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Research on constructing protection sites of wildlife with the support of WCS based on ARIMA

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Abstract: *Wildlife conservation is crucial for maintaining global ecological balance. When endangered wildlife face extinction, it disrupts the food chain and affects biodiversity. The paper examines the feasibility of selecting sites for wildlife conservation, supported by the Wildlife Conservation Society (WCS), aiming to reduce illegal hunting within five years. The research highlights the current substantial but scattered investments in wildlife conservation, emphasizing the need for systematic site selection. Utilizing the ARIMA to predict trends in the illegal elephant trade, the paper finds an 80% reduction in illegal activities post-project implementation. Additionally, the Spearman correlation analysis confirms a significant relationship between the establishment of conservation sites and the reduction of illegal wildlife trade. The research also develops a possibility prediction model, indicating a 93.1% likelihood of achieving the conservation goals within five years, demonstrating the project's potential to enhance global biodiversity conservation effectively.*

Keywords: *protection sites, ARIMA, Spearman correlation analysis, Possibility prediction*

1. Introduction

Protected areas are considered fundamental to the preservation of nature [1]. The illegal wildlife trade has a negative impact on the environment and threatens global biodiversity. It is estimated one may add the estimates the paper reviewed for illegal logging (9 percent of $190 billion, or $17 billion), illegal fishing (20.55 percent of $81.5 billion, or $17 billion), other wildlife trade (roughly $5 billion), and the $11 billion for illegal toxic wastes. Acknowledging that the last two estimates are not based on detailed studies, this places the illegal market size at $50 billion [2]. This trade not only leads to the decline of wildlife numbers and the extinction of species, but also disrupts the ecological balance and exacerbates the problem of illegal hunting. Unsustainable trade in wildlife products both legally and illegally is a leading cause of population declines and increased extinction risk in commercially valuable species [3]. This paper elaborates on the feasibility of establishing a five-year plan, with the assistance of WCS, to systematically develop wildlife conservation sites and combat illegal trade.

WCS is an international non-profit organization dedicated to the protection and conservation of wildlife and their habitats worldwide, and saving wildlife and wildlands, to assure a future for threatened species like elephants, tigers, sharks, macaws, or lynx [4]. The organization endeavors to work in fourteen priority regions that contain fifty percent of the world's biodiversity. WCS, as a client, it's rich economic resources and scientific and technological resources can help the project to be better promoted and improved. At the same time, WCS is able to facilitate this by connecting with the local government and the community. Through this five-year project, WCS can achieve the conservation of global biodiversity, providing local ecological value, tourism value and much more.

To combat the illegal wildlife trade, organizations around the world have used a variety of methods over the centuries: the enactment of relevant laws and regulations [5], the establishment of wildlife reserves [6], the use of advanced technology (GEDI and airborne LiDAR data [7], unmanned aerial vehicles [8], etc.), and community protection [9]. This paper provides a new approach to combat illegal wildlife trade by proposing the establishment of wildlife protection sites for WCS.

Our research has made significant contributions to the construction sites of wildlife in the following areas:

(1) Conducted an in-depth study and application of WCS's resources and influence, combined with ARIMA, to establish an accurate evaluation model of the importance of establishing wildlife protection

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sites to reduce illegal hunting.

(2) Used Spearman correlation analysis habitually to validate the accuracy.

(3) Established a time forecasting model to speculate on the feasibility five years from now, based on political, economic, socio-cultural, and environmental factors.

In this paper, the paper speculates on the impact of establishing wildlife conservation sites on combating illegal wildlife trade and forecast its feasibility over the next five years using ARIMA and Possibility prediction. Section 2 provides a predictive inference using ARIMA, analyzing the impact of establishing wildlife conservation sites on combating illegal wildlife trade. Section 3 introduces Spearman correlation analysis, assesses the impacts on illegal wildlife trade by using Spearman correlation analysis. Finally, Section 4 valuates the likelihood of constructing protection sites of wildlife in five areas and summarizes the findings.

2. A data-driven analysis of Project necessity

2.1 Introduction to ARIMA model

Autoregressive Integrated Moving Average (ARIMA) is a widely used statistical method for time series forecasting. It combines the concepts of autoregression (AR), differencing (I), and moving average (MA) to capture different aspects of time series data and make accurate predictions.

2.2 ARIMA model of the elephant trade

The global wildlife trafficking situation is serious, causing huge negative impacts on Eco-systems and human society, involving a large number of species and a wide range. It is proposed a global ban on trade in ivory is the only realistic solution to the current unsustainable rate of loss of elephants. The ban should be extended to trade in all products from endangered wildlife [10]. Using the global illegal elephant trade over the past few years as an example, the paper builds an ARIMA model before and after the implementation of the project of constructing to predict the change in the global illegal elephant trade over the next five years.

Using the model ARIMA (1,1,1), the paper project the volume of global elephant trade for 60 months before and after the implementation of the project and fit each set of data.

(1) P1 is the predicted value of global illegal elephant trade before the implementation of the project.

(2) L1 is the fitting curve of the predicted value before the implementation of the project.

(3) P2 is the predicted value of global illegal elephant trade after the implementation of the project.

(4) L2 is the fitting curve of the predicted value after the implementation of the project.

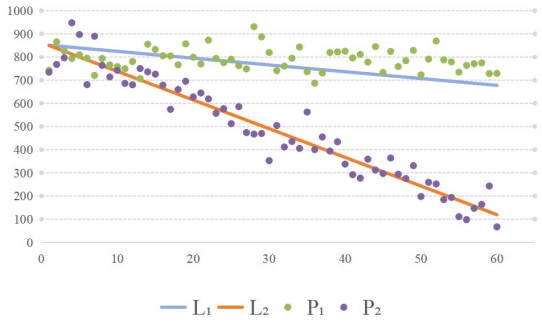

Figure 1: ARIMA projections

Fig 1 shows that before the project is implemented, the volume of elephant trade decreases slowly, to around 700 animals per month after five years. After the implementation of the project, the volume of elephant trade decreases significantly, falling to about 100 per month after five years.

It concludes that the implementation of the project has significantly reduced the number of illegal elephant trade, which has been reduced by about 80% compared to the original.

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2.3 Illegal wildlife trafficking

In addition to the elephant trade, the number of illegal wildlife species involved in the world and the volume of trade are huge, as shown in Table 1.

Table 1: Main species of illegal wildlife trade

Ranking	Taxonomic Group	Quantity
1	Arctocephalus pusillus	473635
2	Chlorocebus sabaeus	269300
3	Lynx rufus	220858
4	Ursus americanus	211663
5	Bettongia penicillata	207750
6	Pecari tajacu	146862
7	Lontra canadensis	139275

It presents that the safety of wildlife is under great threat, and the illegal wildlife trade is also causing great harm to ecological diversity.

At the same time, illegal wildlife trafficking is involved in many regions of the world, and many countries are involved in illegal hunting, smuggling and illegal trade, close to half of them distributed in America, China, and central African [11].

From the above data-driven analysis, it is necessary for the project to proceed. The implementation of the project can greatly reduce the illegal wildlife hunting, thus greatly reducing the illegal wildlife trade, protecting the diversity of the ecosystem, and providing a safer and more reliable living environment for wild animals, which is highly consistent with the client's mission, and also helps WCS to accomplish better tasks in the construction and management of nature reserves.

3. Measurable impacts of illegal wildlife trade

3.1 Introduction to Spearman correlation analysis model

Spearman correlation analysis is a statistical method used to measure the strength and direction of association between two variables. Unlike Pearson correlation, which measures linear relationships, Spearman correlation assesses monotonic relationships, which may be nonlinear.

The specific Spearman algorithm and evaluation basis are as follows:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{1}$$

r represents the correlation coefficient, x_i and y_i respectively represent the i value of the two variables, and $\bar{x}$, $\bar{y}$ respectively represent the average value of the two variables.

The value range of the correlation coefficient is[-1,1], and the relationship is as follows:

$$\begin{cases} |r| < 0.3 & \text{no linear correlation} \\ 0.3 < |r| < 0.5 & \text{low linear correlaition} \\ 0.5 < |r| < 0.8 & \text{significant linear correlaition} \\ |r| > 0.8 & \text{high linear correlaition} \end{cases} \tag{2}$$

3.2 Experimental Design

From the introduction and Section 2, the paper obtains five measurable impacts: Illegal trade, International crackdown, Resident's awareness, Sustainable economic development, Research investment, as shown in Fig. 2.

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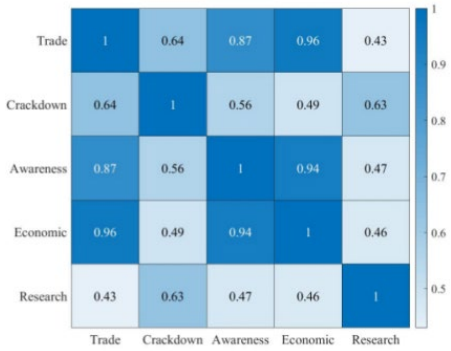

Figure 2: Spearman correlation analysis results

Based on the results of the reduction of illegal wildlife trade directly caused by the construction of wildlife conservation sites and the results of Spearman correlation analysis, the paper can conclude that the measurable impact of the project can significantly guarantee the implementation of international actions, raise the awareness of local residents to protect wildlife, effectively provide conditions for sustainable economic development, and help scientific research to a certain extent.

4. Feasibility of systematically constructing wildlife conservation sites.

4.1 Introduction to Possibility Prediction Model

The Possibility Prediction Model (PPM) is a sophisticated analytical tool designed to forecast the likelihood or probability of specific outcomes or events based on historical data, trends, and relevant factors. By leveraging statistical methods, machine learning algorithms, and time series analysis, the PPM aims to provide insights into future possibilities or scenarios, aiding decision-making processes in various domains such as finance, marketing, healthcare, and environmental conservation. This model allows stakeholders to anticipate potential outcomes, identify risks, and optimize strategies to achieve desired objectives. With its ability to incorporate multiple variables and adapt to changing conditions, the PPM serves as a valuable tool for organizations and policymakers seeking to make informed decisions and navigate uncertain futures. The possibility relationship is as follows:

$$\mathrm{P} = f(X_1, X_2, \cdots\cdots, X_n) \tag{3}$$

where P represents the possibility or probability.X_1, X_2…… X_n are the input variables, which may include historical data, trends, environmental factors, etc.

4.2 Establishment of the model

In order to predict the possibility of WCS to achieve the expected goal of the project, the paper divide the possibility of the whole project to achieve the expected goal into five aspects: cost input, policy support, law enforcement efforts, device prior process, and personnel allotment.

For prediction of probability, define ti, refers to the influence of the above five factors on the original possibility after seeking the help of powers and resources, and sets a floating range for them. Greater than 1 means that the possibility can be improved, and less than 1 means that the possibility is reduced.

In order to determine the probability of the project to achieve the expected goal before adding additional powers and additional resources, the paper determine the weights of five aspects, ωi, and the probability of WCS achieving the expected goal for these five weights, pi.

$$p_a = \sum_{i=1}^{5} p_i \times \omega_i \tag{4}$$

$$p_b = p_a \times \prod_{i=1}^{5} t_i \tag{5}$$

The probability of WCS meeting its expectations in the first five areas of seeking additional help and

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the degree of impact range is as follow Table 2:

Table 2: Five aspects of the possibility and the floating range without extra help

	possibility	**floating range**
cost input	85%	0.8-1.3
policy support	90%	0.95-1.05
law enforcement efforts	70%	0.9-1.2
Device prior process	80%	0.9-1.1
personnel allotment	85%	0.95-1.1

Combined with the weights, the research finds the average probability of achieving the project expectation is 93.1% after over 20000 randomized trials on t_i.

5. Conclusions

Through the above experiments and verifications, our model plays an important role in predicting the feasibility of protecting wildlife:

(1) In-depth Analysis: The research delves deeply into the compatibility and enthusiasm between WCS's strengths and the establishment of wildlife conservation sites: establishing wildlife conservation sites can effectively combat illegal wildlife trade.

(2) Correlation Analysis: The research analyzes the strong correlation between the establishment of wildlife conservation sites and illegal wildlife trade.

(3) Weight Allocation: Based on international policies and economic conditions, the paper allocate appropriate weights to different factors: the research successfully predicts that with WCS's support, the construction of wildlife conservation sites can be completed within five years and significantly enhance wildlife protection.

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