

A TOPSIS-Based Study of State Agency Selection and Species Conservation for Wildlife Conservation

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Abstract. Illegal trade in wildlife has serious impacts on ecosystems, the world's environment and other aspects, including species endangerment and extinction, loss of biodiversity, ecosystem destruction, public health risks and illegal activities and crime. These impacts not only jeopardize the ecological balance and the ecosystem, but also pose a threat to human health and social stability. In order to select suitable countries for wildlife protection, this paper proposes five evaluation indicators: financial resources, human resources, technical support, professionalism and experience, and international influence, and constructs a five-dimensional illegal animal trade evaluation model based on the tosis model. By calculating the data of each region, the regional changes of illegal wildlife trade were demonstrated by using spatial geographic information visualization tools. The results show that China and Indonesia are the most frequent and typical regions of illegal wildlife trade. Then, through descriptive statistical analysis, the data showed that the most illegally traded species were Reptilia, Actinopteri, and Anyhozoa. The above results indicate that there is an urgent need to protect wildlife in China and Indonesia. Also, the international community needs to make joint efforts to strengthen regulation and law enforcement to combat illegal trade in wildlife.

Keywords: Information visualization, TOPSIS model, Descriptive statistical analysis, Wildlife conservation, Combating illicit trade.

1. Introduction

The illegal wildlife trade poses a major threat to our environment and global biodiversity. It is estimated to generate \$26.5 billion annually, making it the fourth largest illegal trade in the world. The first World Wildlife Crime Report shows that crime against wildlife is not limited to certain countries or regions, but is a truly global phenomenon; this particularly organized crime poses a serious threat to thousands of animals and plants, including overpopulated tigers, African elephants and rhinoceroses.

Because wild animals possess beautiful fur, or high medicinal value, or delicious flavor, many people do not hesitate to break the law and engage in over-hunting for financial gain. Some illegal hunters smuggle the captured wildlife into various kinds of products for export, resulting in the dwindling number of wildlife and even the extinction of some of them. [1] Wild animals are important natural and ecological resources. Illegal trade in wildlife not only jeopardizes the ecological environment and public health and safety, but also breeds and promotes a series of crimes such as illegal hunting and illegal transportation, [2] seriously disturbing the social order. Due to the low risk and high efficiency of online trading, offline illegal trade is gradually shifting to online, with more and more wildlife being sold through online channels, and the crime further organized, scaled and hidden. [3]

Many countries have enacted and promulgated laws, and signed international treaties to conserve, preserved and protect wildlife from trade, killed, poached or exploited illegally and taken from the wild. CITES is an example of the such treaties to protect wildlife from international trade, which was signed by the 95 countries in 1975. [4] In the United States, the ecological value of wildlife is ranked ahead of the economic value in the value ranking of wildlife. The ranking of the value of wildlife also further proves that the United States is forward-looking in the concept of wildlife legislation. [5] Many experts believe that cracking down on the demanders is the best conservation strategy. William Conway, president of the New York City-based Wildlife Conservation Society, argues that many rare

animals are very attractive but shouldn't be kept at home, and that the best places to see them are in nature and zoos. [6]

Nonetheless, researched data show that the illegal wildlife trade between China and Indonesia remains unusually high.

2. TOPSIS Comprehensive evaluation method

2.1. The use of TOPSIS to make decisions during the customer selection process

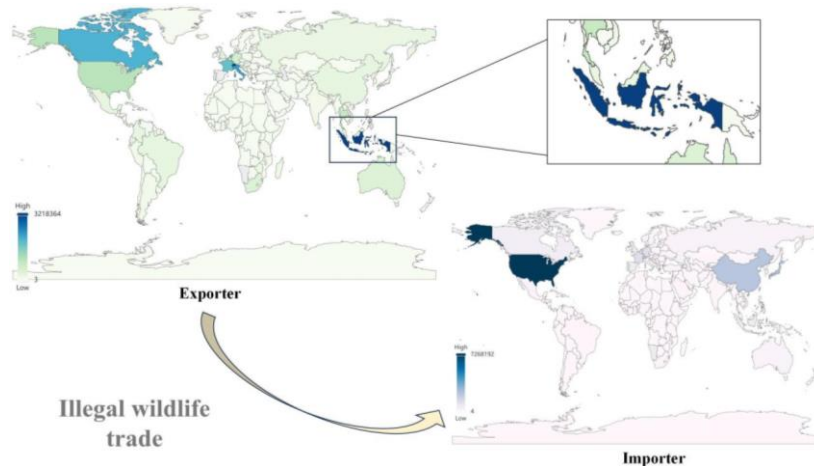


Figure 1. Imports of illegal trade in wildlife from 1978 to 2022

By visualizing and analyzing the data of global wildlife trade transactions from 1978-2023, Figure 1 was plotted by drawing a graph with each country region according to the color from light to dark indicating the import volume from small to large. From the figure, it can be found that from 1978-2022 Indonesia is one of the countries with the most frequent wildlife trade in 25 years.

In response to the above phenomenon, the TOPSIS comprehensive evaluation method was used to comprehensively evaluate the nature of the client from three levels: international wildlife conservation organizations, government agencies, and non-profit social organizations to better select organizations to implement conservation. levels: international wildlife conservation organizations, government agencies, and non-profit social organizations to better select organizations that implement conservation.

The following is a specific implementation of the TOPSIS integrated evaluation methodology and the analysis is used to complete the decision.

Construct the formula for calculating the score:

$$\frac{x - \min}{\max - \min} \quad (1)$$

The deformed formula:

$$\frac{x - \min}{(\max - x) + (x - \min)} \quad (2)$$

It can be regarded as:

$$\frac{D \text{ between } x \text{ and } \min}{D \text{ between } x \text{ and } \min + d \text{ between } x \text{ and } \max}$$

The analogy is that there is only one target to calculate the score: assuming that there are n objects to be evaluated, the normalized matrix of m evaluation indicators is given by Eq:

$$Z = \begin{bmatrix} z_{11} & \cdots & z_{1m} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & z_{nm} \end{bmatrix} \quad (3)$$

It can be regarded as:

$$\frac{\text{D between } z \text{ and min}}{\text{D between } x \text{ and min} + \text{d between } x \text{ and max}}$$

(Remarks: D/d means Distance/distance; min means the minimum value; max means the maximum value)

The formula for defining the maximum value is:

$$Z^+ = (Z_1^+, Z_2^+, \dots, Z_m^+) = (\max\{Z_{11}, Z_{21}, \dots, Z_{n1}\}, \max\{Z_{12}, Z_{22}, \dots, Z_{n2}\}, \dots, \max\{Z_{1m}, Z_{2m}, \dots, Z_{nm}\}) \quad (4)$$

The formula for defining the minimum value is:

$$Z^- = (Z_1, Z_2, \dots, Z_m) = (\min\{Z_{11}, Z_{21}, \dots, Z_{n1}\}, \min\{Z_{12}, Z_{22}, \dots, Z_{n2}\}, \dots, \min\{Z_{1m}, Z_{2m}, \dots, Z_{nm}\}) \quad (5)$$

The formula that defines the distance of the i ($i = 1, 2, \dots, n$) evaluation object from the maximum value is:

$$D_i^+ = \sqrt{\sum_{j=1}^m (Z_j^+ - z_{ij})} \quad (6)$$

The formula that defines the distance of the i ($i = 1, 2, \dots, n$) evaluation object from the minimum value is:

$$D_i^- = \sqrt{\sum_{j=1}^m (Z_j^- - z_{ij})} \quad (7)$$

Then, the formula for calculating the un-normalized score for the i ($i = 1, 2, \dots, n$) evaluator is:

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (8)$$

Obviously $0 \leq S_i \leq 1$, the larger S_i is, the smaller D_i^+ is, i.e., the closer it is to the maximum value.

From the data analysis, it is concluded that illegal wildlife trade in Indonesia needs to be controlled in a timely manner.

2.2. Status of illegal wildlife trade in Indonesia

Illegal wildlife trade between China and Indonesia is high.

(1) China's imports of CITES-regulated wildlife from abroad involve 140 countries and territories, with some Asian and American countries, led by Indonesia and the United States, accounting for 85 percent of the total.

(2) Indonesia is the world's largest archipelagic nation, spanning Asia and Oceania, with a population of 262 million. Indonesia's exports to China amounted to US\$27.962 billion, an increase of 2.8%, accounting for 16.7% of its total exports; Indonesia's imports from China amounted to US\$44.908 billion, a decrease of 1%, accounting for 26.4% of its total imports. The trade deficit between China and Indonesia was US\$16.946 billion, down 6.6%. [7]

(3) Illegal wildlife trade still exists and thrives on online shopping platforms such as Lazada and Shopee, especially in Indonesia and Malaysia. A prime example of online trade is the sale of sharks and rays through live streaming of Indonesian fish markets on Facebook. These videos show a variety of species and their prices, and viewers participate by commenting, asking questions and bargaining. Online trade in sea turtles has only been documented in Indonesia, mainly in bracelets and rings carved from turtle shells.

(4) Indonesia is very rich in biodiversity, but the problem of illegal trade in wildlife is extremely serious, in a complex and thought-provoking context. As a country rich in natural resources and wildlife species, Indonesia has become a target for wildlife traffickers. This market involves a wide variety of animals, including tropical birds, primates, reptiles and some rare mammals. In particular, certain species are highly sought after on the international market, and these are considered rare, unique or ornamental, thus becoming the subject of illegal trade.

(5) December 17, 2019 Indonesian officials The Indonesian government has notified the World Organization for Animal Health (OIE) of an outbreak of 392 cases of African swine fever (ASF) in the country, marking the first outbreak of ASF in the country. [8]

(6) A report in the Indonesian Sun noted that the cases involved a variety of wildlife such as hummingbirds, prairie cynomolgus, crested eagles, eastern barn owls, Malay bears and Bengal cats, which were traded online at prices ranging from RM350 to RM4,000 each.

Statistical analysis of the data for the last few years has resulted in a visualized chart, which is shown in Figure 2. It can be seen that the number of wild animals illegally traded between China and Indonesia from 2000 to 2022 has been on a general upward trend, with a particularly large number in recent years.

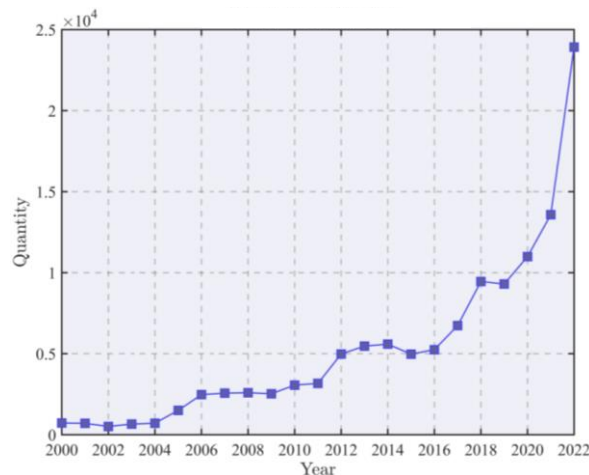


Figure 2. Changes in the quantity of illegally traded wildlife between Indonesia and China from 2000 to 2022

3. Analysis of the three species most heavily traded illegally through descriptive statistics (trade data between China and Indonesia over a number of years)

The description is based on the numerical characteristics of the data. This paper describes the pattern of distribution of sales of products of various animal species based on the commodity information of each animal and sales of each species. The statistical data are described by introducing mean, maximum, minimum, median, standard deviation, skewness coefficient and kurtosis coefficient.

(1) Skewness

The skewness coefficient is used to measure the degree of skewness of the data distribution. $sk=0$ means that the data are approximately symmetrically distributed, that the data are right-skewed, and that the data are left-skewed. The larger the absolute value of the skewness coefficient, the more obvious the skewness of the data distribution. The formula is as follows:

$$S_k = E \left[\left(\frac{x-\mu}{\sigma} \right)^3 \right] = \frac{\mu^3}{\sigma^3} \tag{9}$$

Where S_k skewness coefficient, $E(X)$ is the mean and μ^3 is the third-order center distance.

(2) Kurtosis

Kurtosis coefficient is used to measure the degree of kurtosis in the data distribution:

$$K_u = 0 \tag{10}$$

Indicates that the data distribution is normal:

$$K_u < 0 \tag{11}$$

It means that the data distribution has less kurtosis and more scattered data:

$$K_u > 0 \tag{12}$$

Represents a larger kurtosis of the data distribution and a more concentrated data. The larger the absolute value of the kurtosis coefficient, the more pronounced the degree of kurtosis of the data distribution. The calculation formula is as follows:

$$K_u = E \left[\left(\frac{x-\mu}{\sigma} \right)^4 \right] = \frac{\mu^4}{\sigma^4} \tag{13}$$

Where K_u skewness coefficient, $E(X)$ is the mean and μ^4 is the fourth-order standard distance.

(3) Coefficient solution

The description statistics of the illegal trade quantities of three species of wildlife using MATLAB are shown in Table 1:

Table 1. Table of illegal trade statistics of the three types of wildlife

metric	Reptilia	Actinopter	Anthozoa
least value	41	1	180
crest value	1691	1450	12179
mean	38.16	69.18	181.42
median	33.86	57.28	172.11
skewness	1.47	2.95	2.71
kurtosis	7.03	19.85	27.36
standard error	22.90	48.20	87.65

According to the calculation results, among the species of wildlife exported from Indonesia, the mean of Anthozoa is high and the standard deviation is relatively large, indicating that the sales volume is volatile and the sales volume of Reptilia is low and the standard deviation is relatively small, indicating that the sales volume is less volatile and stable. The skewness values in all three species are greater than 0, indicating that the data distribution is skewed to the right relative to the mean, i. e., there may be some extreme values of higher trade quantities. Among them, Actinopter has the largest skewness value, indicating that its sales volume distribution is more right-leaning compared to other species. The kurtosis values in all three species were greater than 7, indicating that the data distribution is more sharp relative to the normal distribution. The kurtosis value of Anthozoa is the highest, indicating that the sales distribution is the most narrow and further away from the normal distribution.

4. Results

Based on the analysis of the data after visualization, Table 2 was plotted and concluded that governmental organizations in Indonesia were selected as implementers of wildlife protection.

Table 2. Evaluation model data sheet

i \ j	fund	human resources	technical support	Professional and experience	International influence
The International Wildlife Conservation Organizational					
Government agencies a2	4	3	3	5	5
Non-profit social organization a3	5	4	4	4	4
Best b1	2	2	2	2	3
Worst b2	5	4	4	5	4
	2	2	2	2	3

The reasons for the extensive illegal wildlife trade between China and Indonesia are manifold, including economic interests, market demand and regulatory loopholes.

(1) First of all, from an economic perspective, some unscrupulous people make high profits by illegally importing wild animals and their products. The trading price of these wild animals is often much higher than the market value, so some people will take the risk to carry out illegal trading activities.

(2) Secondly, market demand is also one of the important reasons leading to illegal importation of wildlife. The rule of law itself is an integral part of Indonesia's institutional system and serves as a norm of order and a yardstick for behavior in Indonesia's political, economic, and social activities. [9] Some consumers may have an increased demand for certain wildlife due to factors such as personal preference or cultural background, thus stimulating the illegal importation of wildlife.

(3) In addition, as there are regulatory deficiencies and loopholes in wildlife protection in China, this also provides opportunities for some unscrupulous elements to take advantage of. They utilize various means to evade customs inspection and crackdown, and bring wild animals and their products into the domestic market for sale.

From the TOPSIS model, it is concluded that the Government of Indonesia becomes the main organization to control this type of illegal wildlife trade that occurs in Indonesia. Analyzed by data, Reptilia, Actinopteri and Anyhozoa are the three most traded wildlife species.

(1) Indonesia is one of the most biodiverse countries in the world, classified as one of the 17 "super-diverse" countries, two of which are global biodiversity "hotspots". Many of the species found in Indonesia are endemic, i.e. they are found only in the region. These include unique mammals, birds, reptiles and plants.

(2) According to Indonesia's biodiversity profile, which was updated in Indonesia's 6th National Report to the Convention on Biological Diversity (CBD), Indonesia is home to approximately 31,750 plant species, 732 mammal species (14% of the world's total species), 1,711 bird species (17% of the world's total species), 750 reptile species (8% of the world's total species), and 403 amphibians (6% of the world's total species) and 1236 freshwater fishes (9% of the world's total species).

The threat level of a species is one of the most important references for setting its level of protection, and threatened species are the most urgent and in need of protection. [10] The data from recent years were statistically analyzed to produce a graph after visualization, which is shown in Figure 3. It can be seen that Indonesia has the highest number of Reptilia, Actinopteri, and Anyhozoa among the three species of illegally traded wildlife from 2000 to 2022. And the numbers of all three animals are generally on the rise, with Actinopteri and Anyhozoa rising more slowly, and Reptilia rising very quickly, especially in recent years. 78% of today's new human infectious diseases are related to wildlife and are derived from wildlife. [11] Global warming brings disaster and death to wildlife, and the loss of wildlife in turn exacerbates global warming. [12] Therefore, the above three species should be given special attention by the Indonesian government to strengthen control in combating the trade of illegal wildlife.

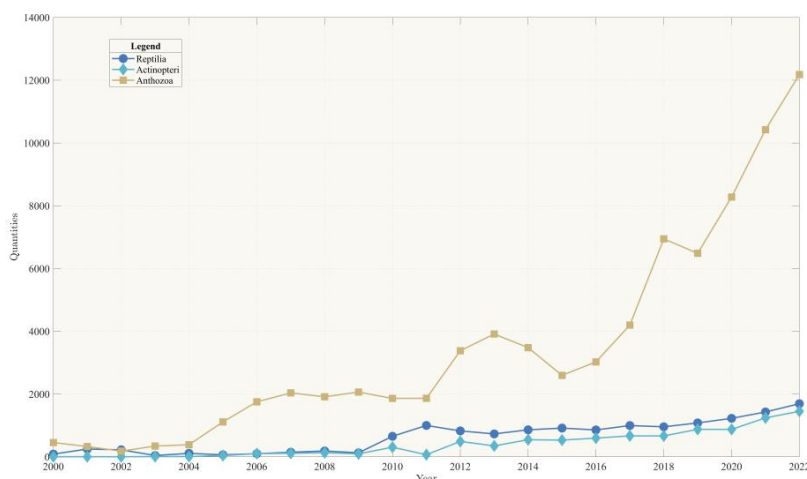


Figure 3. Changes in wildlife populations of three species of Reptilia, Actinopteri, and Anyhozoa in Indonesia from 2000 to 2022

5. Conclusion

In view of the various global ecological and environmental problems caused by wildlife, this paper utilizes specific models to analyze the need to combat illegal wildlife trade. Illegal trade in wildlife threatens wildlife populations, destabilizes ecosystems, spreads disease, and illegal activities have a negative impact on social stability. The three species most heavily traded illegally, as derived from statistical analysis, need to be controlled in a timely manner. Overall, Indonesia, which has almost the most serious wildlife trade, has government agencies that need to: strengthen border management and strictly inspect import and export goods; further strengthen the construction of protected areas, expand the scope of protected areas, and improve the level of management and supervision of protected areas; and intensify the crackdown on illegal wildlife trade activities, as well as strengthen publicity and education on wildlife protection, and improve public awareness and consciousness.

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