, general theories that inform treatments within African

TM that we use in the present study to understand the motivations for and beliefs behind zootherapies used in Cross River. One of these theories is that of “like cures like” (LCL), which is simply that whatever caused the ailment is used to cure the ailment (Izugbara et al., 2005). For example, in the TM system of the Ibibio ethnic group in Nigeria, dog blood and saliva is used to treat a dog bite, snake venom is used to treat a snake bite, and the urine of a “mad” person is used to treat “madness” (Izugbara et al., 2005).

Another theory is based on mythological or cultural conceptions (MCC), and understandably, these types of treatments will be highly specific to each cultural and ethnic groups. Generally speaking, Nigerians believe that illness has physical and supernatural origins, and therefore illness indicates having upset ancestral gods or evil spirits (Soewu, 2013).

Another important theory in African TM is that of sympathetic healing (SYM), or “transfer of aptitudes”, which is where the qualities of the animal or animal part that are helpful to the ailment are believed to be transferred to the patient via their use in zootherapy (Castillo & Ladio, 2019; Soewu, 2013; Friant et al. 2022). In the present study, we divided sympathetic healing treatments into two categories: (1) based on behavioral ecology (SYM-BE), where behavioral and ecological tendencies associated with the animal or part guide their use for certain ailments, and (2) based on morpho-physiological characteristics (SYM-MPC), where an animal part similar to or related to the body part associated with the disease or symptom is used (Soewu, 2008; Soewu, 2013).

Another common healing theory in African TM is that of perceived bioactive constituents, in which animals or certain parts are identified and correlated with healing due to their bioactivity (Soewu, 2013). These treatments are determined over a long period of time with

trial and error, and once “proven” to be efficacious, they are generally accepted and established as common zootherapies (Soewu, 2013).

### **Study Objectives**

In the present study, we utilize data collected on the zootherapies of communities in and near Cross River National Park, Nigeria to contribute to the growing literature on TM, and especially on zotherapy. Specifically, we sought to better understand (1) what animals are most used and what zotherapeutic animals are at high conservation risk, (2) what illness categories and diseases or symptoms are most treated with zotherapy, and (3) what theories of healing drive the zootherapies of Cross River. We aim to contribute to the overall knowledge of zotherapy in West Africa, as well as to provide insights for creating effective intervention strategies for zootherapies that pose a significant human or ecological health concern.

# **BACKGROUND**

## **Traditional Medicine as Healthcare in Africa**

Healing has always been a crucial aspect of human societies, and many cultures, particularly indigenous ones, still utilize traditional medicine (also referred to as folk or indigenous medicine). Traditional medicine (TM) uses nature-derived substances from plants, animals, and minerals to prevent, treat, and cure physical, mental, social, and spiritual ailments (Zhang, 2018). Within African healthcare, TM is especially successful in promoting biopsychosocial fulfilment, which is overall physical, mental, spiritual, and social wellbeing (Ataudo, 1985). TM is rooted in long-standing cultural traditions, is holistic, and is community based (Zhang, 2018). In societies with heavy use of TM, health is often understood as a state of equilibrium involving physical, mental, social, moral, and spiritual health, and so TM is utilized to help with these realms (Ataudo, 1985). Patients who believe in a healing power as a “psychological opium”, perhaps similar to the placebo effect, view TM in a positive light because it helps them to reinstate a sense of belonging, self-awareness, and connection to reality, family, and the broader community (Ataudo, 1985).

TM is still the main, and sometimes the only, medical care available for much of the developing world, including in Africa where it is especially critical for rural communities that lack access to allopathic care (Romero-Daza, 2002; Ataudo, 1985). There are numerous benefits to TM that explain its popularity and use across the globe. TM is more accessible, affordable, and acceptable to many local populations compared to allopathic medicine (Soewu & Ayodele, 2009; Soewu & Adekanola, 2011; Marshall, 1998; Ataudo, 1985; Izugbara et al., 2005). In

Africa, the ratio of traditional practitioners to citizens is 1:500, whereas the ratio of allopathic practitioners to citizens is 1:40,000 (Zhang, 2018).

The World Health Organization (WHO) and member countries have been working to incorporate and regulate TM into official allopathic medical systems since 1978 in order to utilize TM to achieve universal healthcare coverage (Romero-Daza, 2002; Zhang, 2018). That said, the WHO does not blindly endorse all forms of TM because while some elements are beneficial, some are not, and may even be harmful according to allopathic and biomedical standards (Zhang, 1996; Barsh, 1997). Currently, within the official healthcare systems of various African countries, there is high policy variation on incorporating TM. In Ghana, which is an exception rather than the rule, TM is deeply incorporated into primary healthcare and there is government-sanctioned recognition, legislation, and regulation of traditional healers (Romero-Daza, 2002). However, in many African countries, there are problems of mutual distrust and disrespect, and power struggle, between traditional and allopathic practitioners which exacerbate the difficulties in incorporating TM within official healthcare systems (Oseni & Shannon, 2020; Romero-Daza, 2002). Other challenges to its incorporation are secrecy around traditional practices and a lack of resources (Romero-Daza, 2002).

### **Studying Traditional Medicine**

Despite its high usage in developing countries to achieve universal healthcare coverage, and its increasing use in Western countries as complementary or alternative treatments, TM still does not receive the level of academic or sociopolitical attention as biomedicine does (Gale, 2014). When TM is studied, much of the literature addresses the efficacy of said treatments, and

so it is important to consider who has the authority to define and determine efficacy. For example, if we utilize biomedical definitions and standards of efficacy for traditional treatments, there is inherent bias (Waldram, 2000). In truth, there is no single way to define efficacy, and only using restrictive, biomedicine-centered definitions of efficacy hurts our ability to understand TM more deeply, and may perpetuate colonizer practices by assuming Western ideas and practices of healing are superior, and therefore need to be enforced on all communities. As Rhodes and Waldram explain, “every medical system is a cultural system” (Rhodes, 1996) “and is engaged in both healing and curing” (Waldram, 2000).

In contrast to biomedicine, the mere elimination of disease is not necessarily the goal of TM (Waldram, 2000). Instead, as medical anthropologists explain, much of TM involves “symbolic healing”, which places the healing process within a specific social, economic, historical, and cultural context relevant to the patient and their community (Waldram, 2000; Wiley & Allen, 2017). Additionally, a degree of healing can happen while a physiological disease still remains (Waldram, 2000; Wiley & Allen, 2017). For example, treatments can help a patient by alleviating distress or disability, coping psychologically and emotionally with death, and finding a sense of fulfillment or connection to spiritual and social realms (Waldram, 2000). Healing, especially within TM, can be a life-long process rather than an isolated “treat-and-cure” disease incident (Waldram, 2000). The best example of this within Western medical systems is perhaps Alcoholics Anonymous, which focuses on the lifelong process of healing (physically, mentally, and socially) from alcoholism (Waldram, 2000). Assessments of the efficacy of TM should take these points into serious consideration.

## **Traditional Medicine and Ecology**

TM is not only important for universal healthcare coverage, but is also an extremely important factor for biodiversity and ecological health (Alves & Rosa, 2007; Alves et al., 2013). TM is one avenue that potentially increases human damage to local ecosystems which can further impact public health because all systems of medicine, including biomedicine, ultimately utilize materials found in nature. A loss of or reduction in biodiversity impacts human health in various ways including reduced access to and quality of water and food, and increased risk of zoonotic disease spillover (Chivian, 2002). It is important to note that these consequences of biodiversity loss disproportionately affect poor communities. Biodiversity loss also reduces the raw materials utilized for drug discovery, biotechnology, and medical animal models (Alves & Rosa, 2007). As Alves and Rosa put it, we, “may be losing new medicines before species have been analyzed for their chemical content”. Demand of species for TM is one behavior which contributes to the overexploitation of wild plant and animal species (Alves & Rosa, 2007). Thus, it is critical to understand uses of non-human species for TM, in addition to studying the use of non-human species for consumption, to create a broader picture of the risks and consequences of using non-human species from the wild.

## **Traditional Medicine in Nigeria**

In Nigeria, TM is strongly intertwined with the sociocultural system and is a normal part of life, with an estimated 75-80% of the population utilizing TM when seeking healthcare (Ataudo, 1985; Gamaniel et al., 2005). There is definite power in the placebo effect in Nigerian TM (Gale, 2014; Ataudo, 1985; Waldram, 2000). Nigerian traditional practitioners treat the

whole person and are closer, both geographically and interpersonally, to the patients than allopathic practitioners are, thus making them more utilized (Oyeneye, 1985; Akerele, 1987). In Nigeria, TM is critical to solving the lack of access to healthcare in certain communities and is well accepted among Nigerians, especially for psychiatric, orthopedic, maternal, and child health problems (Ataudo, 1985; Oyeneye, 1985; Izugbara et al., 2005; Kpobi & Swartz, 2018). TM has a long history in Nigeria as part of the culture and is a main source of care in rural and urban areas alike (Ataudo, 1985; Oyeneye, 1985). It is used by both high- and low-income households, but specific treatments do vary between ethnic groups (Oyeneye, 1985).

While we did not find any current literature on what illnesses are most often treated with TM in Nigeria, a study from Burkina Faso may give insight to trends of TM use in West African countries, generally speaking (Pouliot, 2011). In Burkina Faso, illnesses including typhoid fever, sickle cell, meningitis, epilepsy, jaundice, and mental illness were most often treated with TM, whereas illnesses including malaria, respiratory illnesses, and unknown fevers were unlikely to be treated with TM (Pouliot, 2011). In recent decades, Nigerian TM has undergone large, structural changes including the education of traditional practitioners to work in modern clinics with similar organization as biomedical clinics, and specialization among traditional practitioners with a referral system, as is common in allopathic medicine (Oyeneye, 1985). However, TM still has not been incorporated into the national healthcare system of Nigeria (Alves & Rosa, 2007).



## **An Introduction to Zotherapy**

Zotherapy is a subset of TM that involves the healing of human disease by use of therapeutics obtained directly from, or ultimately derived from, animal species (Lev, 2003; Alves & Rosa, 2005). Zotherapy has a broad geographical distribution and long-standing historic origins (Alves & Rosa, 2005). For example, zotherapy has been used in the Levant (parts of modern-day Syria, Lebanon, & Jordan) where 99 substances with animal origin have been used for healing since medieval times, 77 of which have been used in the 20<sup>th</sup> century alone (Lev, 2003). Additionally, in traditional Chinese medicine (TCM), over 1,500 animal species are recorded to have a medicinal use (China National Corporation of Traditional and Herbal Medicine, 1995; Alves & Rosa, 2005). In Ayurvedic medicine of India, 15 to 20% of medicines are formed from animal substances (Unnikrishnan, 1998; Alves & Rosa, 2005). In Northeastern Brazil, over 180 medicinal animals are recorded (Costa-Neto, 2004; Alves & Rosa, 2005). As Marques states, “all human culture which presents a structured medical system will utilize animals as medicines” (Marques, 1994).

Not only are products sourced from wild animals critical for TM, they are also increasingly important as raw materials for preparing biomedicines, and discovering new biomedicines (Alves & Rosa, 2007). Over 50% of commercially available drugs are based on bioactive compounds extracted or patterned from non-human species, including plants (Grifo et al., 1997; Alves & Rosa, 2007). Of 252 chemicals deemed essential by the WHO, 8.7% come from animals, and of 150 prescription drugs in use in the United States, 27 have animal origin (Marques, 1997; World Resources Institute, 2000; Alves & Rosa, 2007). Certain zotherapies are now considered efficacious by biomedical standards (Alves & Rosa, 2007). For example, there is a component in snake venom that functions as an ACE inhibitor to raise blood pressure (Bisset,

1991) and poison dart frogs produce an alkaloid toxin which binds to muscle receptors and has analgesic properties (Chivian, 2002). Marine animals seem to be potential sources of biologically natural active products; for example, sponges produce large quantities of monoalide, which is an anti-inflammatory chemical (Carte, 1996; Faulkner, 1992). Another great example of a biomedically effective zotherapy patterned from a wild species are the peptide compounds found in cone snail venom. These peptide compounds block a variety of ion channels, pumps, and receptors of the neuromuscular system and are highly selective in doing so (Alves & Rosa, 2007). This has potential clinical applications for maintaining nerve cells after a period of ischemia, or inadequate blood supply (Malmberg & Yaksh, 1994; Valentino et al., 1993). These peptide compounds are now studied in a synthetic form known as SNX-111, which has been tested in clinical trials for potential in preventing nerve cell death after bypass surgery, head injury, and stroke, and for treating chronic pain associated with cancer, AIDS, and other neuropathies (Miljanich, 1997) . SNX-111 seems to be a promising analgesic as it has 1,000 times the analgesic property of morphine, but does not cause the harmful side effects of morphine including tolerance, addiction, and clouded consciousness (Bowersox et al., 1998).

There are many important reasons to study zotherapy including ecological motivations (maintaining biodiversity, conservation threats), cultural motivations (zotherapy is a critical part of TM that links people and cultures to their environment and promotes the sustainability and value of TM), economic motivations (patterning new biomedical drugs from animal sources, compensating traditional practitioners for their valuable knowledge), and sanitary motivations (zoonotic spillover risk (Friant et al., 2022)) (Alves & Rosa, 2005; Thomas-Walters et al., 2020)). As for the continued economic importance of zotherapy, commercial trade of medicinal animals is currently greater than ever before with an increasing demand for wildlife products

(Alves et al., 2013). It is incredibly important to understand why and how people use wildlife in medicine in order to create effective intervention strategies for cases where zotherapy poses substantial conservation, health, or other risks (Thomas-Walters et al., 2020).

## METHODS

### Study Site Description

The study site consists of nine villages within and near Cross River National Park in Southeastern Nigeria. The park is a lowland rainforest with areas of both disturbed and relatively undisturbed forest, and is the largest contiguous forest still present in Nigeria. The area has several endemic species and houses both critically endangered (the forest elephant (*Loxodonta cyclotis*) and the Cross River Gorilla (*Gorilla gorilla diehli*)) and endangered (the Cross River Chimpanzee (*Pan troglodytes ellioti*), the Drill monkey (*Mandrillus leucophaeus*), and the African tree pangolin (*Manis tricuspis*)) species. Thus, Cross River National Park is one of Africa's most important biodiversity reserves where wild animals have great nutritional, economic, medicinal, and cultural value, and as such are threatened by human behaviors (Friant et al., 2022).

The present study includes data from the nine villages, which have four ethnic groups (Ejagham n=3, Boki n=2, Ayo n=3, Idoma n=1). These villages are politically decentralized with multiple clans led by chiefs. They are typically polytheistic with beliefs centered around gods of the sky, earth, and water. They also believe the forest is host to supernatural beings, and their relationships with animals are critical for religion, folklore, secret societies, gender identity, juju (spells and charms), birth customs, funerals, and other cultural practices. These communities have a mixed economy based on hunting, gathering, and farming of staples such as yam, cassava, and maize. Hunting is critical for food, zootherapy, and cultural rituals. However, hunting does

threaten biodiversity and human health in the area. In these communities, zootherapy (and TM in general) is helpful for psychological, spiritual, and mystical problems in addition to physical health problems (Friant et al., 2022).

For data collection and analysis, the nine villages were categorized by their location to the park (in the park, within the park's support zone, or outside the park) and had varying access to government healthcare facilities. During the study period, two villages directly in the park had no formal healthcare workers or medical facilities, whereas villages within the park's support zone had more active healthcare workers and facilities (Friant et al., 2022).

### **Data Collection**

Data were collected using a mixed-methods approach, including quantitative and qualitative sampling, and include data collected from two separate study periods (2012 and 2017). Both data collection periods were part of larger studies on human-animal interactions with a focus on hunting practices and the consumption of wild animals (Friant et al., 2015; Friant et al., 2019; Friant et al. 2020).

In 2012, oral questionnaires were administered to hunters and non-hunters (n=327 males) in five of the nine communities, using species lists and animal drawings to elicit responses about the zootherapeutic uses of wild animals. We did not ask about fish, invertebrates, or human by-products, but included these if participants mentioned them. In 2017, we conducted free-listing and ranking exercises with key informants (n=50; hunters, traders, traditional healers, and restaurant owners) on the cultural salience of animals used for zootherapy. For more details, see Friant et al., 2022.

## Data Analysis

We organized all data on zootherapy into a table (published in the present study; Table 1) including the animal's common name, species (when possible), body part used, disease or symptom treated, and preparation and administration method. A zootherapy was considered as one treatment if it utilized a different species (or taxonomic group), body part, disease or symptom treated, or preparation or administration method. We used data from this table to describe zootherapeutic practices by the taxonomic class of animals used, species conservation status (IUCN 2021), category of illness treated (ICD-11 2019/2021), sociodemographic group targeted by treatment (e.g., women and children), and theory of healing (e.g., “like cures like”, sympathetic healing).

Some taxa could not be identified by species because of low taxonomic certainty of informants and so we grouped these animals as specifically as possible. These groups include bats, chameleons, crabs, eagles, galagoes, hornbill, monkeys, and vipers. Due to this non-specificity, we also could not determine a precise conservation status for these animals.

Certain diseases or symptoms were difficult to assign to categories based on how they were described by informants, or due to their lack of specificity. For these diseases and symptoms, I consulted various knowledgeable resources (Friant (thesis supervisor), Ayambem and Ifebueme (Cross River research assistants) and Métrey Tiv (MD/MPH; former postdoc with Friant)) to determine where the disease or symptom best fit. For example, one informant reported a zootherapy using porcupine spines for “itchy black leg”, which we collectively determined to be the result of insect bites, and therefore categorized it as an environmental illness.

There are inherent problems in using a biomedical classification system (the WHO ICD 11) to categorize ailments derived from communities that mainly believe in and use TM, and

therefore conceptualize and describe their ailments by different standards. For example, Jedi Jedi is a disease noted in the present study by one informant but is also a common cultural descriptor in West African countries with various meanings. Here, we used the description of Jedi Jedi as a rash and thus it fell into the dermatological category; however, Jedi Jedi often refers to gastrointestinal problems.

To categorize zotherapies by theory of healing, we identified common theories in African TM (“like cures like”, mythological and cultural conceptions, sympathetic healing based on behavioral ecology or morpho-physiological characteristics) and applied them to zotherapies seen in the data, where appropriate. Not every zotherapy fit into an established theory of healing, and there were certain zotherapies that were difficult to categorize. For example, we categorized a few instances of bile used to treat poisoning from stomach pain as sympathetic healing based on morpho-physiological characteristics, because bile would be implicated in the patient experiencing poisoning stomach pain. However, this is not as obvious of an example of sympathetic healing based on morpho-physiological characteristics as the use of leopard skin to treat a skin injury (see results; Table 1).

## RESULTS

Forty-one animals were reported as useful for 214 zootherapeutic treatments (Table 1).

Zootherapies were treated as individual treatments if comprised of a distinct (a) animal, (b) body part, (c) disease or symptom treated, or (d) preparation or administration method.

**Table 1. Medicinal uses of animals (zootherapies) in Cross River**

Year	# <sup>1</sup>	Animal body part	Treatment (as described by participants)	Preparation and administration <sup>2</sup>
<b>African civet (<i>Civettictis civetta</i>)</b>				
2017	5	anus	stomach pain	unknown (2)
		fur	burns	applied to affected area (1)
		scent gland	unknown	dried and sold to people (Hausa) who use it for medicine (1)
2012	2	scent gland	dislocation, body ache	used as rub (1)
		flesh (leg)	child's heat stroke	ash from dried leg mixed with oil and drank by child (1)
<b>Bat (<i>Chiroptera</i>)</b>				
2017	2	brain	enhances intelligence in children	brain is cooked and given to children above the age of six months (1)
		fur	burn	applied to affected area (1)
<b>Blue duiker (<i>Philantomba monticola</i>)</b>				
2017	2	head	headache	head is cooked together with some herbs and then consumed (1)
		bone (skull)	headache	head is cooked, skin is removed, and skull is rubbed on the forehead (1)
2012	32	bone (skull)	headache	skull used as cup to drink from (2)
		bone (skull)	headache	skull used to keep palm oil for rub (1)
		leg (bone and flesh)	headache	ground, sometimes mixed with water, and rubbed on forehead (26)
		flesh	stomach pain	mixed with herbs (peppe soup) and consumed (1)
		intestine	stomach pain	mixed with herbs (peppe soup) and consumed (1)
		skin	multiple	roasted and mixed with medicine and oil, used as lozenge (1)
<b>Boa (<i>Calabaria reinhardtii</i>)</b>				
2017	1	fat	stiffness/ old injury	rubbed on affected area until it softens (1)
<b>Chameleon (<i>Chamaeleonidae</i>)</b>				
2012	2	skin	epilepsy, mental illness	roasted, ground, and rubbed on body (2)
<b>Chicken (<i>Gallus gallus</i>)</b>				
2017	5	flesh	anemia	consumption of chicken pepper soup used as blood tonic (1)
		whole animal (rooster)	many sicknesses	traditional healers use for many medicine (1)
		bone	fracture and dislocation	an injury is given to the animal at the same body part where the patient is injured, then as the chicken is treated, the patient heals mysteriously (1)
<b>Chimpanzee (<i>Pan troglodytes ellioti</i>)</b>				
2017	2	bone	weakness	child wears the bone as a sign of strength (2)



		bone and blood	weakness	bone and blood mixed with chalk and rubbed on leg to improve strength (1)
		flesh	weakness in fetus	eaten during pregnancy to confer strength of animal to unborn child (1)
2012	1	bone (middle finger)	gives strength	dried and mixed with native chalk, used as rub for child (1)
<b>Cobra (<i>Naja melanoleuca</i>)</b>				
2017	8	bile	poison	when added with another [unspecified] ingredient and consumed, the bile will cure poison (1)
		flesh	joint pain	cooked and consumed (1)
		skin	stomach pain	dried and soaked in water, then the extract is given to the patient orally (1)
		venom	snake bite	venom used to produce antivenom (1)
		head	unknown	sold to Yoruba people (1)
2012	1	flesh	unknown diseases	cooked and consumed (1)
<b>Crab (<i>Potamonemus</i> sp.)</b>				
2017	2	flesh (abdomen)	bed wetting	cooked and consumed (1)
		flesh (abdomen)	childbirth	cooked and consumed to ease childbirth (1)
		shell	severe rashes	shell is dried and ground together with white chalk (limestone) and the powder is applied to the affected part (1)
<b>Dog (<i>Canis lupis</i>)</b>				
2017	6	flesh	malaria, fever	meat is prepared in a soup and consumed (3)
		fat	dog bite	fat is extracted when a dog is cooked and then stored (called boa oil), when needed it is mixed with alligator pepper and rubbed into bite wound (2)
		flesh (leg)	weakness in unborn child	legs are cooked and consumed by pregnant women to give strength (1)
		live animal	weakness or walking problems in a child	wash the limbs of a living animal with water, the resulting water is used to "pump" (give enema to) a child (1)
		fur	dog bite	fur of the dog that bit you is placed on the wound (1)
<b>Drill Monkey (<i>Mandrillus leucophaeus</i>)</b>				
2017	2	bone (thigh)	waist pain or walking problems	tied to affected area (1)
		palm	unknown	unknown (1)
		head	unknown	unknown (1)
2012	1	bone	give strength	dried, ground, mixed with water, and used as enema for child (1)
<b>Dwarf Crocodile (<i>Osteolaemus tetraspis</i>)</b>				
2017	2	feces	swelling	ground and rubbed on affected area (2)
<b>Eagle (<i>Accipitridae</i>)</b>				
2017	2	brain	mental problem	used to prepare medicine to enhance intelligence (2)
		eye	eye problem	used to prepare medicine to enhance eyesight (2)
<b>Elephant (<i>Loxodonta cyclotis</i>)</b>				
2017	11	feces	swelling or bone problem	rub on swelling (2), rub on bone problem (1), or unknown ailments (1)
		feces	wound	add to snuff (tobacco) to seal wound (1)
		feces	dysentery	mixed with tree bark and local gin (distilled palm wine) and drank (1)
		feces	epilepsy	mixed with herbs and rubbed all over the body (1)
		bone	dislocation	bone is fixed to the same bone that is fractured in the patient's body (1)
		skin	filariasis	dried skin is ground and rubbed on the body (1)
		tusk	neck pain	tied around the neck (1)
		limbs	walking problems (child)	wash the limbs of an animal with water, the resulting water is used to pump the stomach of a child (enema) (1)
		tusk, teeth	unknown	sell to Hausa people (1)

		synovial fluid (patella)	joint pains	mixed with palm oil and drunk by patients to cure joint pains (1)
		synovial fluid (patella)	gonorrhea infection	mixed with bitter leaf and consumed (1)
2012	7	feces	wound	mixed with water and rubbed on wound (3)
		feces	fever	mixed with local gin (distilled palm wine) and drank (1)
		bile	stomach problem	mixed with local liquor and drank (1)
		fat	cough	melted and drank (1)
		stomach fluid	give strength	water from stomach drank (1)
		stomach	give strength	stomach with water used for pillow (1)
<b>Flying Squirrel (<i>Anomalurus beecroftii</i>)</b>				
2017	11	fur	burns or injury	rubbed/placed on affected area (10)
		fur	catarrh cough	fur is grinded with herbs and consumed (1)
2012	21	fur	burn	rubbed on burn or other wound or sore (21)
<b>Galago (<i>Galago</i> spp.)</b>				
2017	1	fur (tail)	burns	rubbed on affected area (1)
<b>Genet (<i>Genetta genetta</i>)</b>				
2017	2	anus	toothache	unknown (1)
2012	2	skin	cough, cold	roasted then mixed with water and drank (2)
<b>Giant Pouched Rat (<i>Cricetomys emini</i>)</b>				
2017	2	flesh	malaria	prepared and eaten as pepper soup (2)
2012	4	flesh	epilepsy	boiled and consumed (1)
		gall bladder	gonorrhea	boiled and consumed (1)
		intestine	swollen stomach	mixed with sweet yam and consume (1)
		intestine	kidney problem	boiled with water consumed (1)
<b>Gorilla (<i>Gorilla gorilla diehli</i>)</b>				
2017	4	bone	give strength	ground and mixed with water then consumed (1)
		bone	give strength	mixed with herbs to perform a ritual (1)
		bone	give strength	tied to child's neck and worn as they grow (1)
		bone	give strength	ground bone and mix with water to pump baby (enema) (1)
		flesh	strength for unborn child	consumed by pregnant women (1)
<b>Hornbill (<i>Bucerotidae</i>)</b>				
2017	6	head	unknown	sold to Hausa and Yoruba people who use for medicine (1)
		beak	unknown	sold to Hausa and Yoruba people who use for medicine (1)
		feathers	unknown	sold to Hausa and Yoruba people who use for medicine (1)
		legs	unknown	unknown (3)
<b>Guinea fowl (<i>Guttera plumifera</i> or <i>Agelastes niger</i>)</b>				
2017	2	unknown	unknown	unknown (2)
<b>Leopard (<i>Panthera pardus</i>)</b>				
2017	3	feces	joint pain	ground with other herbs, mixed with palm kernel oil, and rubbed on affected part (1)
		skin	skin injury	unknown (1)
		whiskers	epilepsy	put into water and consumed (1)
2012	1	flesh	cough	cooked and consumed (1)
<b>Monkey (<i>Cercopithecus</i> spp.)</b>				
2012	62	bone (skull)	cough, child's cough	used as cup to drink boiled water and herbs from (46)
		feces	cough	drank with water/ local liquor (13)
		intestine	cough	boiled and drank broth (2)
		fur	prevent sickness	mixed with local liquor and drank (1)
		bone (skull)	headache	ground, mixed with water and rubbed on head (1)
<b>Monitor lizard (<i>Varanus niloticus</i>)</b>				
2017	10	skin	cough	soaked in water and consumed daily (9)
		fat	stomach pain	unknown (1)
2012	7	flesh	epidemic cough	boiled and broth drank (5)
		skin	child's convulsions	dried in sun, used as lozenge (1)
		skin	child's convulsions	dried in sun, wore on necklace (1)

<b>Palm civet (<i>Nandinia binotata</i>)</b>				
2017	1	skin	skin injury	unknown - used as a replacement of leopard (1)
2012	1	feces	baby's stomach pain	mixed with water and used as enema for baby (1)
<b>Pangolin (<i>Manis tricuspis</i> or <i>Manis tetradactyla</i>)</b>				
2017	7	head and fingers	stomach pain	placed on affected area (1)
		skin	stomach pain	placed on affected area (1)
		skin	unknown	sold to Yoruba people who use it for medicine (1)
		scales	Jedi Jedi and spleen problems	burnt into ashes and ground, then added to palm oil for baby to consume (1)
		scales	cough	roasted and eaten (1)
<b>Porcupine (<i>Atherurus africanus</i>)</b>				
2017	1	spines	asthma	roasted and the smell is inhaled (1)
2012	7	spines	pain, injury, or itchy black leg	burned and ashes used as rub (3)
		spines	boil	laceration tool (1)
		intestine	malaria, general sickness	boiled and drank as broth or consumed (2)
		heart	stomach pain	mixed with alcohol and drank (1)
<b>Potto/ Angwantibo (<i>Perodicticus potto</i> or <i>Arctocebus calabarensis</i>)</b>				
2017	9	flesh (forelimb)	give fetus strength and ease delivery	cooked and dried and put in soup for pregnant woman to consume (5) (some put 6-inch nails into the pot to soften the tough meat) (some specify right forelimb as the useful part of body)
		bone	weakness (baby)	roasted and ground, used to pump baby (i.e., as enema) (1)
		bone	weakness (baby)	roasted and ground, used to mark baby (i.e., rubbed in cuts made with a razor blade) (1)
		flesh	weakness of joints/ body (child)	meat is dried, ground into powder, and mixed with other herbs to rub into razor cuts made along the child's chest, joints, and waist to cure weakness within 7 days (1)
		flesh	weakness of joints/ body (child)	meat is dried, rubbed on limbs of child unable to walk (1)
		hand and limbs	unknown	sold to Yoruba people for medicine (1)
2012	5	flesh (leg)	give strength to baby	flesh roasted and eaten by pregnant women (2)
		flesh	cough, gonorrhea	boiled without ingredients and broth consumed (2)
		flesh	hernia	cooked with leaves and consumed in large quantity (1)
<b>Puff Adder (<i>Bitis arietans</i>)</b>				
2017	1	head	breast problems	rub on affected area (1)
<b>Python (<i>Python sebae</i>)</b>				
2017	31	bile	poisoning/ stomach pain	added to local gin and one shot taken (person must wait 30 minutes before drinking water or else will die) (9)
		fat	inflammation/ rheumatism	apply to anything inflamed (8)
		fat	dislocation/ bone problem/ body pain	melted and oil is applied to the affected area (8)
		fat	cough	sundried and sucked on as lozenge (1)
		fat	injury	applied to affected area after cutting it with razor blade (1)
		teeth	lactation problem	used to make a cut on breast to relieve pain (1)
		teeth	snake bite treatment	used to make a cut where snake bite occurred to relieve pain (1)
		bile	epilepsy	mixed with other ingredients and taken orally (1)
2012	35	fat	dislocation/ body pain	used as rub on affected area (14)
		fat	fever/ malaria	mixed with liquor and consumed (4)
		fat	cough	dried in sun to use as lozenge (1)
		bile	poisoning	put in local liquor, consume, wait 30 minutes before drinking water to avoid death (8)
		kidney	malaria, body pain	put in local liquor and drank (3)
		teeth	breast pain	used as a laceration tool to release pain of breast (3)
		teeth	boil	used as a laceration tool to release pain of boil (1)
		flesh	body pain	cooked and consumed (1)
<b>Red duiker (<i>Cephalophus dorsalis</i> or <i>Cephalophus ogilbyi</i>)</b>				

2017	15	flesh (tail)	eases childbirth, prevents miscarriage	cooked and mixed with herbs and given to pregnant women to help expand the cervix or who have previously suffered a miscarriage (3)
		flesh (leg)	eases childbirth	dried leg is roasted and dipped into a cup containing water and the resulting extract is given to a pregnant woman (1)
		bone	rib pain	bone is ground and rubbed in skin that was cut with razor (1)
		flesh (thigh)	severe headache, migraine, epilepsy	dried meat ground, mixed with herbs, and applied in razor blade marks made on the forehead (4)
		flesh	enhances intelligence in children	cooked and eaten with other herbs (1)
		flesh (neck)	heart disease	cooked and eaten with other herbs (1)
		flesh (neck)	fibroids	cooked and eaten with herbs (1)
		pancreas	pain	unknown (1)
2012	5	skin	epilepsy, malaria	roasted, mixed with water or alcohol, and drank (4)
		flesh (thigh)	malaria	mixed with herbs and consumed (1)
<b>Red river hog (<i>Potamochoerus porcus</i>)</b>				
2017	2	ear	swollen jaw (child)	cooked and eaten (1)
		unknown	unknown	unknown (1)
2012	14	bone	boil	mixed with water and rubbed on boil (14)
<b>Snail (<i>Achatina achatina</i>)</b>				
2017	3	shell	eye infection	ground and rubbed on eye (1)
		shell	walking problem (child)	shell used to store medicine that is applied to an area of the leg after cutting with razor blade (1)
2012	1	flesh	spit in eye from cobra	rubbed in eye after a snake spits in it (1)
<b>Tortoise (<i>Kinixya erosa</i>)</b>				
2017	19	feces	rheumatism	collected, dried, mixed with alligator pepper until smooth, and applied on the portion affected after it has been pierced and little razor cuts have been made (1)
		shell	convulsions, epilepsy	burnt and blended with pepper and rubbed on body/chest or mixed with palm oil and consumed (2)
		shell	cough, tuberculosis, breathing difficulty	burnt and blended with pepper and rubbed on body/chest (1)
		shell	cough, tuberculosis, breathing difficulty	mixed with palm oil and consumed (1)
		brain	brain function	dried, ground, mixed with native leaves and used as rub (1)
		brain	brain function	mixed with native leaves and consumed as peppe soup (2)
		bone	bone pain, sprain, or dislocation	tied around affected area (2)
		shell	unknown	ground and rubbed on body (1)
		flesh (leg)	unknown	cooked and consumed (1)
		head	unknown	sold to Yoruba people for unknown medicine (1)
		shell	stomach pain	stores medicine that is later applied to and cut made from razor blade on stomach (1)
		shell	unknown	usage only known by the witch doctor (1)
		skin	stomach pain	boil and rub on affected area (1)
2012	12	bone	dislocation, waist pain, joint pain	tied to body where affected (5)
		bone or shell	give child strength	ground, mixed with water, and used as enema (2)
		bone or shell	give child strength	ground, rubbed in scarifications (2)
		bone or shell	give child strength	ground, given to child with food (1)
		intestine	tuberculosis, cough	mixed with palm oil and drugs, drank (1)
		heart	tuberculosis, cough	mixed with palm oil and drugs, drank (1)
		skin	tuberculosis, cough	mixed with palm oil and drugs, drank (1)
<b>Viper (<i>Viperidae</i>)</b>				
2012	1	teeth	breast cancer	used to bleed breast (1)
<b>Water chevrotain (<i>Hyemoschus aquaticus</i>)</b>				
2017	9	flesh/ skin/ bone (leg)	epilepsy, convulsions, high fever, severe cold	roasted and soaked in water for days and water is taken twice a day (7)
		skin	fever	roasted and the smoke is inhaled while roasted (1)

2012	42	flesh/ skin/ bone (leg)	fever chills	roasted, ash mixed with water or local liquor and drank (41)
		bone	promote child's growth	roasted, ash mixed with water and used as an enema (1)
<b>Turaco (<i>Corythaeola cristata</i>)</b>				
2017	4	feathers	whooping cough	feathers from the tail are roasted and ash is mixed with palm kernel oil and taken orally (1)
		bone marrow	whooping cough	animal is cooked and the bone marrow is sucked (1)
		head	unknown	sold to Yoruba people for medicine (1)
		feathers	unknown	sold to Yoruba people for medicine (1)
		leg	unknown	sold to Yoruba people for medicine (1)

<sup>1</sup> Indicates the number of times an animal was listed by participants in each study year.

<sup>2</sup> Numbers listed indicate the number of times participants described a medicinal use.

Mammals were the most used class for zotherapy comprising 24 of the 41 animals, followed by reptiles (9) and birds (6) (Figure 1). Thirty-one different families were used, with the most common being *Bovidae* (3 of 41 animals). The most used animals were the tortoise (*Kinixya erosa*), python (*Python sebae*), elephant (*Loxodonta cyclotis*), red duiker (*Cephalophus dorsalis* and *Cephalophus ogilbyi*), and potto or angwantibo (*Perodicticus potto* and *Arctocebus calabarensis*) (Figure 2).

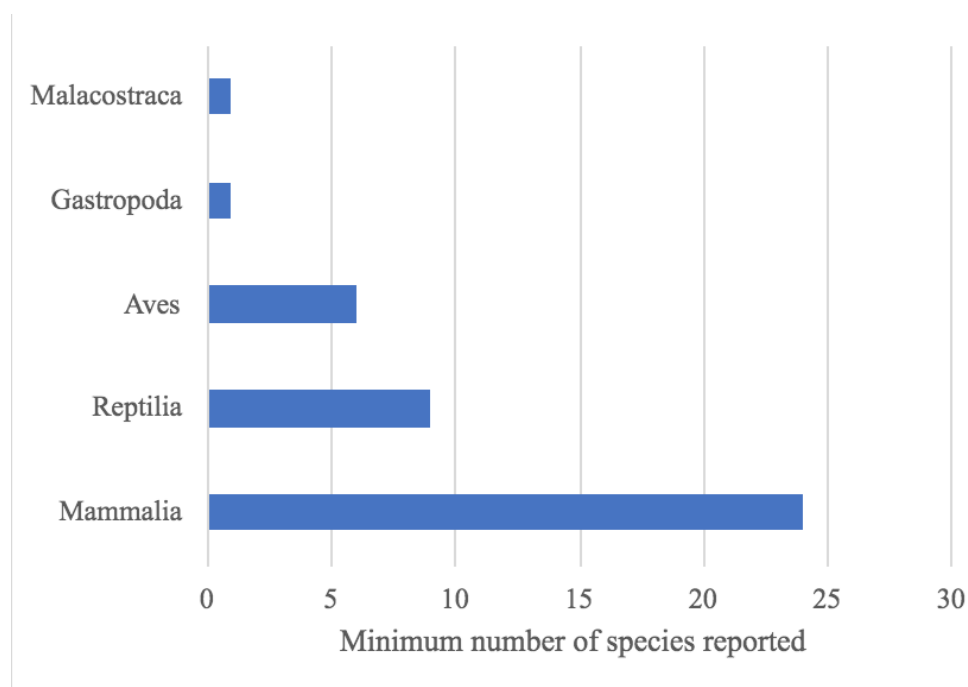
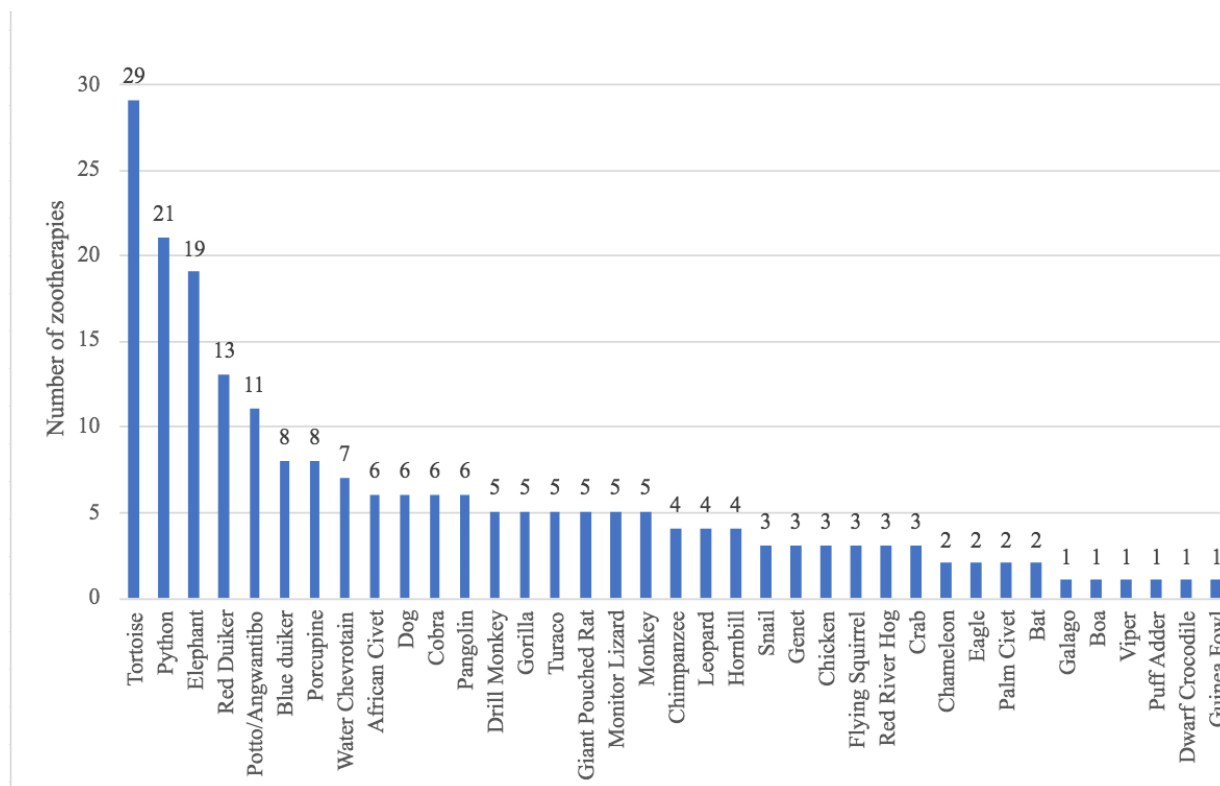


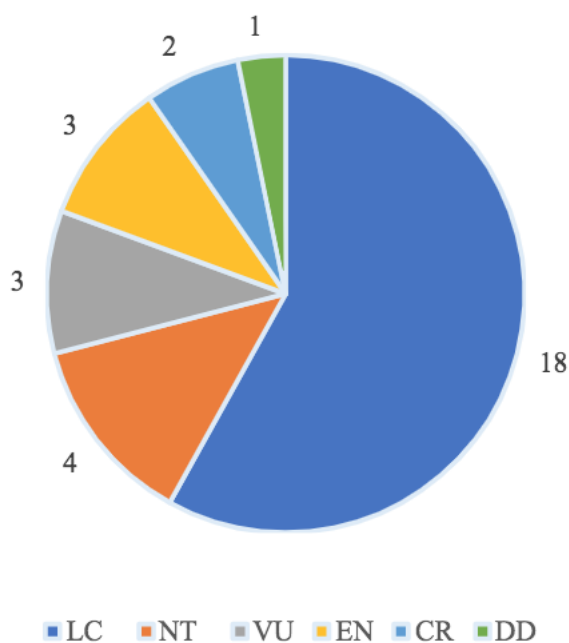
Figure 1. Minimum number of species used for zotherapy in Cross River by class



**Figure 2. Number of zootherapies used in Cross River per animal**

Eighteen animals are of least concern (LC); four are near threatened (NT; potto (*P. potto*), angwantibo (*A. calabarensis*), python (*P. sebae*), and red duiker (*C. dorsalis*)); three are vulnerable (VU; dwarf crocodile (*Osteolaemus tetraspis*), leopard (*Panthera pardus*), and long-tailed pangolin (*Manis tetradactyla*)); three are endangered (EN; drill monkey (*Mandrillus leucophaeus*), African tree pangolin (*Manis tricuspis*), and chimpanzee (*Pan troglodytes ellioti*), and two are critically endangered (CR; forest elephant (*L. cyclotis*) and Cross River gorilla (*Gorilla gorilla diehli*)) (Figure 3). Eight animals did not have species-specific designations from informants and so were not considered in this analysis. However, several local species of these animals (bat, chameleon, crab, eagle, galago, hornbill, monkey, and viper) are at various degrees of threatened (IUCN 2021). Seven of 89 Nigerian bats species are endangered or near threatened; three of eleven Nigerian chameleon species are vulnerable or near threatened; five of 41 Nigerian

crab species are endangered or vulnerable; 14 of 55 Nigerian eagle species are critically endangered, endangered, vulnerable, or near threatened; two of five Nigerian galagoes are near threatened; two of 14 Nigerian hornbill species are vulnerable; 15 of 18 Nigerian monkey species are critically endangered, endangered, vulnerable, or near threatened; two of 32 Nigerian vipers are vulnerable (IUCN 2021). Additionally, one species (tortoise (*K. erosa*)) is considered data deficient (DD) and an additional two animals were not found in the IUCN database (giant African snail (*Achatina achatina*) and dog (*Canis lupis*)), and so were also excluded from this analysis.



**Figure 3. IUCN Conservation Status of species used in Cross River for zotherapy**

Participants from our study reported using zotherapy for 68 different diseases or symptoms, including unknown (or unreported) ailments, across 18 categories of illness (Table 2) as determined by the WHO's International Classification of Disease 11 (ICD-11 2019/2021). The most treated categories were health promotion (27 of 214 zotherapeutic treatments),

musculoskeletal (27), unknown (25), parasites, toxins, and infectious agents (24), respiratory (22), and nervous system (20) (Table 2).

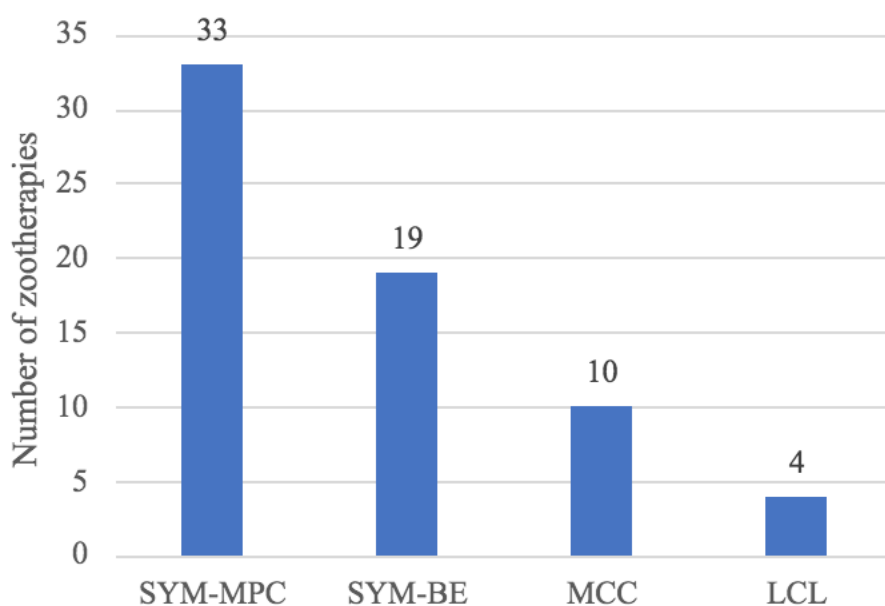
**Table 2. Illness categories, their corresponding diseases and symptoms, and the number of zootherapies for each illness category**

<b>Category</b>	<b>Diseases and Symptoms</b> (as described by participants)	<b># of Zootherapies</b>
<b>Health Promotion</b>	Give strength/help weakness (21), brain function/enhance intelligence (4), prevent sickness (1), promote growth (1)	27
<b>Musculoskeletal</b>	Fracture/dislocation (7), joint pain (4), walking problems (4), bone pain/problem (3), rheumatism (2), waist pain (2), weakness of joints/body (2), neck pain (1), rib pain (1), sprain (1),	27
<b>Unknown</b>	Unknown (22), many sicknesses/multiple (3)	25
<b>Parasites/Toxins/Infectious Agents</b>	Malaria (7), tuberculosis (5), fever/chills (4), gonorrhea (3), poisoning (3), dysentery (1), filariasis (1)	24
<b>Respiratory</b>	Cough (13), whooping cough (2), breathing difficulty (2), cold/severe cold (2) catarrh cough (1), epidemic cough (1), asthma (1)	22
<b>Nervous System</b>	Epilepsy (9), headache (6), convulsions (4), severe headache/migraine (1)	20
<b>Gastrointestinal</b>	Stomach pain/problem (13), hernia (1)	14
<b>Dermatological</b>	Burns (5), boils (3), rashes (2) (including Jedi jedi (1))	10
<b>Reproductive Health</b>	Childbirth (4), breast pain/problems (2), breast cancer (1), lactation problem (1), preventing miscarriage (1), fibroids (1)	10
<b>Trauma/Injury (general)</b>	Injury/skin injury (4), wound (2), swelling (2), stiffness (1)	9
<b>Other/General</b>	Body ache/pain (general) (7), inflammation (1)	8
<b>Environmental</b>	Dog bite (2), snake bite (2), heat stroke (1), spit in eye from cobra (1), itchy black leg (from biting/sucking insects) (1)	7
<b>Cardiovascular/Hematological</b>	Anemia (1), heart disease (1), spleen problems (1)	3
<b>Ophthalmological</b>	Eye infection (1), eye problem (1)	2
<b>Oral Health</b>	Toothache (1), swollen jaw (1)	2



<b>Psychiatric</b>	Mental illness/problem (2)	2
<b>Behavioral</b>	Bed wetting (1)	1
<b>Urological/Nephrological</b>	Kidney problem (1)	1

The most treated ailments were unknown (22 of 214 instances), giving strength or helping with weakness (21), cough (13), stomach pain or problems (13), epilepsy (9), malaria (7), general body aches and pains (7), and fracture and dislocation (7) (Table 2). Of 214 total zootherapies described, 32 of these are specific to children or babies (for example bed-wetting, walking problems, and promoting growth). An additional six are related to pregnancy (for example easing childbirth and lactation problems), and another four are sex-specific to females (including breast pain, problems, or cancer). Zootherapies were not described to have uses that are sex-specific for males.



**Figure 4. Healing theories behind zootherapies used in Cross River by theory (SYM-MPC = sympathetic healing based on morpho-physiological characteristics; SYM-BE = sympathetic healing based on behavioral ecology; MCC = mythological and cultural conceptions; LCL = “like cures like”)**

Of 214 total zootherapies described, 66 aligned with a theory of healing known to African TM (Figure 4). Fifty-two zootherapies aligned with the theory of “sympathetic healing”

(SYM), with 33 zootherapies founded on morpho-physiological characteristics (SYM-MPC) of the animal used, and 19 zootherapies founded on behavioral-ecological traits (SYM-BE) of the animal used. An additional four zootherapies aligned with the theory of “like cures like” (LCL), and another ten zootherapies aligned with mythological or cultural conceptions (MCC) about the animal used. We did not find any zootherapies that aligned with the theory of perceived bioactive constituents.

A few other patterns emerged from our data on zootherapy. All five zootherapies listed for treating burns utilize fur, although of different species. Additionally, there are 16 zootherapies where primates are utilized to fight weakness or give the patient strength. There are only seven zootherapies utilized to fight weakness or give the patient strength that are not derived from primates. These zootherapies are formulated with dog (*C. lupis*), forest elephant (*L. cyclotis*), or tortoise (*K. erosa*). Finally, all four zootherapies related to breast problems (breast pain, lactation problem, breast cancer, etc.) are treated with various species of snakes.

## DISCUSSION

We report the use of 41 animals in Cross River, Nigeria for 214 zootherapeutic treatments for 68 diseases or symptoms across 18 categories of illness. Sixty-six of these zotherapies aligned with a theory of healing within African TM. The insights we illuminate in the present study on which zotherapies are most important to Cross River, culturally and medically speaking, is important information that contributes to the understanding of local health needs, motivations for zotherapy use, and of human-environment interactions which have impacts on ecological and human health alike.

### **Conservation and Biodiversity: Perspectives and Impacts**

Mammals were most used for zotherapy, followed by reptiles and birds (Figure 1). This pattern is consistent with reports of zotherapy from other regions, for example, in Brazil, Argentina, and Southwestern Ethiopia where mammals, reptiles, and birds are the most used, often with mammals being the most frequently used for zotherapy (Ferreira 2012; Ferreira 2009; Alves, Santana, & Rosa 2012; Martinez 2013; Castille & Ladio 2019; Edae & Mohammed 2018).

While over 40% of zotherapeutic animals in use in Cross River are marked as least concern by the globally focused IUCN Red List, these animals may be at higher risk on a local scale. Furthermore, many species used in zotherapy in Cross River are near threatened, vulnerable, endangered, or critically endangered (Figure 3). Given these data, 27% of animals used for zotherapy in our study communities are at some level threatened globally, and this is likely an underestimate given the inability to precisely access the conservation status of several

animals involved. However, while we could not determine their precise status for several zotherapeutic animals, some local species of these animals (bat, chameleon, crab, eagle, galago, hornbill, monkey, and viper) are at various degrees of threatened (Soewu, 2013; IUCN 2021). Particularly of importance is that almost one-third of Nigerian chameleon species, one-fourth of Nigerian eagle species, two of five Nigerian galago species, and over 80% of Nigerian monkey species are at some level threatened (IUCN 2021). So, our finding that, at the bare minimum, 27% of zotherapeutic animals in Cross River are threatened, is comparable to other regions, including Brazil, where 21% of zotherapeutic species are on at least one endangered species list (Alves, Santana, & Rosa 2012).

Knowing the uses and cultural importance of these zotherapeutic animals, and especially of the critically endangered to near threatened ones, is helpful in triaging where to focus conservation efforts, and what species to target for replacement (with least concern or domestic species), with the goal of avoiding overexploitation of natural resources for zotherapy. For example, since the forest elephant (*L. cyclotis*) is critically endangered globally and makes up the third highest number of zotherapies in Cross River (Figure 2), the forest elephant should be a top priority when attempting to find culturally appropriate substitutions for zotherapies made from this species in order to create successful conservation efforts and improve local ecological health.

### **Illnesses Treated with Zotherapy**

Zotherapy in Cross River, Nigeria is used for 68 different diseases or symptoms across 18 different WHO-defined categories, with health promotion, musculoskeletal, unknown,

parasites, toxins, and infectious agents, respiratory, and nervous system related ailments being the most frequently treated with zootherapy. This supports previous findings that TM is exceptionally well accepted and highly used by Nigerians for orthopedic (musculoskeletal) problems (Oyeneye, 1985). However, the frequent treatment of respiratory illness with zootherapy in Cross River contradicts a previous finding from Burkina Faso (Pouliot, 2011). These findings are comparable to other regions, including Northeast Brazil, where respiratory and musculoskeletal diseases are among the most treated with zootherapy and Argentina, where infections and musculoskeletal diseases are among the most treated with zootherapy (Ferreira, 2012; Martinez, 2013). The specific diseases and symptoms most often treated with zootherapy include weakness, cough, stomach pain or problems, epilepsy, malaria, general aches and pains, and fracture or dislocation. Again, this is comparable to other regions including Northeast Brazil where cough is one of the most treated symptoms (Ferreira 2012), but contrasts with Burkina Faso where respiratory illness is not commonly treated with TM (Pouliot, 2011). These results give us crucial insights into the health needs of Cross River communities, especially as they may lack access to allopathic care.

Interestingly, one study was previously conducted on zootherapy in various ecological zones of Nigeria where the rainforest zone includes data collected from Cross River and Oyo states (Adeola, 1992). Researchers at the time found several zootherapies that closely resemble our recent data, which may show continuity in certain zootherapies used in Cross River over time. Examples of this continuity include tortoise used for chest pain (Adeola, 1992) and for cough, tuberculosis, and difficulty breathing (Table 1); puff adder used to prevent adultery in women (1992) and for breast problems – a female-specific ailment (Table 1); python for backache and spinal cord injury (1992), and for body pain (Table 1); gray duiker for

stomachache (1992), and blue duiker for stomach pain (Table 1). This continuity over time of zootherapeutic treatments is consistent with the fact that TM and zotherapy in Nigeria has strong historical and sociocultural roots (Ataudo, 1985; Oyeneye, 1985).

Our data indicate some patterns related to who is treated most often with zotherapy: 32 zootherapeutic treatments are specific to children or babies, six are specific to pregnancy, four are specific to females, and none are specific to males. Although it is possible there are zotherapies specifically for males in Cross River, we either failed to collect these data, or research informants did not want to, or could not, disclose this information. These findings support previous indications that TM is exceptionally well accepted and used by Nigerians for maternal and child health problems (Oyeneye, 1985). It is evident that maternal, female, and child-specific health problems are common in these communities and, keeping in mind that two of the nine study site villages had no formal healthcare facilities or workers, these health problems must be addressed with TM and zotherapy due, at least in part, to this lack of access to allopathic medical care.

### **Theories and Patterns of Healing for Zotherapy**

Almost one-third of the zotherapies reported in Cross River align with a theory of healing known to African TM (Figure 4). Four treatments align with the “like cures like” theory. For example, snake venom (cobra) or teeth (python) were used as anti-venom to treat a snake bite, or to relieve pain at the bite site. Additionally, dog fat and fur were used to treat a dog bite, and specifically the fur of the dog that bit the individual was used. The use of dog and snake body parts to treat dog and snake bites respectively was also found in Nigerian Ibibio

zootherapies (Izugbara, Etukudoh, & Brown, 2005), perhaps indicating cross-ethnic transmission of zootherapies.

Ten other treatments align with mythological or cultural conceptions associated with the animal used. For example, snakes are, “blamed for deceiving Eve in the garden of Eden so God cursed them to have no legs” (Friant unpublished data; see Appendix), which shows a cultural association between snakes, sin, and women, which is not an uncommon association across cultures. Perhaps because of this mythological or cultural conception, every instance of breast problems (lactation, breast cancer, breast pain, etc.) is treated with a species of snake in our data. Other examples of mythological or cultural conceptions informing zootherapeutic treatment are the use of fur for burns (of bat and flying squirrel, which are grouped together by locals based on environmental beliefs), and red duiker for pregnancy related ailments (easing childbirth, preventing miscarriage) (Friant unpublished data; see Appendix). These zootherapies grounded in mythological and cultural conceptions help us to better understand how communities in Cross River perceive and understand their environment, which may prove useful for interventions to replace certain high-risk zootherapies in culturally informed ways.

A vast majority of zootherapies that do align with a theory of healing, align with the theory of sympathetic healing. Nineteen of these zootherapies are founded on sympathetic healing based on behavioral ecology, for example the use of various primates (chimpanzee, drill monkey, gorilla, potto, or angwantibo) and the elephant to give strength to patients, or assist with walking problems, because these animals are perceived as powerful, strong, and difficult to hunt (Friant unpublished data; see Appendix).

Thirty-three zootherapies are founded on sympathetic healing based on morpho-physiological characteristics, for example the use of bat, eagle, or tortoise brain to enhance

intelligence, elephant synovial fluid to treat joint pain, leopard or palm civet skin for skin injury, tortoise shell to give strength, and eagle eyes to treat eye problems. Many of the zotherapies following sympathetic healing based on morpho-physiological characteristics were frequently repeated throughout the data and these include (1) the use of heads or skulls of various animals (blue duiker, monkey) to treat headaches, (2) the use of gastrointestinal-related tissues of various animals for gastrointestinal ailments (blue duiker intestines for stomach pain; cobra or python bile to counteract poisoning; elephant bile for stomach problem; giant pouched rat intestine for swollen stomach), and (3) the use of bones of various animals (chicken, drill monkey, elephant, red duiker, tortoise, and water chevrotain) for musculoskeletal ailments, such as fracture, dislocation, or walking problems (Table 1).

Morpho-physiologically motivated zotherapies may be easiest to target for replacement, especially given that a related body part of multiple animals is used for the same disease or symptom. For example, bat, eagle, and tortoise brain can all be used to enhance intelligence (Table 1). However, bats are known to be frequent carriers of zoonoses (Han et al., 2016; Johnson et al., 2020; Olival et al., 2017; Luis et al., 2013), therefore posing a human health risk, and one-fourth of Nigerian eagle species are threatened (IUCN 2021), therefore posing a conservation risk. So, public health and biodiversity intervention programs could collectively achieve their respective goals by supporting the use of tortoise instead of bat or eagle brain.

Additional patterns were also seen in the data, that we could not link to pre-existing healing theories. For example, all five zotherapies used to treat burns utilize fur of various species, and no other animal part is used to treat burns. Additionally, a majority of zotherapies that give the patient strength were made from primates, and those not made from primates were made from dog (*C. lupis*), forest elephant (*L. cyclotis*), or tortoise (*K. erosa*). This may be due to



the strong cultural associations of primates as strong, and perhaps also because of their social behavioral and physical appearance similarities to humans (Friant unpublished data; see Appendix).

Overall, knowing which theories and motivations for zootherapies in Cross River are most prevalent, and understanding those theories themselves, will prove useful when proposing to change a specific zotherapy to one that better supports both ecological and human health because the proposed change will be based on a local understanding of ecology, illness, and treatment.

### **Limitations and Future Studies**

Our study had certain limitations that decreased the interpretation of the data. The data collected in 2012 and 2017 were collected for different studies specifically on hunting and animal consumption, and so a study designed more precisely for understanding zotherapy in Cross River could elicit better results. For example, including more traditional practitioners and more females (especially compared to the 2012 data collection), could provide more accurate data on what zootherapies are used, and who or what ailments they are used for. Additionally, the exclusion of fish and invertebrates from the animals we asked about in data collection could have skewed our results if informants did not think to, or thought they should not, discuss these animals' use in TM. Furthermore, future studies could incorporate additional data collection processes, such as semi-structured interviews, that target local theories of healing that inform zootherapies in Cross River. These interviews could be conducted with traditional practitioners, as well as community members, to get broader input on why zootherapies are used or believed to

be efficacious. Future studies into the biomedical or pharmaceutical efficacy of highly salient animal-derived substances (e.g., fur for burns) used in zootherapy in Cross River may prove useful to biomedicine, as well as increase acceptance of traditional medical knowledge and its value among all medical systems.

## CONCLUSION

Zootherapy, or the use of animals in healing, is a critical part of traditional medicine, which continues to provide healthcare globally, especially in areas that lack access to allopathic medicine. In the present study we found that 41 animals were used for 214 distinct zotherapeutic treatments in Cross River National Park in Southeastern Nigeria, to treat 68 different diseases or symptoms. We found that certain treatments utilize endangered, or critically endangered species, and these should be a focus for conservation strategies in implementing treatment substitutions in culturally appropriate ways. The categories of health promotion, the musculoskeletal system, unknown treatments, solutions for parasites, toxins, and infectious agents, and the respiratory and nervous systems are most often treated with zootherapy, which provides insight into the health needs of communities in Cross River not currently being met by allopathic medicine, due potentially to access barriers or preference for traditional medicine. Finally, we determined that 66 of the 214 zotherapies are aligned with a specific theory of healing, including “like cures like”, mythological or cultural conceptions, and sympathetic healing. Having a greater understanding of the theories driving zootherapy in Cross River will prove valuable in many ways, including guiding interventions for specific zotherapies with significant human health or conservation risk.

## Appendix: Unpublished, supporting data

**Table 3. Local environmental knowledge, beliefs, and understandings on animals used in zotherapy in Cross River (unpublished data from Friant)**

Group name	Animals	Habitat and movement	Feeding ecology	Morphology/ biology	Behavior/ personality	Inter/ intra species relationships	Human-animal relationships
<b>Dogs</b>	domestic dog, African civet		feeds on flesh, scavengers, also feed on palm nuts, feeds on feces if not tamed	poisonous bite	barks		some domesticated
<b>Pigs</b>	domestic pig, red river hog*		eat rotten things, eats too much, scratches in mud with mouth and tusks to eat	long mouth	wild, destroyer, dangerous		destroys cassava/crops/farms, divided and given to age grade and chiefs when killed
<b>Deer/ Antelope</b>	ogilby duiker*, bay duiker, yellow backed duiker, sitatunga, blue duiker, water chevrotain, black deer, bushbuck	live on ground, cannot climb trees, good jumpers (some)		similar features, small legs, stripes, long mouth, good hearing	fast, hard to see, harmless	move together	culturally significant, killed during ceremonies and festivals, when killed part is usually given to chiefs, used to pay fines, sacrificed by pregnant women (red deer); skin used to make drums, visits farms when quiet, destroys farms
<b>Cows</b>	domestic cow, buffalo*			large bodied, horns, multiple kidneys (buffalo), produce milk	dangerous, wicked, wild, more aggressive than deer, very powerful	moves alone, buffalo urinate through its tail and uses it to attract/ kill prey	domestic cow is commercially good (get from outside the community); buffalo can attract and attack human with poisonous urine; feces poisonous (cause severe itching) makes people run; mostly killed for its tusks; tusks are valuable and used for chiefs regalia; destroys farms; open road in forest
<b>Elephant</b>	elephant		feeds on everything on earth, feeds all the time	largest animal ever seen, tiny eyes (believed to be borrowed from earthworm)	walks day and night, king of the forest, mightiest animal, bulldozer	moves alone; only moves with other elephants	flies squirrel useful to treat burns
<b>Bats</b>	insect bat, fruit bat, flying squirrel	fly up; cannot go down; makes holes in tree and stays in them		like bird but, not like bird; not animal, not bird; have the same wings/ feathers; feeds and defecates by mouth			
<b>Fowl</b>	domestic chicken, black guinea fowl, blue guinea fowl, turaco, hornbill	fly; found in thick forest	feeds on fruits, especially palm; also eat ants; some feed on leaves to replenish their gizzard	feathers, two legs, protruded mouth, lay eggs	make same calls; time keepers (makes call at same time everyday); lay eggs on ground (guinea fowl)		difficult to hunt
<b>Cats</b>	palm civet, golden cat, genet, leopard*	jump from tree to tree (civet and genet)	feed on flesh of other animals		active at night, hide, dangerous, aggressive	resists any association	always far from humans, skin used in traditional regalia; leopard is symbol of authority and strength; totem for Ekpe (leopard) society
<b>Goat</b>	goat		feeds on herbs, grass, cassava by-product, plantain peels				domesticated; used for festivities, sacrifice, and to pay fines
<b>Snail</b>	snail		feeds on sand, leaves, mushroom	shell			mostly consumed by children
<b>Monkeys</b>	guenons (mona monkey, pruess's monkey, red eared monkey, putty nosed monkey, crowned monkey), red colobus monkey, drill monkey, monkey,	live in trees; jumps from tree to tree; climbs; climbs on stick; always go back up (monkeys)/ live in hill and valley (cannot live in ordinary place), live on tree and ground, not fast climbers	feed on fruit, plantain, banana, occasionally worms from soil	resemble humans, long tails (monkeys)	behave like humans: breast feeds; call for their young ones; if male is killed, female will come carry him away (chimpanzee); has wisdom, tastes food before eating it, Powerful (chimpanzees, gorillas, drill monkeys)	love themselves (move together); live with duiker; feeding one trees while they feed below; moves with hornbill who alerts them of danger	stones humans for protection and to threaten them

	chimpanzee, gorilla*	(gorilla, chimpanzee drill monkey)					
<b>Water shrew</b>	water shrew	lives in land and water, always goes back to water	kills animals in water and eats them on land, kills animal on land and eats them in water	has water and land characteristics			
<b>Bushbabies</b>	galagos, potto, angwantibo, otter, mongoose, squirrel*, tree hyrax	lives on rock and comes out to feed (rock hyrax); jumps/moves from tree to tree and enters hole (squirrel, potto); always goes back to water (otter)	feed on palm nuts (squirrel), eats fish (otter), eats flesh (galago)	animals with colors; small but strong; tight grip, and three toes (pottos)	nocturnal doesn't sleep because of big eyes (galago); hygienic animal (hyrax)	snake mocked by squirrel	very strong meat when cooked, eaten by pregnant women to make baby strong, escape easily after being shot (potto/angwantibo); hunters mistake them for other animals because of big eyes (galago)
<b>Fish</b>	fish	live permanently in water	feeds on smaller fish, fruit, termites, worms, loose sand, leaves, water hyacinth				humans extract from water
<b>Pangolins</b>	tree pangolin, long-tailed pangolin	eat on the ground and then enter tree	catch and swallow insects, including termites and ants	scales, long tails	night type and day type, crafty, hides, coil/fold themselves when afraid or sleeping and can fall on the ground	snake easily skilled by cusimanse	very delicious; tongue is medicinal; scales are used for medicine and as soup thickener
<b>Rodents</b>	porcupine*, grass cutter, Gambian pouched rat, cusimanse	live in an anthill (pouched rat); enter hole (pouched rat and cusimanse)	herbivores, feeds mostly on grass, cassava, ripe plantain, ripe palm ants, breadfruit; eats succulent stems instead of leaves	includes animals with strong hairs and spikes	nocturnal, destructive		good taste; destroys crops, especially cassava
<b>Reptiles</b>	African dwarf crocodile*, monitor lizard, python, cobra, tortoise*	inside forest; live in water and land, always go back in water (crocodile, monitor lizard); crawling animals (snakes); moves with house (tortoise)	feeds on frogs and toads (snakes) and fellow snakes (puff adder); feeds on mushrooms (tortoise); eats fish (crocodile and monitor lizard)	scales; poisonous bite (snakes); shell (tortoise)	dangerous; sluggish, cunning, deceitful and a very good politician (tortoise)		taste and color of meat is the same and similar to fish; one hand and leg from monitor lizard used for making medicine; blinds people with saliva (cobra); tortoise shell used to bathe deceased chief; when people eat the deceitful tortoise, they will not shed tears when they cry; snakes blamed for deceiving eve in the garden of eden so God cursed them to have no legs

\* Identified as group leader

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# Grace Lemke

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## Education

**The Pennsylvania State University**  
**Schreyer Honors College**

Eberly College of Science / *Bachelor of Science in Biology*  
College of the Liberal Arts / *Minors in Spanish and Anthropology*

University Park, PA  
May 2022

### **Biology of Ecohealth**

*Study Abroad Student*

Kilimanjaro and Serengeti NP, Tanzania

May 2019

- Experienced Tanzanian ecology, history, and culture, including the Hadza and Maasai
- Learned and discussed principles of Ecohealth and One Health as they relate to local Tanzanian communities
- Researched and wrote a capstone paper on differing attitudes towards vaccinations between Tanzania and the United States

### **Tropical Field Ecology**

*Study Abroad Student*

Osa Peninsula, Costa Rica

Dec 2021-Jan 2022

- Planned and completed three research projects to explore field ecology within Costa Rican ecosystems
- Gave three official research presentations to all professors and students

## Work and Research Experience

### **RISK Lab**

*Research Assistant*

University Park, PA

Mar 2021-Present

(Anthropology, Infectious Disease & Nutrition, Socioecological Systems, and Public Health Linkages)

- Analyze data on rural Nigerian communities' perceptions of wildlife, use of wildlife in traditional medicines, and One Health as it applies to these communities
- Conducted literature review to situate data and analysis in greater discussion of human and wildlife health and ecology
- Anticipated publication of a paper in the Journal of Human Ecology and an Honors Thesis for the Schreyer Honors College on Zootherapy in Cross River, Nigeria

### **Penn State University Libraries**

*Peer Research Consultant*

University Park, PA

Sept 2020-Present

- Serve as a peer tutor and reference assistant for student research projects and papers
- Participate on the Libraries Student Advisory Group to direct library work with student input during monthly meetings
- Researched, curated, and presented an exhibit with Special Collections on women and transgender individuals experiences with healthcare
- Received 2021 Outstanding Student Employee Award for Outreach

*Welcome Desk Attendant*

Jul 2019-Aug 2021

- Greeted and assisted students, staff, faculty, and visitors with library questions
- Created training documentation on transgender & non-binary inclusive customer service

## **Leadership & Volunteer Experience**

### **Schreyer for Women**

University Park, PA

*President, Special Projects Director/Chair*

April 2019-March 2022

- Oversaw the operations and programming of the executive board and general body members
- Represented the organization and communicate with our stakeholders including Schreyer Honors College administration and alumni on a weekly basis
- Planned and facilitated over 12 club meetings and larger Penn State community events including a workshop with the Center for Sexual and Gender Diversity, a screening and discussion of PBS' *The Vote*, and a bi-monthly book club centering stories by women of color

### **Schreyer Career Development Medical Team**

University Park, PA

*Student Leader and Coordinator*

Jan 2020-Present

- Coordinate mentorship program between over 10 Penn State medical students in the American Medical Women's Association (AMWA) and over 25 pre-med undergraduates
- Plan and host monthly events with the AMWA leadership team including a discussion on medical ethics, an interview workshop, and networking sessions
- Organized an information session with Project Horseshoe Farm to introduce undergraduates to their Community Health Fellows program

### **Arts for Health at Penn State**

University Park, PA

*Engagement Post Lead and Founding Member*

Jan 2020-Aug 2021

- Joined 15 other students to create a new Arts for Health initiative to educate on and display the beneficial nature of the arts for human health
- Designed engagement posts for our Instagram blog project

### **Days for Girls at Penn State**

University Park, PA

*Operations Team Volunteer and Educator*

Oct 2019-Sept 2020

- Specialized in sewing reusable menstrual kits for DFG International
- Taught students and community members sewing techniques during 2-hour collaborative sewing events monthly
- Researched and gave a presentation on gender inclusivity in menstrual health advocacy titled "Not All Women Menstruate; Not All Menstruators are Women"
- Earned Days for Girls International Ambassador of Women's Health training certificate