Reduction of Illegal Wildlife Trade: A Project Approach

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Abstract: Exploring the influencing factors of illegal wildlife trade and revealing its characteristics is of great significance for reducing illegal wildlife trade and protecting global biodiversity. In this study, grey prediction model, regression model and other methods were used to analyze the target customers of the project and determine the factors affecting the illegal wildlife trade. At the same time, the prediction model of future project development is established, and the evaluation index of project development is put forward accordingly.

1. Introduction

In recent years, the illegal wildlife trade has received increasing attention from the international community, not only it is illegal, but also it disrupts the balance of ecosystems. The illegal wildlife trade is estimated to be the fourth largest illegal trade in the world, worth up to $26.5 billion annually. Although there is already a Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), there are many illegal elements, Therefore, this paper will plan a project with the goal of significantly reducing illegal wildlife trade, and establish relevant models to prove the feasibility of the project and the final benefits. [1]

2. Our work

1) Pearson correlation analysis is conducted by analyzing data published in relevant organizations and literature. Through analysis, combined with relevant literature, analyze what research is needed for the project and convince the client to participate in the project.

2) In order to visualize the key data, this study selected African elephant death data as a prediction sample. A time series prediction model was used to predict the death of African elephants from 2024 to 2029 and compare it with actual data. When it is found that the predicted result is significantly lower than the actual value, the assistance of other agencies can be sought.

3) To explore the equilibrium amount affecting illegal wildlife trade, we first used the regression model to analyze the four types of factors in Question 1 and Question 2, and concluded that there is a negative correlation between sustainable capital investment and illegal wildlife trade, and listed the relationship as follows: $Y_t = 1567294 - 25.5251X$, a gray prediction model was established to predict the quantity of illegal wildlife.

In order to ensure the accuracy and rationality of the model solution, this paper eliminates some factors and puts forward the following assumptions:

Hypothesis 1: The rationality and effectiveness of data collection: The assumption is that all the collected data are real and reliable;

Hypothesis 2: Assume that the impact of sustainable investment amounts, African elephant mortality data, Internet searches for wildlife-related information and CITES wildlife trade are taken into account during the project implementation, without regard to other factors and independent of any other factors.

Hypothesis 3: Assume that 11 indicators are included in the evaluation of achieving the expected indicators of the project.

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3. Pearson correlation coefficient model

3.1 Project introduction

In view of the continuous population growth, the expanding scope of human activities and the rapid development of the Internet, the project aims to promote countries to enact laws and regulations to combat illegal wildlife trade through international cooperation, clarify the boundary between illegal wildlife trade and legal wildlife trade, and strengthen the protection of endangered species and wildlife.At the sametime, it advocates that countries sign conventions on the protection of wildlife and legal wildlife trade, and organizes actions to crackdown on cross-border illegal wildlife trade[2].In addition, countries are called upon to establish long-term surveillance camps at high-risk poaching sites within their borders and to develop enforcement strategies based on their national circumstances. Work with competent organizations and research institutes to conduct research on the basic situation of endangered species and their conservation measures.

As the largest intergovernmental organization in the world, the United Nations has a large number of member states and a number of specialized programs, which have the authority to cooperate with other organizations or research institutions. Responsible for coordinating international affairs among member states, formulating international law and promoting sustainable development, the United Nations has a strong policy driving capacity to help change the legislation of member states and encourage states to participate in the legislation of illegal wildlife trade. In addition, the United Nations enjoys the financial support of member states, project funding and international assistance to facilitate the organization of transnational activities to combat illegal wildlife trade. Through its own influence, it advocates that countries strengthen the popularization of laws and regulations related to illegal wildlife trade, raises awareness of the importance of protecting species diversity and popularises the existing protected wildlife[2].

3.2 Model establishment

To convince the client, citing CITES data on African wild elephant mortality from 2014 to 2020 and IUCN's sustainable investing in protected areas and biodiversity, as well as Google's wildlife Search Index, in conjunction with CITES wildlife trade data overtime, Pearson's correlation coefficient was used to analyze the correlation between public concern, investment in protected areas, African elephant deaths, and wildlife trade.

Four sets of data are substituted into the following formula in pairs, and Pearson correlation is used to analyze the data.

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

Finally, the thermodynamic analysis diagram shown in Figure 1 is obtained.

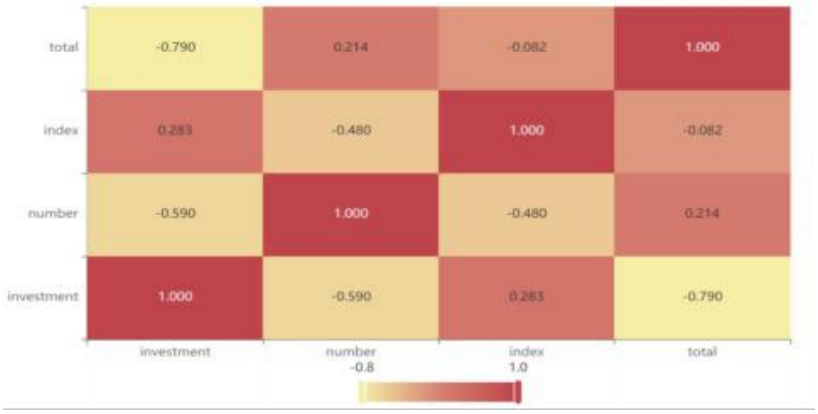

Figure 1: Correlation thermodynamic analysis diagram

3.3 Result analysis

From the heat map analysis in Figure 1, it can be clearly observed that there is a strong negative correlation between the amount of sustainable investment in protected areas and the amount of wildlife trade and the mortality rate of African elephants. This means that as sustainable investment in protected areas grows, the amount of wildlife trade and African elephant mortality will decrease accordingly. However, the weak correlation between African elephant mortality and wildlife trade volume suggests that African elephants are still present despite being a smaller proportion of wildlife trade. In addition, the Google search index with illegal wildlife trade as the search term showed a weak positive correlation with the amount of sustainable investment in protected areas. That is, when sustainable investment in protected areas increases, the corresponding Google search index will also rise[3].

Therefore, this paper hopes that the United Nations can increase investment and publicity efforts, and strengthen supervision measures.

4. ARIMA

4.1 Model Construction

To provide a clearer picture of the additional power and resources that clients will need to execute this project, this paper uses data on African elephant deaths and a time series prediction model to make predictions. Consider the actual situation and see if you need to seek help from other organizations. For modeling, we took the following steps. [4]

Step 1. The unit root test is performed on the original sequence by PP test method. The non-stationary time series is transformed into stationary time series by difference transformation or log-difference transformation, and then ARIMA model is constructed for stationary time series.

Step 2. PP test method is adopted to carry out unit root test on the original sequence, transform non-stationary time series into stationary time series by difference transformation or log-difference transformation, and then construct ARIMA model for stationary time series:

$$Y_t = c + a_1 Y_{t-1} + \cdots + a_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \cdots + \beta_q \varepsilon_{t-q} \tag{2}$$

Step 3 Use the established ARIMA model for prediction

4.2 Solution and Result

The final forecast data is shown in Table 1.

Table 1: Forecast

model	2024	2025	2026	2027	2028	2029
Forecast	987	913	839	764	690	616
UCL	1969	2010	2041	2062	2078	2088
LCL	6	-184	-363	-534	-698	-856

In the ARIMA model, our ideal scenario, using African elephant deaths as an example, is that the number of deaths due to illegal wildlife trade is decreasing year by year.

The expectation is good, and the result may not be as good as the actual situation, so we should combine the actual situation, when we find that the predicted value is far lower than the actual value, we can seek help from other organizations. For example, the International Union for Conservation of Nature (IUCN) can be asked for help in the field of scientific research.[5] Alternatively, the World Wildlife Fund could seek it to advocate for biodiversity.

5. Comprehensive model prediction and evaluation system

In this study, the aim is to explore the relationship between sustainable investment amounts, annual African elephant mortality data, Internet searches for wildlife conservation information and the CITES wildlife trade catalogue by using regression forecasting models and grey forecasting models.

The analysis shows that with a significant increase in the amount of sustainable investment over the next five years, the amount of illegal wildlife trade is expected to be effectively curtailed.

5.1 Model Construction

The results of regression prediction model analysis on sustainable investment amount, African elephant death data, Internet search volume of wildlife protection related

	Coefficients	Standard error	t Stat	P-value	Lower 95%	Upper 95%	floor 95.0%	Upper limit 95.0%
Intercept	1567293.89	882644.9071	1.775678847	0.173870913	-1241676.133	4376263.914	-1241676.133	4376263.914
X Variable 1	-25.52567717	9.439654952	-2.704090065	0.073531026	-55.5668722	4.515517854	-55.5668722	4.515517854
X Variable 2	-412.4269656	454.4243973	-0.907581037	0.431008218	-1858.60821	1033.754279	-1858.60821	1033.754279
X Variable 3	1277.726079	16076.84082	0.079476191	0.94165849	-49885.9566	52441.40876	-49885.9566	52441.40876

Figure 2: Regression prediction model analysis results

In the study, three variables are explored: X Variable1, which represents the amount of sustainable investment; X Variable2, which represents annual data on the deaths of African elephants; X Variable3 represents the number of searches on the Internet for information related to wildlife conservation. In this context, ap-value is defined as the probability of obtaining a result that is more extreme than the actual sample observation if the null hypothesis holds. If the p-value is small, it indicates that the probability of occurrence of the null hypothesis is low. According to the small probability principle, if this happens in actual observation, it is reasonable to reject the null hypothesis. The smaller the p-value, the stronger the basis for rejecting the null hypothesis. The value of P ranges from 0 to 1, excluding 0 and 1. In general, there are three criteria, which are 0.01, 0.05 and 0.1. Through regression prediction analysis, the P-values obtained were 0.0735, 0.4310 and 0.9416, respectively.[6]The linear relationship between these three P-values and illegal wildlife trade is shown in Figure 2.

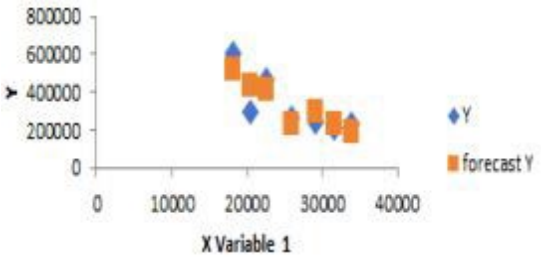

Figure 3-a:X Variable 1 Line Fit Plot

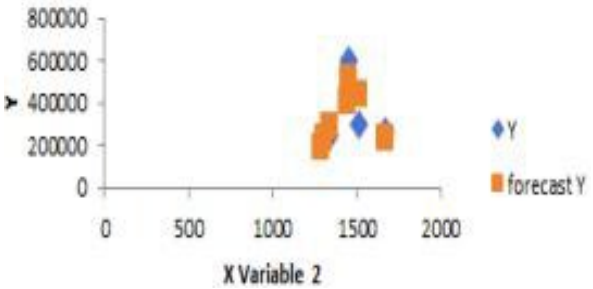

Figure 3-b:X Variable 2 Line Fit Plot

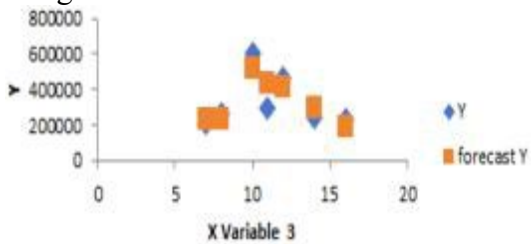

Figure 3-c:X Variable 3 Line Fit Plot

Figure 3: Linear relationship between P-values and illegal wildlife trade

As can be seen from the above analysis, there is a negative correlation between the amount of sustainable investment and the amount of illegal wildlife trade (See Figure 3). The regression model is established as follows:

$$Y_t = 1567294 - 25.5251X \tag{3}$$

Where Y is the amount of illegal wildlife trade and X is the amount of sustainable investment.

In order to further estimate the scale of illegal wildlife trade in the next five years, this study first constructed a grey prediction model to predict the amount of illegal wildlife trade between 2010 and 2019. The model was validated and analyzed by comparing the actual amount of illegal wildlife trade

from 2020 to 2022 with the forecast error.[7]

The prediction model of $CM(1,1)$ is:

$$X_Y^{(1)}(k+1) = (X^{(1)}(0) - \frac{u}{a})e^{-ak} + \frac{u}{a} \tag{4}$$

The predicted values from 2020 to 2027: $X_Y^{(0)}$ = [268578.8, 238018.5, 208088.4,178775.6, 150067.4, 121951.3, 94415.15, 67446.9];

5.2 Solution and Result

The result of model construction is shown in table 2:

Table 2: The result of model construction

After verifying the difference C value	Small error probability p value
0.1929	0.857

It can be seen from the data that the posterior difference is 0.193<=0.35 than the C value, indicating that the accuracy level of the model is very good. The p value of small error probability is 0.857<0.95, indicating that the accuracy of the model is qualified.

The results show that over the next five years, the amount of illegal wildlife trade will gradually decrease as the amount of investment increases dramatically. Sustainable investments to measure and combat illegal wildlife trade are recommended in the following eight areas:

1) Habitat protection: Focus on the protection and management of wildlife habitats, including the establishment of protected areas, forests, wetlands and other key ecological areas.

2) Scientific research and monitoring: Support wildlife conservation related research projects, covering species research, habitat monitoring, ecosystem assessment and other fields, to provide a scientific basis for decision-making.

3) Anti-poaching and law enforcement: Intensify efforts to combat illegal hunting and wildlife trafficking, invest in training and equipment for law enforcement agencies, and improve law enforcement efficiency.

4) Education and public awareness: carry out wildlife protection publicity and education activities to raise public awareness and awareness of wildlife protection, and promote sustainable consumption and behavior change.

5) International cooperation: Participate in international wildlife protection organizations and projects, strengthen international exchanges, and jointly cope with global wildlife protection challenges.

6. Comprehensive evaluation and analysis model

Fifteen samples were randomly scored in terms of five scoring rules: cost-effectiveness, quality control, stakeholder satisfaction, risk management, innovation, sustainability, teamwork, publicity scope, organization of related activities, and system development. Then, the rank-sum ratio comprehensive evaluation method is adopted for the data, and the time schedule is set as a negative indicator, while other indicators are positive indicators. The non-diagnosis and treatment method was used to divide the data into three levels, and the entropy weight method was used to carry out variable weights for the related scoring rules. Then the logistic regression model is used for predictive analysis, and the positive and negative results of the project are finally obtained.[8]

6.1 Model Construction

Step 1: The entropy weight method is used to confirm the weight of the scoring rules.

Step 2: Calculate the ranking value, sort each specific evaluation index according to its index value, get rank R, and use rank R to replace the original evaluation index value, and plug the result into the following formula.

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{pmatrix} \tag{5}$$

Step 3: Through calculation, RSR sorting results are obtained, as shown in Table 3.

Table 3: Summary of grading results

indexes	RSR ranking	Probit	RSR fitted value	grading
2	1	7.128045234184983	0.6902985603175986	3
2	3	6.110771616636786	0.5978643121713089	3
2	2	6.501085946044025	0.6333301012737891	3
3	6	5.430727299295458	0.5360722986016419	2
1	4	5.841621233572914	0.5734080470449638	2
2	10	4.7466528968642	0.47391409261449025	2
2	11	4.569272700704542	0.45779649673347594	2
3	13	4.158378766427086	0.420460748290154	2
2	5	5.622925723210088	0.5535363480992285	2
2	7	5.2533471031358	0.5199547027206275	2
3	8	5.083651733907129	0.5045353862280164	2
2	12	4.377074276789912	0.4403324472358894	2
1	9	4.916348266092871	0.4893334091071015	2
2	14	3.8892283833632146	0.39600448316380893	1
2	15	3.498914053955975	0.36053869406132877	1

6.2 Solution and Result

The results are then brought into logistic regression, predictive analysis is performed, and the Classification evaluation index as shown in Table 4 are obtained

Table 4: Classification evaluation index

accuracy rate	recall rate	accurate Rate	F1	AUC
1	1	1	1	1

Detailed interpretation of the research results shows that the project has achieved remarkable results in sample accuracy. The positive effects of this precision are expected to drive the continued development of the project in the future, beyond the current five-year planning cycle. Further, samples from the second phase of the project revealed far-reaching features that significantly reduced the amount of illegal wildlife trade.

However, this paper cannot ignore the possible disadvantages of this project. These adverse factors include but are not limited to: due to lack of solidarity or lag in schedule, the project may not effectively reduce the illegal wildlife trade, but instead make the trade more frequent, resulting in an increase in the illegal wildlife trade. The emergence of this situation will undoubtedly have a negative impact on the long-term development of the project.

From a deeper perspective, this situation warns the client that in the process of pushing forward the project, it should not only focus on the positive side of the outcome, but also pay attention to possible problems, and adjust the strategy in time to ensure the smooth progress of the project. To do this, we need to strengthen teamwork, improve work efficiency, and ensure that the project schedule is in line with the plan.[8]

Overall, the program has achieved significant results in reducing the illegal wildlife trade, but there

are still potential downsides that need attention. By strengthening solidarity and cooperation and optimizing the implementation plan, we can ensure the sustainable development of the project and lay a solid foundation for achieving more long-term goals. In this process, we should fully recognize the complexity of the project, constantly learn and improve, in order to achieve better results in the future work.

7. Conclusion

We developed regression models and grey prediction models to illustrate the measurement of illegal wildlife trade.

(1) The purpose of the regression model is to establish a linear relationship between the amount of sustainable investment and the illegal wildlife trade, and to demonstrate a roughly negative correlation.

(2) The grey prediction model is designed to predict the change trend of the quantity of illegal wildlife trade in the next five years, and it is verified that the use of the grey prediction model is reasonable, but it also proves that the model has the problem of poor fit, which needs to be improved in the future.

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References

[1] Michaelt Sas-Rolfes, Daniel W.S. Challender, Amy Hinsley, Diogo Veríssimo, E.J. Milner-Gulland. “Illegal Wildlife Trade: Scale, Processes, and Governance.” Annual Review of Environment and Resources 2019, vol. 44, no.1, 201-228.

[2] Martins, Claudia & Engel, Monica & Guimarães, Maria & Montanheiro Paolino, Roberta & Schulz, Francine & Esteves, Carolina. (2022). Social Repercussion of Translocating a Jaguar in Brazil. Frontiers in Conservation Science. 2. 788641. 10.3389/fcosc.2021.788641.

[3] Moore, Jennifer & Mulindahabi, Felix & Masozera, Michel & Nichols, James & Hines, James & Turikunkiko, Ezechiel & Oli, Madan. (2017). Are ranger patrols effective in reducing poaching-related threats within protected areas?. Journal of Applied Ecology. 55. 10.1111/1365-2664.12965.

[4] Tow, Jia Hao & Symes, Will & Carrasco, L Roman. (2021). Economic value of illegal wildlife trade entering the USA. PloS one. 16. e0258523. 10.1371/journal.pone.0258523.

[5] Lu Yi. Research and Application of Grey Prediction Model [D]. Zhejiang University of Science and Technology,2014.

[6] Tinsman, Jen & Gruppi, Cristian & Bossu, Christen & Prigge, Tracey-Leigh & Harrigan, Ryan & Zaunbrecher, Virginia & Koepfli, Klaus & LeBreton, Matthew & Njabo, Kevin & Cheng, Wenda & Xing, Shuang & Abernethy, Katharine & Ades, Gary & Akeredolu, Excellence & Andrew, Imuzei & Barrett, Taneisha & Bernáthová, Iva & Černá Bolfíková, Barbora & Diffo, Joseph & Smith, Thomas.

(2023). Genomic analyses reveal poaching hotspots and illegal trade in pangolins from Africa to Asia. Science. 382. 1282- 1286. 10.1126/science.adi 5066.

[7] Chen F, Wang J, Deng Y. Road safety risk evaluation by means of improved entropy TOPSIS–RSR[J]. Safety science, 2015, 79: 39-54.

[8] Liang D, GiamX, Hu S, et al. Assessing the illegal hunting of native wildlife in China[J]. Nature, 2023, 623(7985): 100- 105.