

The Current Conservation Efforts and Future Prospects for the Endangered Nubian Ibex (*Capra nubiana ibex*) in Sudan

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Abstract

A comprehensive action plan for the conservation of the endangered species, the Nubian ibex in Sudan, can be developed by gaining a thorough understanding of their current status, conservation strategy, and relevant laws and regulations, as well as raising awareness about the importance of protecting endangered species. The Nubian ibex is listed as an endangered species on The International Union for Conservation of Nature (IUCN) Red List, highlighting the need for further research on population conservation efforts due to insufficient population data. To address this knowledge gap, a questionnaire was conducted with various stakeholders, including police officers, researchers, and lecturers, representing a diverse range of organizations and universities. The findings revealed that hunting is the primary factor contributing to endangerment. Mammals account for 80% of endangered species, while reptiles comprise less than one-tenth. Research centers are recognized as the main governing body, and 85% of participants are concerned about the declining population. Hunting accounted for less than half of the threats to the ibex population in Sudan, while habitat loss made up a quarter. Mining, climate change, human activity, and agriculture were also identified as risks. However, there were no plans, strategies, procedures, or measures in place to conserve the Nubian ibex. There were also no initiatives to preserve its biodiversity, and awareness about endangered species was lacking. Although participants believed that laws were effective in protecting the ibex, no licenses were issued for its conservation, and annual surveys were not conducted. Additionally, there were no recorded instances of Mukhalfat related to the Nubian ibex. In light of these findings, we propose various conservation meas-

ures to address these challenges. These measures include the implementation of laws and regulations, conducting annual surveys to monitor population trends, protecting habitats, establishing breeding and releasing programs, launching awareness campaigns, undertaking rehabilitation efforts, enhancing research efforts, and developing comprehensive conservation strategies. Additionally, it is crucial to foster cooperation among wildlife institutes to ensure the effective implementation of these conservation measures.

Keywords

Nubian Ibex, Sudan, Endangered Species, Conservation Status, Law, Regulations, Awareness

1. Introduction

1.1. General Overview

Biodiversity encompasses species diversity, genetic composition, and ecosystems, and is crucial for ecosystem services that benefit humanity [1] [2] [3]. Unfortunately, biodiversity is rapidly declining [2], posing a significant risk to people from various socioeconomic backgrounds. Habitat loss harms biodiversity. Human activities like deforestation, urbanization, and agriculture destroy natural habitats, harming many species. Conservation biologists suggest protecting and restoring habitats like forests, wetlands, and grasslands. This requires strong policies, regulations, and collaboration between governments, NGOs, and local communities. Overexploitation of resources is another challenge. Unsustainable practices like hunting, fishing, and harvesting can lead to population declines and extinctions. Conservation biologists stress the need for sustainable resource management, including quotas, season restrictions, and protected areas, to ensure species survival [4]. Conservation scientists stress the importance of socioeconomic factors in biodiversity decline, aiming to create effective policies [5]. This is crucial due to the unprecedented degradation of the biosphere, which undermines human well-being and challenges the conventional development model [2].

Biodiversity conservation involves the protection of the variety and range of species within a particular area, along with the preservation and control of both species and their habitats [6] [7]. However, the preservation of key species within a biodiversity hotspot can act as a measure of the overall success and results of biodiversity conservation initiatives in that specific region, to some extent.

There has been a noticeable decrease in the population of *Capra nubiana ibex* in the Red Sea State in Sudan. This decline can potentially be attributed to various factors, including the threats they face, raising awareness, and implementing effective conservation strategies and legal frameworks. Nevertheless, it is crucial to conduct a thorough investigation into the potential factors that have contributed to the decline of *Capra nubiana ibex* to safeguard the remaining species.

The research endeavors to acquire a deeper understanding of the present conservation endeavors and future possibilities for the Nubian ibex, an endangered species in Sudan. The precise goals encompass the provision of comprehensive insights into the essential elements required for conservation, including awareness, knowledge, framework, plans, and strategies. Furthermore, the integration of law, policy, and perspectives amplifies the efficacy of these institutions.

1.2. Sudan Physical and Biological Description

Sudan, a vast nation spanning 1.8 million/km², lies between latitudes 10°N and 22°N and longitudes 22°E to 38°E. Its topography is mainly gentle plains, with notable features like Jebel Marra, Massif Red Sea Hills, and Nuba Mountains. Average annual temperatures range from 26°C to 32°C. The north is arid and semi-arid, with temperatures around 30°C and rainfall of about 150 mm per year. The central area has a semi-arid and savannah climate, with temperatures around 27°C and rainfall of about 200 mm per year. Rainfall, crucial for agriculture, varies greatly between the north and south of the country [8]. Sudan's ecological composition can be divided into five vegetation zones based on rainfall distribution: desert, semi-desert, low rainfall savannah on clay and sand, high rainfall savannah, and mountain vegetation [9].

1.3. Sudan Wildlife and Endangered Species

Sudan possesses a diverse and expansive range of ecosystems, including deserts, mountains, grass savannahs, and marine and inland waters. These ecosystems are home to abundant and varied wildlife, including globally significant and endangered species. Protected areas in Sudan house numerous endemic species, as identified by the International Union for Conservation of Nature [10].

Sudan's remarkable biodiversity is evident through its representation of mammalian orders, as it encompasses 12 out of the 13 mammalian orders found in Africa [11]. The subsequent account provides a comprehensive overview of the biodiversity present in Southern Sudan, categorized according to ecological zones. The data sources utilized for this description include the Post-Conflict Environmental Assessment of Sudan (PCEA) [11].

In 2011, Sudan had 12 wildlife orders, including buffalo, lion, roan antelope, and elands in Dinder and Radom National Parks. Hippos are now scarce, with only three remaining south of Alrosseries Dam. Elephants migrate seasonally, with a small herd in Dinder and a larger one in Radom. Wildlife occurs in protected areas and fragmented habitats, including various ecosystems like deserts, woodland, and marine environments. Unfortunately, many species have declined or disappeared from their habitats. Species like red-fronted gazelles, Dama gazelles, Barbary sheep, Nubian ibex, and lions are critically endangered. Sudan's ecosystem has also suffered significant losses, including flooded grasslands, mountain vegetation, and equatorial forests, along with flagship species like rhinos, okapis, chimpanzees, zebras, and various gazelles. These losses oc-

curred after the separation of South Sudan [8]. The Nubian ibex and klipspringer can be found in the Red Sea hills. The Barbary sheep inhabit the mountains of Northern Darfur. The greater kudu can still be found in Jebel Mara, Jebel El Dair, and some Nuba mountains. There have been reports of 71 species of mammals and reptiles, including one critically endangered species. Three species are critically endangered globally, and four species are extinct locally. There is also wildlife ex-situ, primarily Dorcas gazelle (*Gazella dorcas*), in 22 farms. The region also boasts 51 species of reptiles [8].

1.4. Sudan Nubian Ibex

Once widely distributed in the mountainous regions of northeastern Africa and the Middle East, the *Capra nubiana ibex* is now primarily found East of the Nile in Egypt, in the northeast of Sudan, in northern Ethiopia, Western Eritrea, West Jordan, and in scattered locations of western and central Saudi Arabia, Yemen, and southern Oman [12] [13]. However, it is important to note that the species is extinct in Lebanon and Syria [14]. In Sudan, the *Capra nubiana ibex* exists in small isolated populations in various locations within the Red Sea hills [15]. According to [14], the *Capra nubiana ibex* were previously documented to inhabit three protected regions situated along the Red Sea shoreline, namely the Erkawit and Sinkat Sanctuaries, as well as the Tokar Game Reserve. Additionally, these animals were also found in the northernmost area of the region, near the border with Egypt. The exact number of ibexes remaining in Sudan is uncertain, but reports suggest that it is unlikely to exceed a few hundred in the Red Sea Hills [16]. Although some data is available in reports from the Wildlife Research Center (WRC) and Wildlife Conservation General Administration (WCGA), a significant amount remains unpublished. Despite successful survey efforts and interest in the species, there is no comprehensive report on its distribution and status. An update is necessary for future conservation plans and strategies on a continental scale due to increasing concerns about its conservation.

1.5. Sudan Wildlife Law, Policies, and Regulations

The NCS wildlife conservation strategy in Sudan places a high priority on the preservation of habitats, implementation of economic policies, fostering regional cooperation, and establishment of nature reserves and national parks, which collectively cover a significant portion of the country's land area. The strategy also emphasizes the importance of research and development in the field of conservation, advocating for an integrated approach that balances conservation efforts with sustainable use of natural resources. To effectively manage and safeguard biodiversity, particularly species facing threats, it is imperative to monitor key components of biodiversity. Additionally, it is crucial to identify and monitor activities that pose a risk to the environment, such as deforestation and unplanned grazing. The organization and maintenance of data are essential for the sustainable management of natural resources, and it is recommended that

the United Nations Convention on Biological Diversity (UNCBD) align its activities with the management of nature reserves. The Hunting Protection Act currently grants wildlife officers the authority to investigate and scrutinize any unlawful hunting practices, which is advantageous for the general public. Nevertheless, this law does not align with international agreements, and therefore, there is a necessity to revise the Wildlife Conservation Acts to tackle the obstacles that impede sustainable wildlife management [17]. Protected areas in Sudan are off-limits without authorization under the Wildlife Act of 1987 and New Sudan Wildlife Provisions of 2003. Each area has a Wildlife Force to enforce these rules. No development is allowed in any protected area, except for access roads and housing for wildlife personnel [17]. Since 1902, Sudan has enacted forest and wildlife legislation and established an environmental committee in 1972, which came into fruition in 1977. Sudan has signed and ratified over eight conventions, including the Kyoto Protocol, Cartagena Protocol on Biosafety, and Stockholm Convention on Persistent Organic Pollutants. Sudan actively participates in global environmental conferences and has pledged to advance the Green Economy at Rio + 20. Sudan has ratified the Paris Agreement and produces reports on climate change. As a party to numerous international and regional agreements, Sudan effectively manages its natural resources, including the United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on Biological Diversity (UNCBD), Ramsar Convention, and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These agreements serve as guiding principles for Sudan's management practices and contribute to global environmental conservation efforts [18].

1.6. Wildlife Institutes Roles and Responsibilities

The Higher Council for Environment and Natural Resources (HCENR), a government entity in Sudan, is responsible for protecting the environment and developing sustainable resources. It coordinates environmental affairs and resource management at federal and state levels, led by the Prime Minister. The HCENR's main goals are to create policies, conservation plan, and enforce environmental laws. It also promotes international cooperation and participation in global environmental conventions. The Ministry of Tourism and Wildlife, responsible for overseeing various aspects of wildlife affairs in Sudan, assumes a pivotal role in the administration of marine protected areas and national parks. In addition to its regulatory function, the ministry also governs the utilization of national parks by pastoralists. The responsibilities of the Wildlife Forces encompass safeguarding, maintaining, and managing the wildlife and environment, as well as detecting, apprehending, and prosecuting poachers. Additionally, they are tasked with ensuring the safety of clients, visitors, and tourists, and holding custody of exhibits on behalf of the Secretariat. The objectives and Mandates of the Wildlife Research Center are to Conduct wildlife surveys and explore new sites for relocation and protection, to Monitor and protect wildlife populations according to

designated schedules, to Conduct research to conserve natural environments in protected areas, to Promote environmental awareness and the importance of wildlife conservation, to Integrate scientific research in resource management, to Discover the potential contributions of wildlife to enrich human life, and to Encourage investment and tourism in wildlife.

2. Methods

2.1. Questionnaire

A questionnaire was developed to gather information on the status, conservation strategy, and laws and regulations surrounding the Nubian Ibex in Sudan (**Supplementary file 1**). The target audience included Wildlife Research Centers, researchers, assistant researchers, and lecturers from University of Khartoum and University of Bahri, as well as police officers from the Wildlife Conservation General Administration in Khartoum, and Red Sea State in Port Sudan. Respondents affiliated with the Wildlife Conservation General Administration represented 50% of the sample, while 10% were research assistants and researchers from the Wildlife Research Center, and 9% were university lecturers. Educational attainment was also analyzed, with 54.50% of respondents holding a university degree and 45.50% completing post-graduate studies. These findings are presented in **Supplementary file 2, Figure S1** and **Figure S2**.

2.2. Data Analysis

Data was gathered from police officers, researchers, and lecturers, encompassing a diverse range of organizations and universities. A set of 100 questionnaires was disseminated, and the collected data underwent analysis utilizing statistical software, namely MS Excel 2010 and SPSS. The analysis of the collected data involved determining the frequency in percentage (%) to derive fundamental statistical measures and figures.

3. Results

3.1. Endangered Species Assessment

Feedback from Institutions Assessing Endangered species—Nubian ibex in Sudan regarding the potential extinction of endangered species, revealed that over half of respondents expressed high concern for potential extinction, while less than half expressed moderate concern **Figure 1**. Few respondents were unfamiliar with endangered species, with one-third denying knowledge and less than half having limited understanding **Supplementary file 2, Figure S3**. Hunting was identified as the primary factor contributing to endangerment by one-third of respondents, with habitat loss, climate change, disease, and other reasons cited less frequently in **Figure 2**. Mammals accounted for 80% of endangered species, while reptiles were less than one-tenth, Interestingly, no endangered species of amphibians were reported in **Figure 3**. In this investigation, participants were tasked with identifying the authority responsible for determining the

endangered status of animals. Results showed that around 25% recognized research centers as the primary governing body and scientific authority. The Wildlife Conservation General Administration accounted for less than 25% of responses as management authority, while conservation societies made up less than 20%. Over 17% identified universities, and an equal percentage believed all of these entities collectively hold this responsibility **Figure 4**. The study asked participants to rank methods of helping endangered species. These methods included donating to NGOs, implementing conservation strategies, buying endangered species as pets, and other approaches like supporting government institutions, establishing zoos, raising awareness, breeding, and supporting wildlife research centers **Supplementary file 2, Figure S4**. Participants were surveyed to measure their willingness to allocate time and money to conserve endangered species. The results showed that a majority of participants were highly willing to contribute, with over half expressing this level of willingness. Additionally, more than one-third of participants indicated their willingness to contribute, while just over one-tenth had no intention to do so. These findings are shown in **Supplementary file 2, Figure S5**.

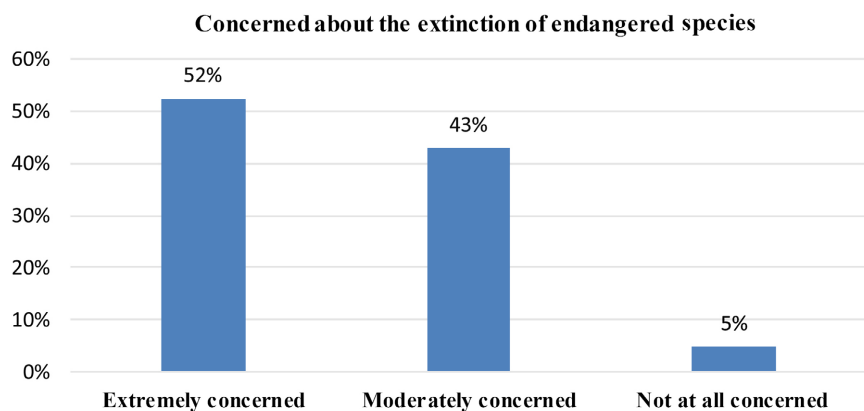


Figure 1. The number of respondents who are worried about endangered species becoming extinct.

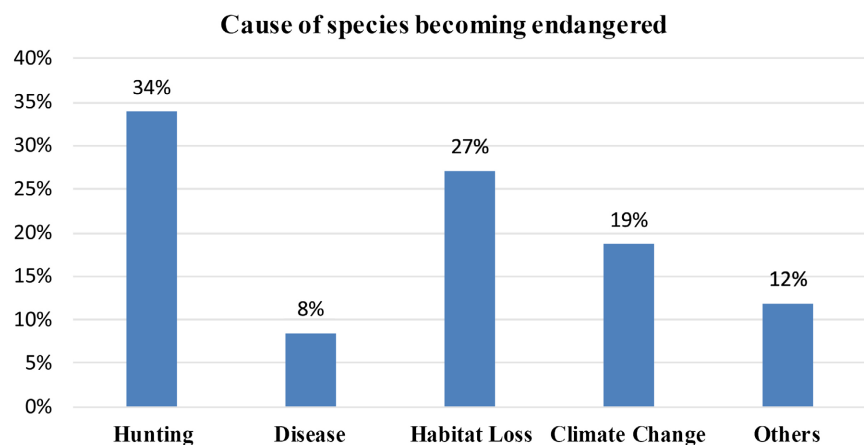


Figure 2. The main causes of species endangerment in Sudan.

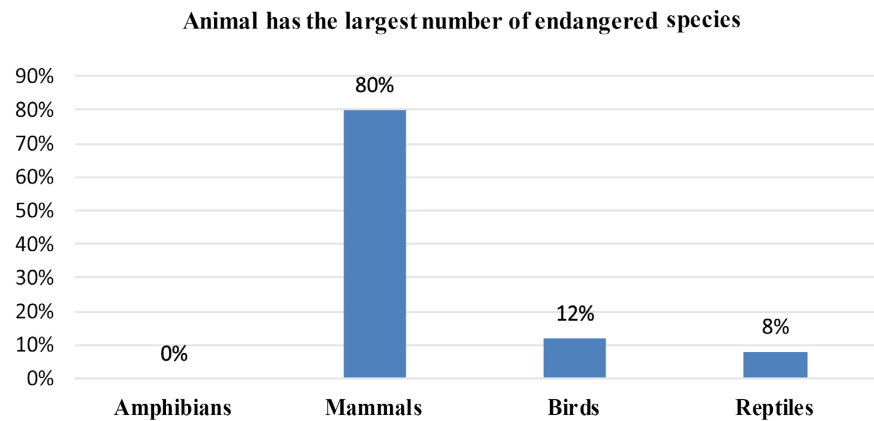


Figure 3. Shows the taxonomic groups with the most endangered species in Sudan.

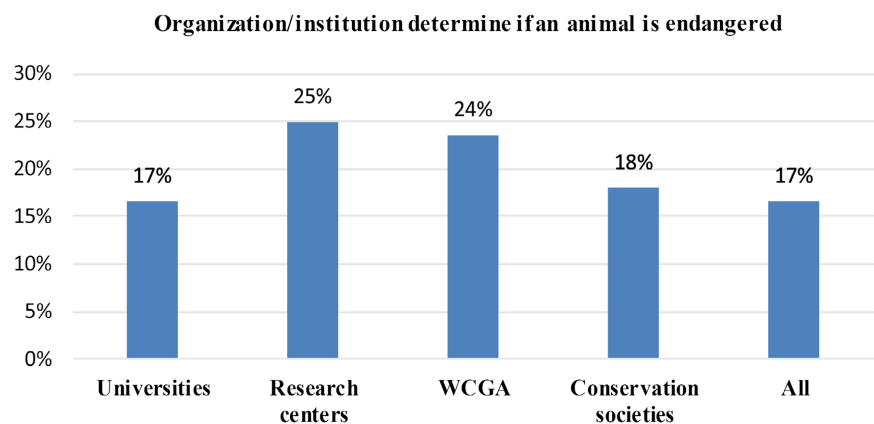


Figure 4. Illustrates how an organization/institution assesses an animal species as endangered.

3.2. Nubian Ibex Status

When inquired about their previous encounters with Nubian ibex, it was discovered that Over 60% of participants had not observed Nubian ibex before, while less than 40% had refer to **Supplementary file 2, Figure S6(a)**. Observations were made in various locations, including South Arkaute, Algurashi Zoo, Al Aqaba, Kuku Zoo, Arbaat Dam, Kassala State, Red Sea, and the area between Egypt and Sudan. Additionally, the participants were questioned about the timing of their most recent observation of the species, Half of the participants had observed Nubian ibex more than 5 years ago, while an equal number had observed them within the past year and 2 - 3 years ago **Supplementary file 2, Figure S6(b)**. Regarding the distribution of observations based on gender, less than half of the observations were unspecified, with a quarter identified as male and female, and the rest as young Nubian ibex refer to **Supplementary file 2, Figure S6(c)**. These observations were made in the same locations mentioned earlier, including South Arkaute, Algurashi Zoo, Al Aqaba, Arbaat Dam, Kuku Zoo, Kassala, Red Sea, and the area between Sudan and Egypt. A majority of over 65% of the respondents believed that Nubian ibex can be found in animal zoos, with

Kuku Zoo being a popular location. Some claimed to have seen one or two at the zoo, while others denied their presence. 13 respondents stated observation as the primary motive for keeping them in captivity. Less than 35% believed they don't exist in zoos. See **Figure 5**, According to the study on Nubian ibex in Sudan, 85% of respondents are concerned about the declining population, while the rest believe it is stable. **Figure 6** shows no reported increase in population numbers. The conservation measures proposed by the participants encompassed a diverse range of approaches. A notable proportion, including laws and regulations (16%), annual surveys (14%), habitat protection, breeding and releasing programs, and awareness campaigns (11%), rehabilitation initiatives (<10%), research and comprehensive strategies (<8%), habitat conservation and research augmentation (5%), and collaboration among wildlife institutes (2%). See **Figure 7** for more information. During the investigation, participants were asked about the main dangers to Sudan's ibex population. Results showed hunting was less than half the threat, while habitat loss made up a quarter. Mining was a threat to over 10%, and climate change to less than 10%. The rest identified human activity and agriculture as threats see **Figure 8**.

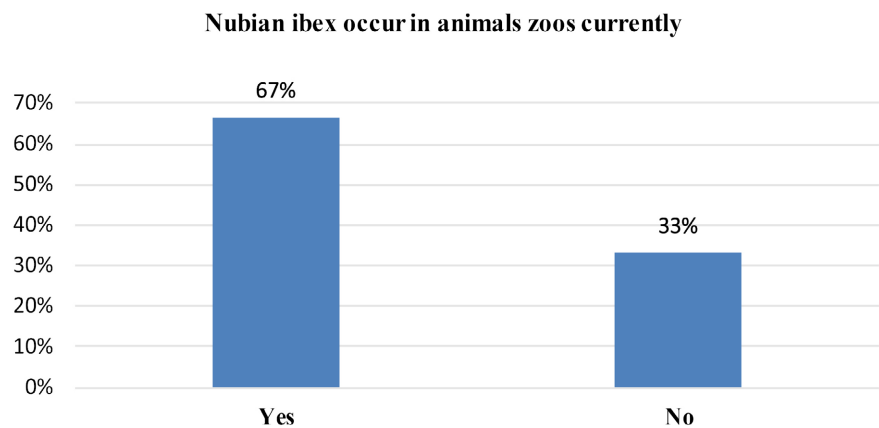


Figure 5. Shows Nubian ibex in current and past zoos.

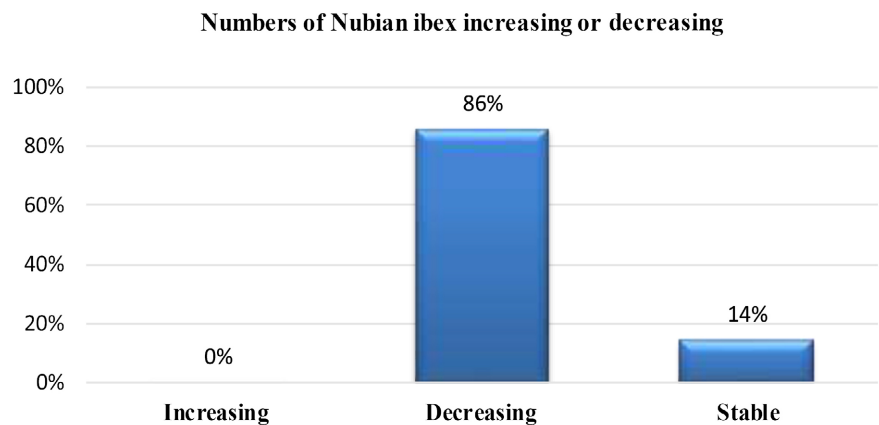


Figure 6. Shows the trend in the Nubian ibex population, indicating if it is increasing or decreasing.

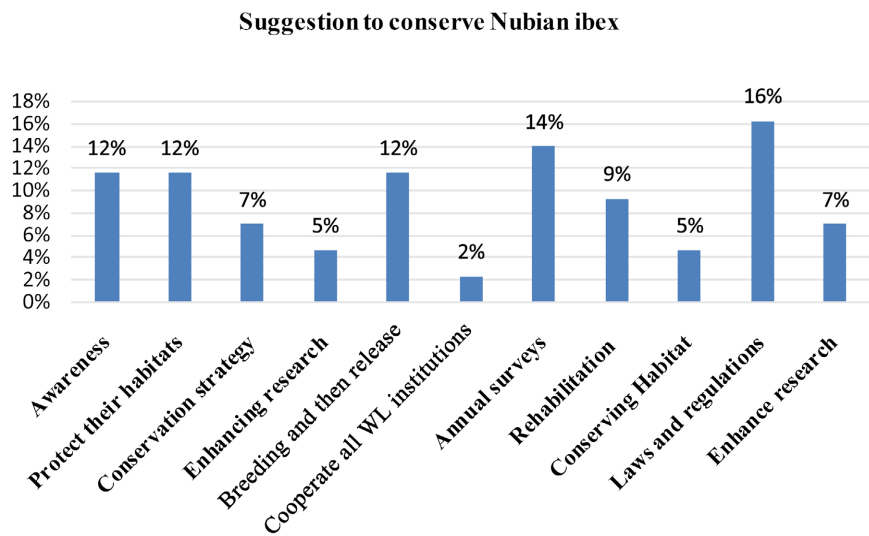


Figure 7. Proposes a conservation strategy for Nubian ibex in Sudan.

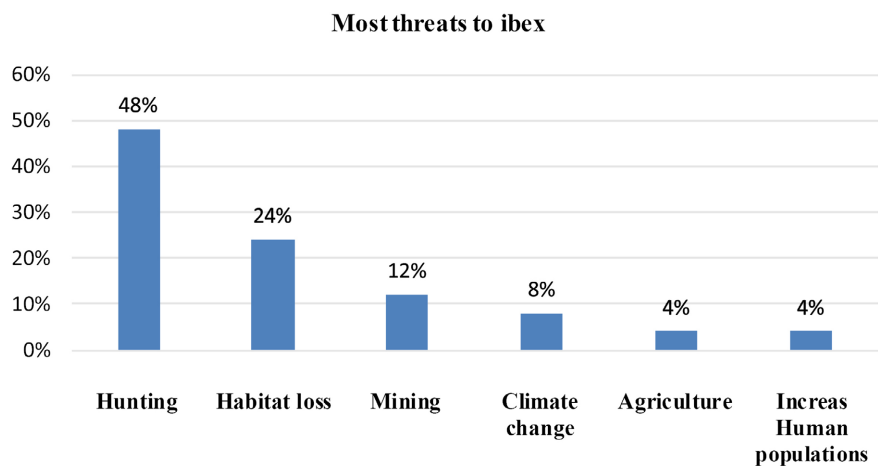


Figure 8. Shows the main threats to Sudan's ibex population.

3.3. Conservation Strategy

In regards to the potential implementation of a conservation strategy for all endangered species in Sudan, a mere fraction of the participants, specifically less than 10%, provided an affirmative response. Conversely, over 45% disagreed, less than 10% partially agreed, and less than 15% were uncertain see **Supplementary file 2, Figure S7**. All participants were asked about plans or strategies for conserving Nubian ibex in Sudan. They confirmed that there were no such plans or strategies, resulting in a 100% non-availability rate **Figure 9**. Similarly, when asked about procedures or measures for conserving the Nubian ibex, all participants reported their unavailability to see **Supplementary file 2, Figure S8**. During the inquiry, all individuals were asked about efforts to preserve the Nubian ibex's biodiversity. The results showed that every participant reported no such initiatives. **Figure 10** also confirms that none of the respondents reported any positive occurrences.

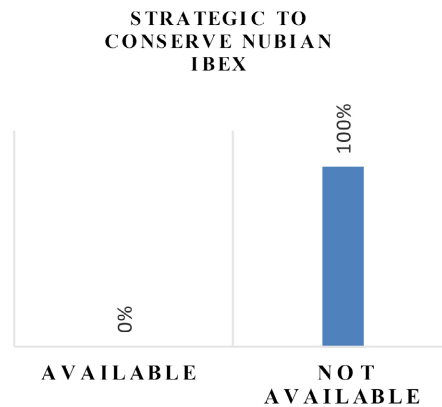


Figure 9. Shows there is a conservation plan for Nubian ibex in Sudan.

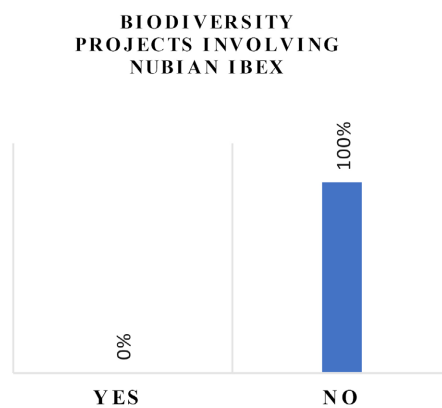


Figure 10. Shows the inquiry on biodiversity initiatives for Nubian ibex.

3.4. Law and Regulations, Awareness of Endangered Species

When investigating awareness of endangered species in Sudan. The findings revealed that less than 10% of respondents recognized their importance, while most lacked awareness. Some mentioned increased awareness due to events in 2015. Over one-third believed laws had no impact on Nubian ibex protection, while over two-thirds believed they were effective. All respondents agreed no licenses were issued for Nubian Ibex and Sudan did not conduct annual surveys. In the investigation of the Nubian ibex in the Arbaat Dam area in 2017, the majority of respondents believed there were no recorded instances of Mukhalfat related to the Nubian ibex, while less than 5% believed such Mukhalfat did exist. These findings are detailed in **Supplementary file 2, Figures S9-S13.**

4. Discussion

Our findings on the assessment of endangered species in Sudan, show that over 50% of participants are concerned about extinction. This aligns with previous studies by [19] [20], which suggest that the number of species on Earth may be underestimated. Unfortunately, many respondents showed little knowledge of endangered species, with one-third denying any knowledge and less than half having limited understanding. One-third of respondents identified hunting as

the primary factor contributing to endangerment, while habitat loss, climate change, disease, and other factors were mentioned less. Mammals made up 80% of endangered species, with reptiles accounting for less than one-tenth. No endangered amphibians were found. It is worth noting that species with low population density are highly susceptible to the impacts of hunting, as they have a high probability of extirpation due to their small numbers. Recent studies have examined the combined effects of habitat loss and hunting, both at regional and pantropical scales [21] [22], revealing that tropical mammals have lost approximately 40% of their distribution as a result of these combined factors [23].

Participants identified the governing body responsible for determining endangered animal status. 25% recognized research centers as the primary scientific authority. Less than 25% identified the Wildlife Conservation General Administration and CITES Roles and tasks. The Scientific Authority identified specimens and determined national status, while the Management Authority communicated with the CITES Secretariat and granted permits and certificates. Most participants were eager to contribute, with over half showing enthusiasm. Additionally, more than a third expressed willingness to contribute. The study surveyed effective methods for assisting endangered species, including donating, implementing strategies, purchasing pets, and supporting institutions. As reported by [24] Recommended programs can come from various entities and should include both focused projects and a comprehensive approach. Saving one species without addressing habitat destruction is limited, and preserving habitats is insufficient without addressing climate change.

Over 60% of the participants had no prior encounters with Nubian ibex. Encounters were reported in various locations, with half of participants observing the species over 5 years ago. Results suggest the species' status and distribution align with previous studies [14] [15]. Less than half of the observations in the mentioned locations were unspecified in terms of gender. The variation in these observations is due to the social behavior of Nubian ibexes. Typically, herds consist of females, young individuals, and males up to three years old. However, males can also be solitary or form temporary groups of up to eight individuals. During the breeding season, males join female-dominated herds for six to eight weeks. Large males engage in battles, often involving horn clashes [25]. The investigation revealed that hunting was the main threat to Sudan's ibex population, accounting for less than half of the danger. Habitat loss made up a quarter, while mining and climate change posed a threat to a certain and smaller percentage, respectively. Human activity and agriculture were also identified as dangers. Previous research classified the Nubian ibex as "vulnerable" due to declining population and threats such as competition with livestock, hunting pressure, and habitat destruction [14]. Participants proposed conservation measures such as implementing laws, conducting surveys, safeguarding habitats, and raising awareness through campaigns. [26] emphasized the need for additional efforts beyond protected areas. Wildlife conservation is a collective endeavor, with each individual playing a crucial role in safeguarding wild animals and their habitats

for future generations.

The implementation of a conservation strategy for endangered species in Sudan has received a negative response from a majority of participants. Almost half disagreed, indicating a lack of plans or strategies. All participants also reported a lack of procedures for conserving the Nubian ibex. When asked about their efforts to preserve the ibex's biodiversity, none reported any positive occurrences. These findings contrast with Sudan's NCS wildlife conservation strategy, which prioritizes habitat preservation, economic policies, regional cooperation, and nature reserves. The strategy emphasizes an integrated approach to conservation and sustainable use of natural resources, with monitoring biodiversity and identifying environmental risks being crucial for effective management.

The Sudan investigation found that many participants lacked awareness of the Nubian ibex and believed laws had no impact on its protection. However, most had faith in these laws and didn't know of any Mukhalfat cases. No licenses were granted for the ibex, and surveys were limited. Sudan is a signatory to resource management agreements, but wildlife law enforcement is uncertain. The Wildlife Conservation General Administration and National Parks Act work to protect wildlife and parks.

The survey results have certain limitations as the Ministry of Finance and National Economy, Ministry of Environment, Ministry of Petroleum and Companies, and HCENR were not included in the survey. Additionally, the number of respondents was limited and the data was analyzed simply, providing only a surface-level understanding of the perspectives.

5. Conclusions

Hunting poses a significant threat to the population of the Nubian ibex, leading to its endangerment. Mammals, including the Nubian ibex, make up a large portion of endangered species, accounting for 80% of the total. In contrast, reptiles face a lower risk, making up less than one-tenth of endangered species. Research centers are the main governing body recognized for addressing the issue of the Nubian ibex's endangerment. These centers play a crucial role in studying and understanding the declining population of the ibex. A majority of participants, 85%, express concern over the decreasing numbers of the Nubian ibex.

In Sudan, hunting contributes to less than half of the threats faced by the ibex, while habitat loss constitutes a quarter. Other risks identified include mining, climate change, human activity, and agriculture. These factors collectively contribute to the endangerment of the Nubian ibex. Unfortunately, there are no existing plans, strategies, procedures, or measures in place to conserve the Nubian ibex. This lack of conservation efforts is concerning as it leaves the species vulnerable to further decline. Additionally, there is a lack of initiatives aimed at preserving the biodiversity of the Nubian ibex and raising awareness about endangered species. Although participants believe that laws are effective in protecting the ibex, there have been no licenses issued for its conservation, and an-

nual surveys are not conducted. This lack of action and monitoring further worsens the challenges faced by the Nubian ibex. Furthermore, there have been no recorded instances of Mukhalfat with the Nubian ibex. Mukhalfat refers to the traditional practice of protecting and conserving natural resources in Sudan. The absence of Mukhalfat in relation to the Nubian ibex highlights the need for increased efforts and initiatives to preserve this endangered species.

In conclusion, the primary cause of the Nubian ibex's endangerment is hunting.

6. Recommendations

In light of these discoveries, we propose a range of conservation measures to address these challenges. These measures involve implementing laws and regulations to safeguard endangered species and their habitats. By enforcing strict legislation, we can ensure that activities such as hunting, poaching, and habitat destruction are prohibited, and those who violate these laws are held accountable.

Conducting annual surveys to monitor population trends is crucial for understanding the status of endangered species. By regularly tracking their numbers, we can identify any decline or recovery and adjust conservation efforts accordingly. These surveys can also help us identify the primary threats to their survival, enabling us to prioritize conservation actions.

Preserving habitats is another essential measure. Many endangered species depend on specific habitats, such as forests, wetlands, or coral reefs, for their survival. By establishing protected areas and implementing sustainable land-use practices, we can conserve these habitats and ensure the long-term survival of the species that depend on them.

Implementing programs for breeding and reintroducing endangered species into the wild is a vital conservation measure. Captive breeding programs can help increase the population size of endangered species and provide individuals for reintroduction efforts. By carefully selecting individuals for breeding and releasing them into suitable habitats, we can enhance their chances of survival and promote population growth.

Initiation awareness campaigns are crucial to engage the public and raise awareness about the importance of conservation. By educating people about the threats faced by endangered species and the actions they can take to help, we can foster a sense of responsibility and encourage behavior change. Awareness campaigns can include educational programs, public events, and media campaigns to reach a wide audience.

Undertaking rehabilitation efforts is necessary for species that have been impacted by human activities or natural disasters.

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Conflicts of Interest

The authors declare no conflicts of interest the publications of this paper.

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Supplementary File 1

The Questioners Presented for Institutions to Assessing Nubian ibex status in Sudan.

Q.1 How concerned is you about the extinction of endangered species?

- a) Extremely concerned
- b) Moderately concerned
- c) Not at all concerned

Q.2 How much do you know about endangered species?

- a) Yes
- b) No
- c) A little bit

Q.3 what is the largest cause of species becoming endangered in Sudan?

- a) Hunting
- b) Disease
- c) Habitat Loss
- d) Climate Change
- e) Others

Q.4 what type of animal has the largest number of endangered species in Sudan?

- a) Amphibians
- b) Mammals
- c) Birds
- d) Reptiles

Q.5 What organization/institution determine if an animal is endangered?

- a) Universities
- b) Research centers
- c) WCGA
- d) Conservation societies
- e) All

Q.6 Rank these methods of helping endangered species from most effective (1) to least effective (5)

	1	2	3
Donating to an NGO			
Conservation strategy			
Buying endangered species as pets			

Others

Q.7 How willing would you be to donate time and money to help protect endangered species?

- a) Extremely Willing

- b) Willing
- c) No chance

Q.8 Have you ever observed Nubian ibex?

- a) Yes
- b) No
- c) if yes where
- d) Last observation of species was before (when)
 - 1) Last year
 - 2) Before 2 - 3 years
 - 3) More than 5 years

e) 1. Numbers () 2. Male () 3. Females () 4. Young () 5. Where

Q.9 Are all endangered species in Sudan subject to conservation strategy?

- a) Yes
- b) No
- c) Most
- d) Not sure

Q.10 Are there plans or strategic to conserve Nubian ibex in Sudan? If so please provide details and can you supply a link to the documents? Or attached?

- a) Available
- b) Not Available

Q.11 What are the processes/steps to conserve Nubian ibex?

- a) Available
- b) Not Available

Q.12 Are there any examples of large scale biodiversity projects involving Nubian ibex?

- a) Yes
- b) No
- c) Please provide details of examples (if any)
 - 1) Available
 - 2) Not Available

Q.13 What are most threats to ibex in Sudan?

- a)
- b)
- c)
- d)

Q.14 Awareness of Importance of endangered species

- a) Yes
- b) No
 - 1) If yes when
 - 2) Organizers

Q.15 Do you think Laws and Regulations are affected to protect Nubian ibex?

a) Yes

b) No

Q.16 Are there licenses issued related to Nubian Ibex in Sudan

a) Yes

b) No

a.1) If yes; No of licenses annually

Q.17 Are any annual national surveys of endangered species? If so please can you list or attach details

a) Yes

b) No

Q.18 Area there MUKHALFAT recorded related to Nubian ibex in Sudan

a) Yes

b) No

If yes No of MUKHALFAT

1) Types

2) Place

3) Year

4) More details

Q.19 Do you think Nubian Ibex occur in animals zoos currently or previously

a) Yes

b) No

If yes mention the name of zoo

Number of Nubian ibex

c) Purpose

Q.20 Do you think the numbers of Nubian ibex increasing or decreasing?

a) Increasing

b) Decreasing

c) Stable

Q.21 What is your suggestion to conserve Nubian ibex in Sudan?

Name:

Q.22 Level of education

a) Secondary

b) University

c) Post graduated

Q.23 Position

Note: You can supplement materials (weblinks, hardcopies, soft copies etc.) or any further comments you would like to add.

Supplementary File 2

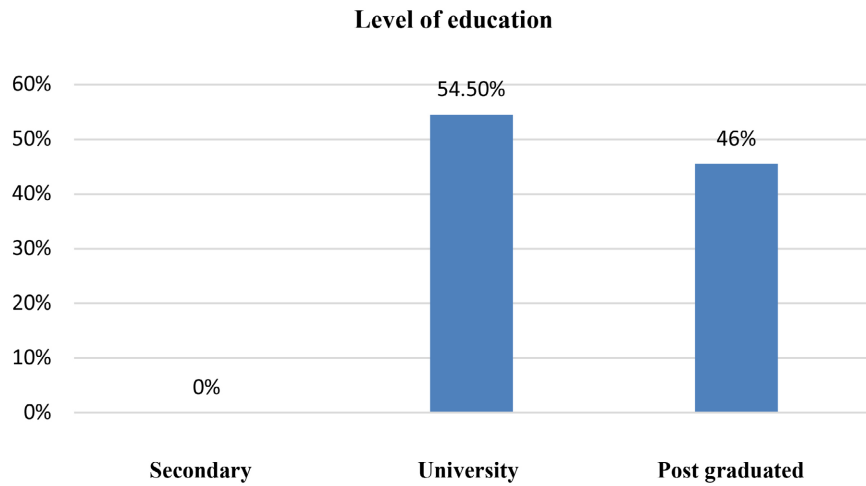


Figure S1. Shows the education levels achieved by individuals.

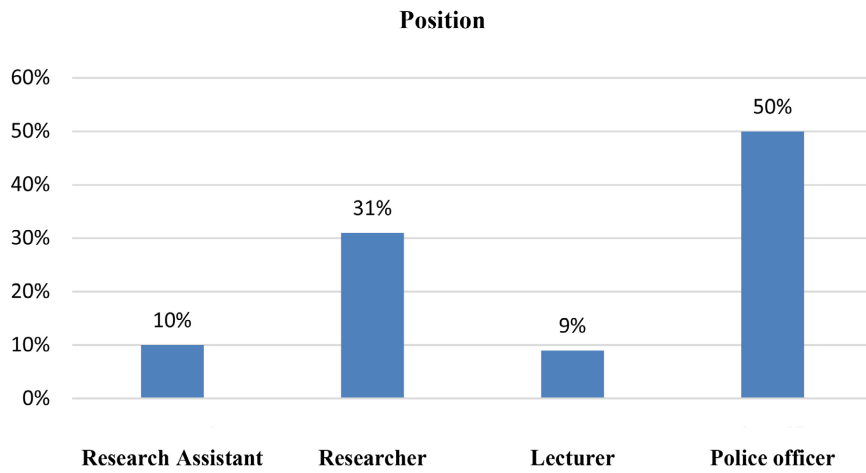


Figure S2. Shows the individual positioning of the respondents.

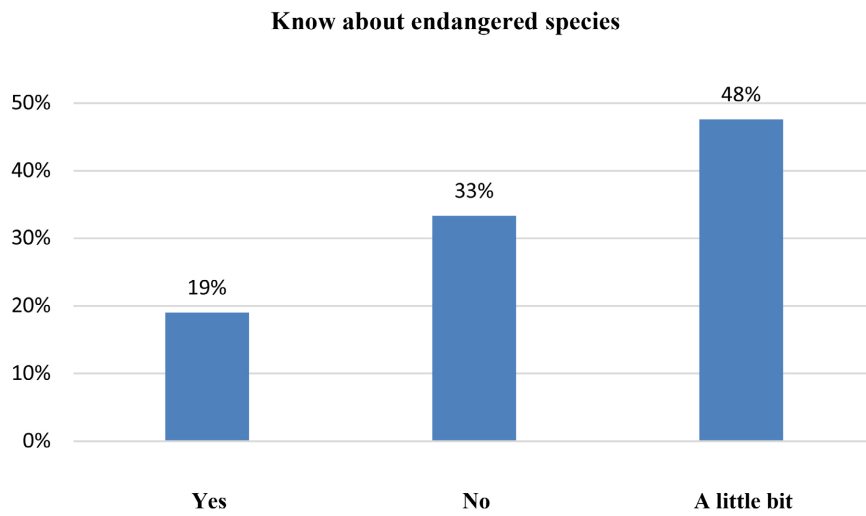


Figure S3. Shows individuals' knowledge of endangered species.

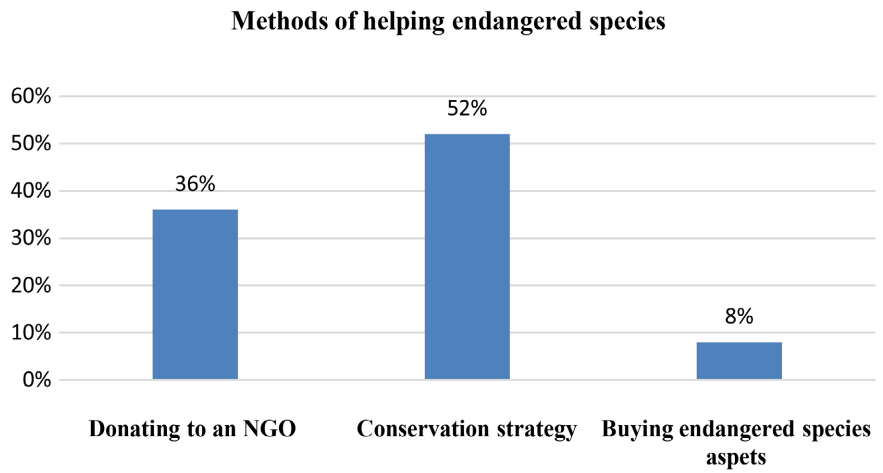


Figure S4. The methods used to aid endangered species.

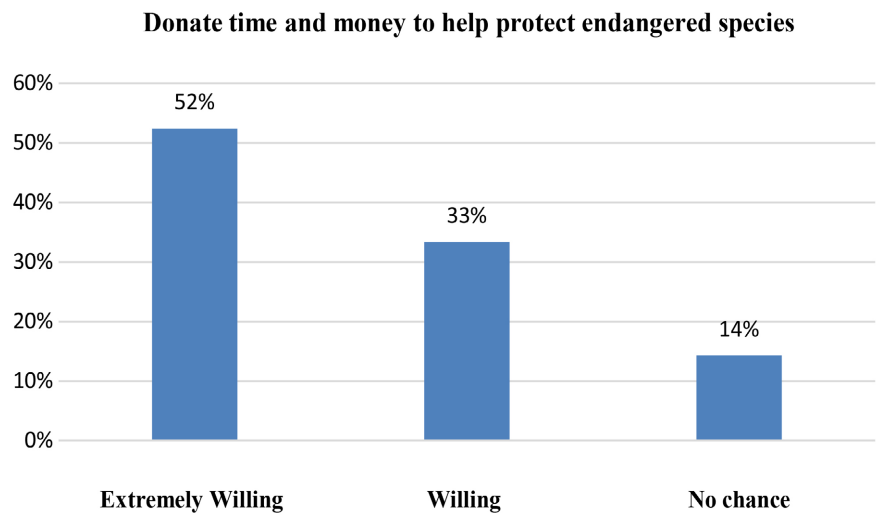
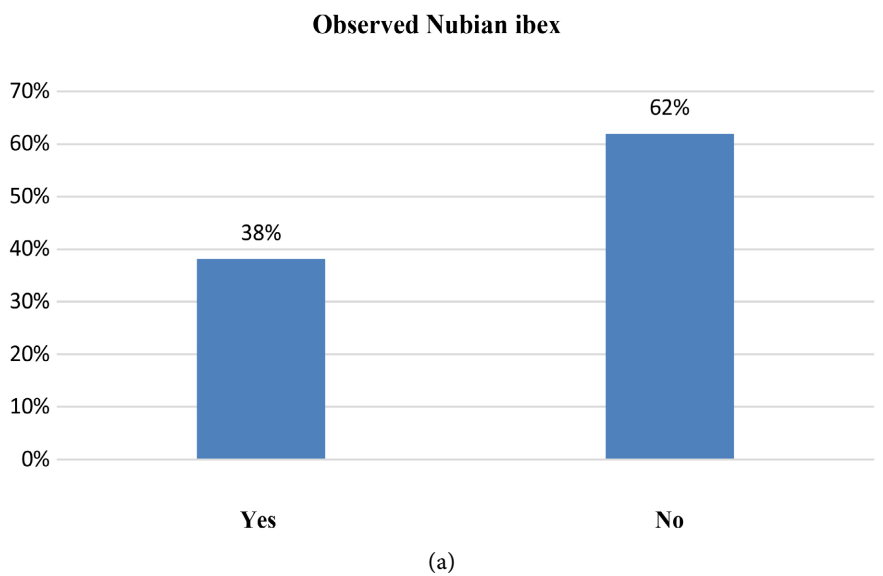


Figure S5. Shows people’s willingness to donate time and money to help endangered species.



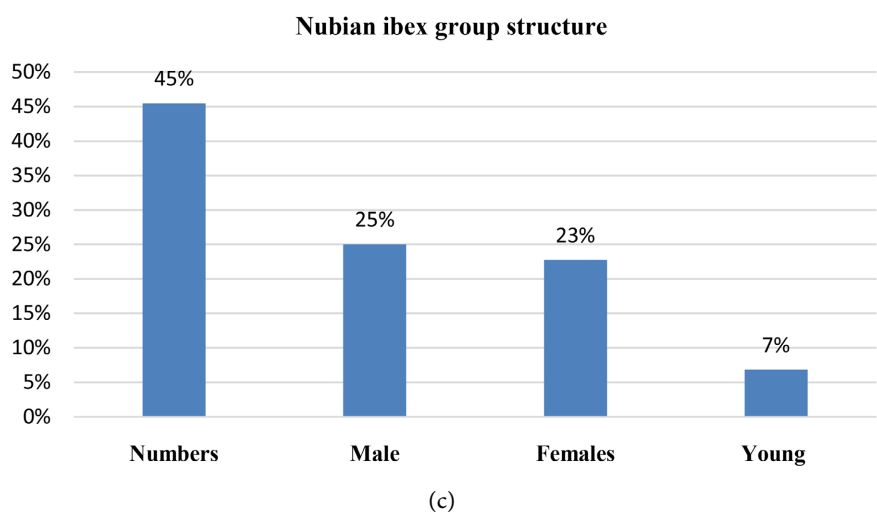
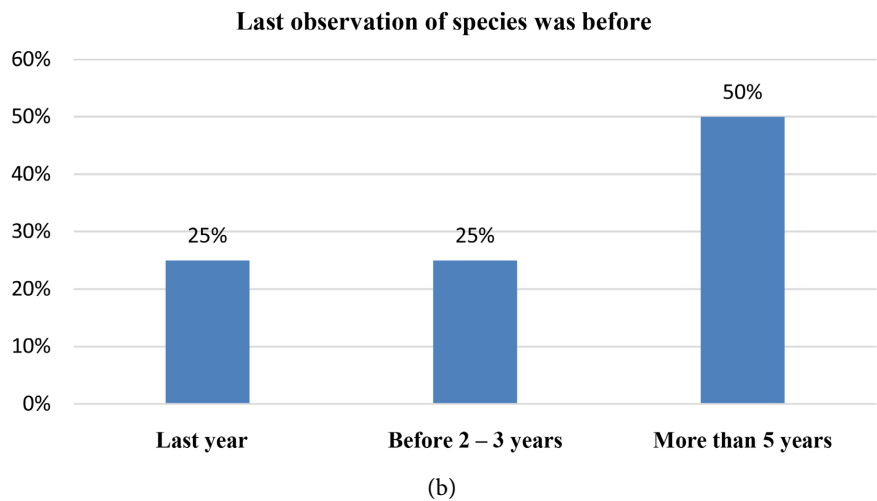


Figure S6. (a) Shows the observed Nubian ibex; (b) Shows the latest recorded observation of the Nubian ibex before now; (c) Illustrates the specific identification of the Nubian ibex group structure.

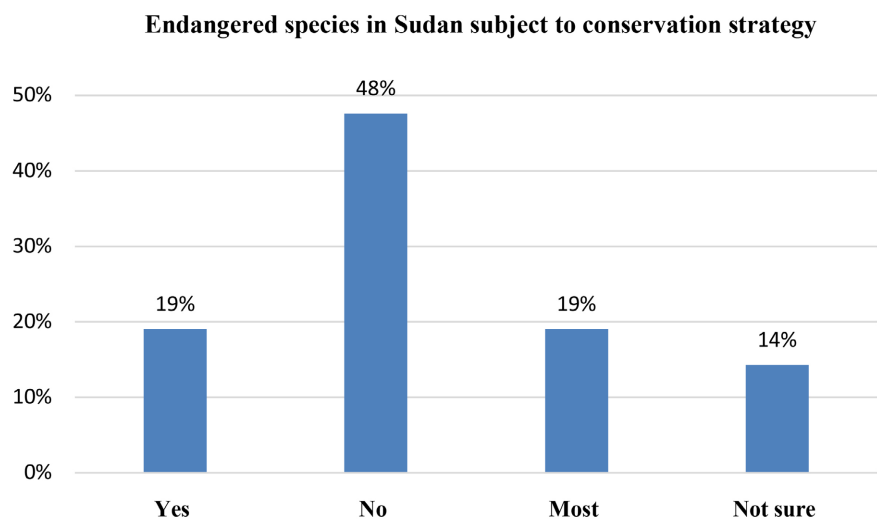


Figure S7. Shows if all endangered species in Sudan have a conservation strategy.

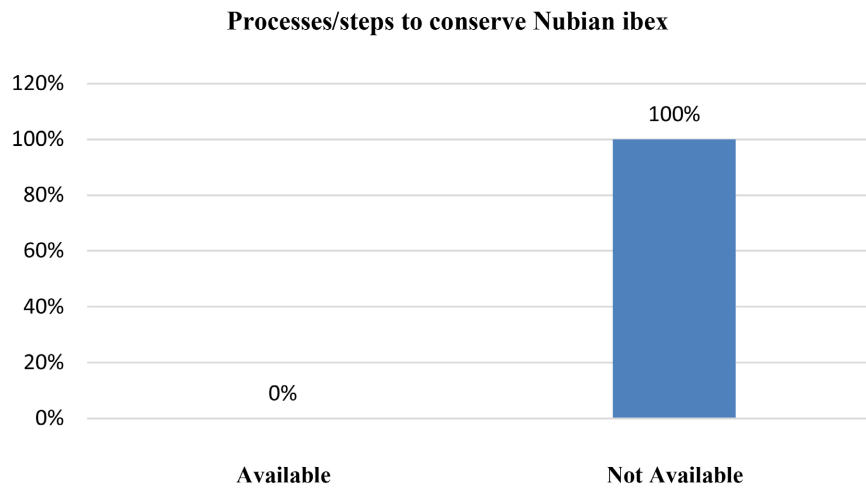


Figure S8. Shows the steps in conserving the Nubian ibex.

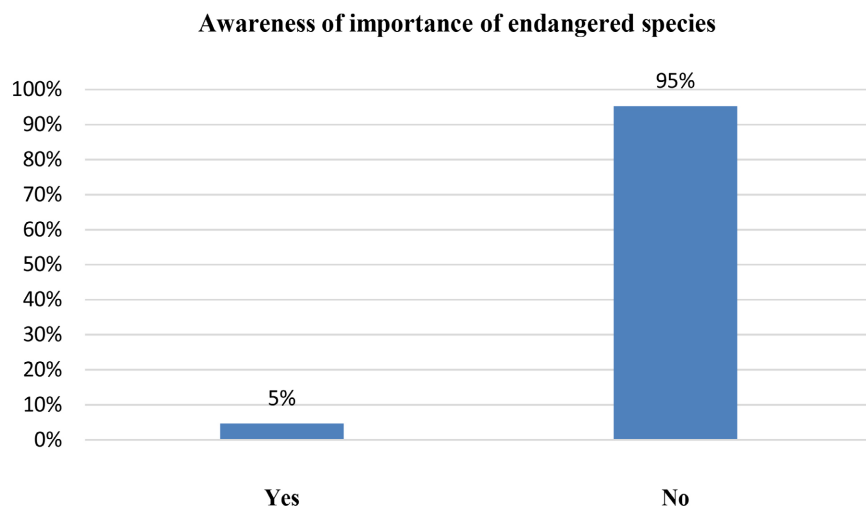


Figure S9. Shows the recognition of the significance of endangered species.

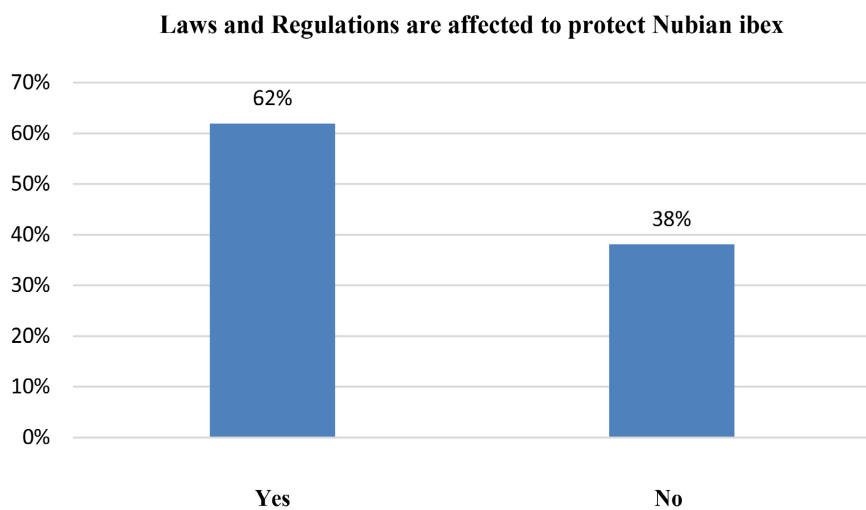


Figure S10. Shows how laws and regulations can impact the preservation of the Nubian ibex.

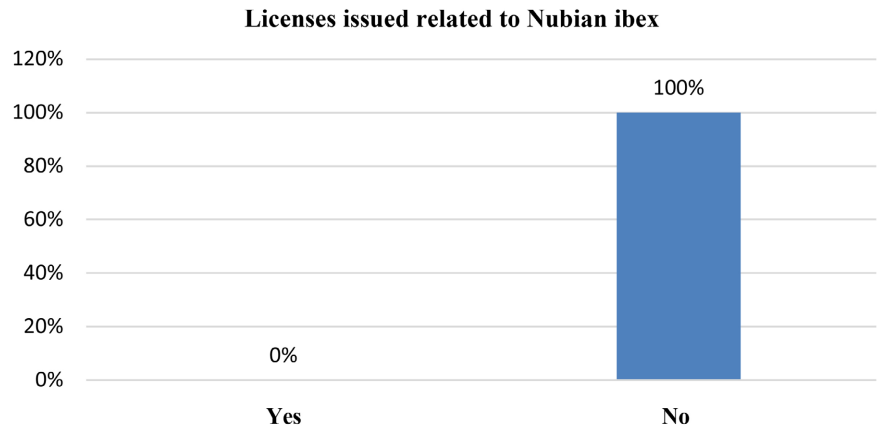


Figure S11. Shows licenses issued in Sudan for the Nubian ibex.

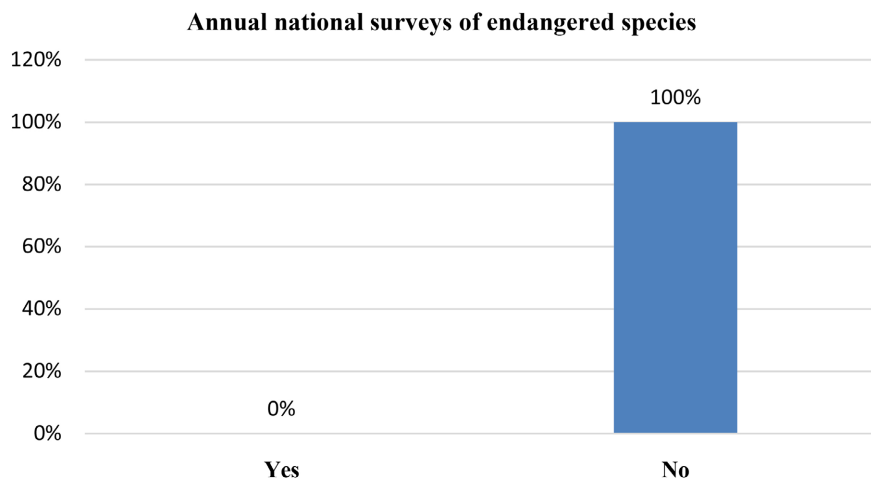


Figure S12. Shows annual national surveys on endangered species.

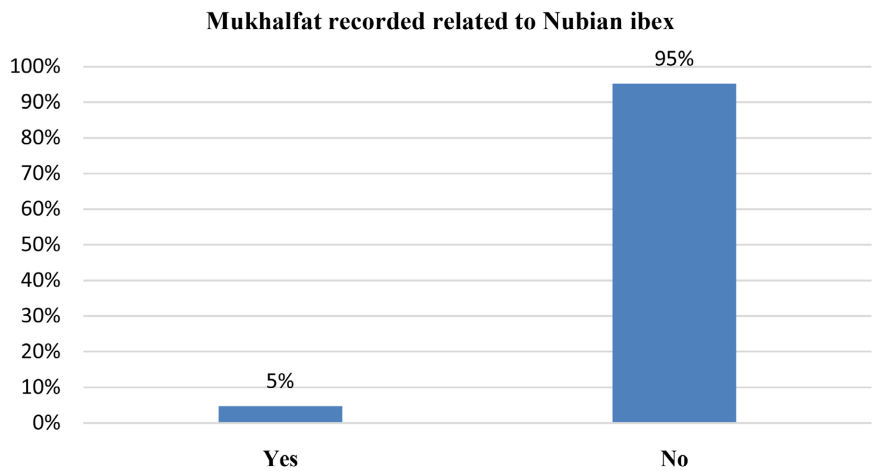


Figure S13. Shows MUKHALFAT's documented information on Nubian ibex in Sudan's geographical area.