Allocation of Endangered Plants Species Fund Based on Data Model

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Abstract: With the acceleration of human development, many valuable species have been wiped out and extinct from their habitats. In order to change the scale, many non-profit organizations have begun to raise funds to protect endangered creatures. However, there are usually some conflicts between the cost and the funds we collect, and they are not equivalent at all. In order to solve this fund allocation problem, we aim to solve this problem and create a model determined by its cost-benefit analysis to calculate the protection priority of a specific plant and use the model. Based on the classification and calculations, we wrote a note to FRPCE to analyze our models and introduce them to our concepts of cost, benefit, and protection priority. FRPCE may use our conclusions to analyze the protection sequence and fund collection projects. We have three advantages, including multiple models and their characteristics, adjusting data from a human perspective, and the stability of expenditure items..

1. Introduction

"Biodiversity" is the ecological complex formed by biology and environment and the sum of various ecological processes related to it, including ecosystem, species and gene. Biodiversity is the condition for human survival, the basis for sustainable economic and social development, and the guarantee for ecological security and food security. Countries around the world are taking concerted action to tackle the growing global biodiversity crisis. The protection methods include local protection, ex-situ protection and so on. These require long-term and substantial funding.

The significance of plants in preserving biodiversity is that photosynthesis, exercised by land plants and algae, is the primary source of energy and organic matter in almost all ecosystems. Plants are producers in most terrestrial ecosystems, forming the basis of the food chain. Many animals depend on plants for their shelter and for their supply of oxygen and food. Terrestrial plants are the key to the circulation of water and several other substances. Plant roots also play an important role in soil development and preventing soil erosion. It is the key to promote the material exchange and energy flow between organisms and the environment.

However, thousands of species of plants and animals are threatened with extinction, and biodiversity conservation actions can often save them. The benefits of conservation actions vary from project to project, so how these funds are allocated is important. It also considers that each project has different time and money requirements, so we monitor the budget closely to allocate funds efficiently. So, we need to determine how to effectively fund biodiversity conservation activities for endangered and threatened species.

2. Nomenclatures

Table 1 Index Needed

Index	Meaning of index
P_i	The ith plant, i=1,…,48
U_i	Uniqueness index of the ith plant
B_i	Benefit index of the ith plant

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FS_i	Feasibility of success of the ith plant
AAC_i	Average spending adjusted price of the ith plant in their protecting project
FC_i	The first-year cost of the ith plant protecting program.
P_iC_n	The nth year cost of the ith plant protecting program. ($FC_i=P_iC_i$)
AP_iC_n	The nth year adjusted cost of the ith plant protecting program.
TC_i	Total spending price of ith plant in their protecting project,
ATC_i	Total adjusted spending price of ith plant in the protecting project
Y_i	Expectation year to finish the ith plant protection project.
$RATC_i$	Relative the total adjusted spending price of ith plant in the protecting project to the ATC_{48} plant(plant-415)
RFC_i	Relative he first year cost of the ith plant protecting program to the FC_{48} (plant-415)
Pri	Priority index of ith plant

3. Models of the Projects

3.1 Basic Model

In this model, we first assume that we all the plants need to be protected in the first year, because each of them has benefits and is threatened from biological extinction. Since then, we suggest there is a situation that we spend all the 48 plants protection program at the same time, and here is the graph when this situation happened.

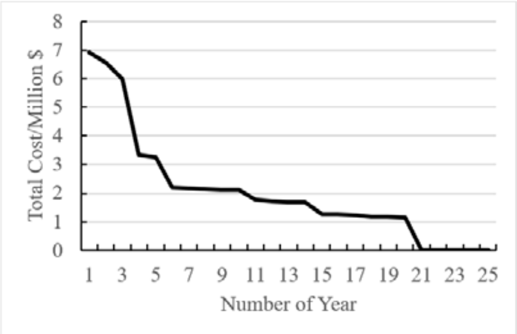

Fig.1 Total Cost of Each Year

Table 2 Total Cost Of Each Year

Year	1	2	3	4	5	6
Total cost/Million $	6.93058	6.55632	5.9933	3.34385	3.25	2.20
Year	7	8	9	10	11	12
Total cost/Million $	2.17	2.15	2.13	2.13	1.77	1.71
Year	13	14	15	16	17	18
Total cost/Million $	1.70	1.68	1.27	1.25	1.23	1.17
Year	19	20	21	22	23	24
Total cost/Million $	1.16	1.15	0.01	0.01	0.01	0.01

As can be seen from the chart, if we invest a lot of money to protect all endangered species on the list, it is not difficult to see that the total investment is decreasing year by year, and almost no investment is needed in the last five years. This is indeed ideal, since the survival rate and social value of plants remain stable while investment declines, thus successfully protecting endangered species. But this is not feasible. Because there is a lot of preparatory work to do at the beginning, the investment for the first three years will be very large, and given the current lack of funds, we cannot protect many species at the same time. We need to improve on that. Therefore, we need to combine the benefit, taxonomic uniqueness and success of plants to select some specific plants for protection. That's how you maximize your profits. We can make urgent prioritization to relieve economic pressures and maintain long-term stable investment. At the same time, the economic value of some plants is not high, there is no need to invest a lot of money to save their survival rate, can let nature, perhaps it has been written into the elimination of the list. The ultimate viability of the plant is also important. Some plants may have a high fertility rate, but they also have a high mortality rate, so the chances of saving them are low and there is less needed to invest heavily. So blind and massive investment may lead to less effective protection of endangered species.

3.2 Introduce an Improved Model

3.2.1 The Basic Principle of a New Model

Because the first model has an important defect, we are likely to introduce a new model that will combine the factors of time, cost and preciousness to analyze the protection time and the list of priorities.

In order to assure that each year our spending is roughly equal, we suggest to make Flowering Plants-415 a special plant because it costs much more money than other plants and its protection period is twenty years, which is longer than most of the plants we protected. Because of its length and its disparate cost, we put it into the special cluster that despite its uniqueness, benefits and success rate.

The second model first in turn analyzes the threaten rate of each species and then arranges them into different clusters. We need to use these clusters to suggest that the priority of protection time and use these models to generate a fund-rating project that the money we collected does not change a lot in the maximum extent.

The basic principle of our model is:

1: protecting the valuable plants preferentially

2: making sure that each year cost is roughly equivalent

3.2.2 Value Analysis

Firstly, we may use the rule to calculate preciousness which does not contain the analysis of cost and year, but only the profit that protecting plants bring. This value factor is influenced by the Feasibility of success, since this data measures the probability of success of this project, and it does influence the expecting value.

We will rearrange the serial number of each plant to make it easier to analyze. We use the number 1 to 48 to demonstrate the flowering-plants, by the sequences in the data table, from the upmost plants(plants-502) to the down-most plants(plants-415)

When people are thinking about the money they are going to spend, one dollar and one thousand dollars seem totally different. When spending same amount of money today or one weeks later, people's opinions also vary, since spending money one day later seems totally different with one years later. Because of this cognitive difference of time gap, we suggest using an adjustment to change the value we are going to spend.

We use the processed data to stimulate this cognitive difference by stating that

$$AP_iC_n = \left(1/\ln\left(e+n\right)\right)P_iC_n \quad (1)$$

$$ATC_i = \sum AP_iC_n \quad (2)$$

$$AAC_i = ATC_i / Y_i \quad (3)$$

$$RAAC_i = \left(AAC_i\right)/\left(AAC_{48}\right) \quad (4)$$

$$RFC_i = \left(FC_i\right)/\left(FC_{48}\right) \quad (5)$$

By adjusting these numbers, we may use a better way to calculate the cost and the spending expectations.

We use a function to change the P_iC_n to a suitable form by multiplying it with a function which is related to the year, so we may use this function to imitate the spending-delay expectations. In this functions, we can find out that in the first year, the year-related function is one, and as time pass by, the function is gradually decreasing below one, which means that the adjusted spending is slightly lower than real spending, which is corresponded to the cognition we discussed above. By multiplying this function, we are able to find a way to stimulate the supposed spending and then use what we have calculated to analyze the data.

After we calculate the P_iC_n, we may calculate the aggregate P_iC_n to get the adjusted total spending ATC_i of a plants protection program. ATC_i, may tell us the total expected cost of specific protection, and we are able to use it to measure the cost prospection of each plant.

By dividing the ATC_i by the program duration, we are able to understand the expected cost of each year of a program AAC_i. We may use this index to demonstrate the expect the average cost of this program, after adding the effect of time delay expectations.

We suggest that the first-year cost is also important because the first-year cost is the money we need to spend right now, so first year cost is relatively more important than seconds year cost and cost of later years. In addition, the adjusted first year cost is equal to the unprocessed first year cost, so we want to use this as a connection of the real data and the expected data.

However, we may find out that the order of magnitude between cost and other factors like uniqueness and benefits is too large, so we prefer to use a standard cost to demonstrate the limit of the spending. We find out the P48 (plant-415) is a special case because it has the greatest cost and its protection time lasts for twenty years. Because of its uniqueness in the cost and time, we decide to choose P48 as the standard. We compare all other FC_i and AAC_i to get RFC_i and $RAAC_i$. After this transmission, the magnitude of RFC_i and $RAAC_i$ is similar to other factors.

We may use several factors to decide which one we should protect firstly without considering the spending money of every year.

According to our point of view, we suggest we may use the factors of U_i, B_i, FS_i, $RAAC_i$, RFC_i, and Y_i to demonstrate the factor of priorities.

$$\Pr_i = \left(\left(U_i \times B_i\right) / \ln\left(Y_i\right)\right) \times FS_i - RAAC_i - RFC_i \qquad (6)$$

We may use P_i to demonstrate the priority of protection. The greater the P_i is, the quicker we need to protect.

Firstly, I suggest multiplying U_i with B_i to demonstrate the value index. Since uniqueness and benefit themselves have already meant the profit of protecting these plants, we need to find a way to combine these two factors together to get an aggregate profit index. According to the data table, we may find that both Benefit and Taxonomic Uniqueness have values like fractions, so we suggest that the data of Benefit and Taxonomic Uniqueness are something about comparison. In addition, since Benefits means threaten level and the complexity of protection, and Taxonomic Uniqueness represents biodiversity, we suggest that multiplying these two data to illustrate its protective interests.

Secondly, since there will be a delay of the start of the protection and the completion of the program, the time delay must consider. For example, the benefit we earn ten year later is totally different from benefit we earn tomorrow. In this endangered plant protection project, a plan that takes ten year to finish may produce different value than project which takes three years, even though it has the same benefits. For the sake of stimulating this phenomenon, we use $1/\ln\left(Y_i\right)$ as a parameter and multiply this to the value index to imitate the influence of time. According to this multiplication, if two plants have same value index, but their duration are different, this equation prefers the shorter one. On the other hand, the quick-finished program will generate positive externality after its protection, so the faster the program and the higher the benefits.

Thirdly, we multiply the index with the feasibility of success. This is comprehensible because even if people finish all the program, they fail to discourage the plants from being extinction, then there will be no benefits at all. Since the factors we calculate above is totally about protective values, so by multiplying the factors and the feasibility of success is a direct way of calculating the finally values of protecting a specific plant. The higher the feasibility of success, the greater possibility of bringing high benefits, and our equation also presents that. If two plants have identical data about other factors but only different with feasibility of success, the one with higher probability has higher priority index.

Then we want to find an index to represent both benefit and cost, so we may subtract the total cost to form total value. We need to take account of the cost, so we use two indexes to represent the cost. Each of them represents different factors of cost. Firstly, $RAAC_i$ represents the average cost of the program. By the adjustment of the cost by year, we may use $RAAC_i$ to represent the long run cost. Since $RAAC_i$ implies the cost of a long period of time. On the other hand, the RFC_i shows the detail of what we need to spend in the first year, because of this, we may use this as a short run representation. By combining short run and long run cost, we can determine the total cost, and therefore get the index about aggregate benefits and cost. The differences between these two important factors is the priority index.

Therefore, we adjust and then calculate the priority value of each plants. Here is a table to display all these data.

Table 3 the Priority Order of Each Project

unique_id	priority index	order
1-Flowering Plants-502	0.223226	1
1-Flowering Plants-436	0.066304695	2
1-Flowering Plants-536	0.48505211	3
1-Flowering Plants-486	0.176711167	4
1-Flowering Plants-183	0.004008311	5
1-Flowering Plants-480	0.03496266	6
1-Flowering Plants-135	0.086811201	7
1-Flowering Plants-481	0.208763684	8
1-Flowering Plants-176	0.036093121	9
1-Flowering Plants-475	0.003614599	10
1-Flowering Plants-546	0.054989	11
1-Flowering Plants-558	0.138936273	12
1-Flowering Plants-553	0.083441259	13
1-Flowering Plants-442	0.060049438	14
1-Flowering Plants-537	0.14866163	15
1-Flowering Plants-548	0.15381677	16
1-Flowering Plants-426	-0.028414279	17
1-Flowering Plants-452	0.02519812	18
1-Flowering Plants-173	-0.032483071	19
1-Flowering Plants-455	-0.1182083	20
1-Flowering Plants-133	0.01808444	21
1-Flowering Plants-168	0.025557792	22
1-Flowering Plants-476	0.037104147	23
1-Flowering Plants-543	-0.012157304	24
1-Flowering Plants-137	0.076135373	25
1-Flowering Plants-485	-0.135671998	26
1-Flowering Plants-528	-0.019652475	27
1-Flowering Plants-520	0.031182478	28
1-Flowering Plants-514	0.151761073	29
1-Flowering Plants-517	-0.118525479	30
1-Flowering Plants-529	-0.018293685	31
1-Flowering Plants-557	-0.105071139	32
1-Flowering Plants-492	-0.063232191	33
1-Flowering Plants-186	-0.054217716	34
1-Flowering Plants-179	0.048381796	35
1-Flowering Plants-560	0.062159889	36
1-Flowering Plants-530	-0.019499137	37
1-Flowering Plants-440	-0.114117726	38
1-Flowering Plants-513	-0.074977202	39
1-Flowering Plants-127	-0.102727626	40
1-Flowering Plants-524	-0.096427631	41
1-Flowering Plants-122	0.034213019	42
1-Flowering Plants-508	-0.296871497	43
1-Lichens-567	-0.358025123	44
1-Flowering Plants-507	-0.345941783	45
1-Flowering Plants-519	-0.325871983	46
1-Flowering Plants-551	-0.655144563	47

1-Flowering Plants-415	-1.933150568	48

By using this model, we suggest that we need to protect these plants by its priority index. We protect the most prior plant in the first year and protect the second most prior plant in the second year and then until we protect the least precious plant in the 48 years. This is used to stimulate the situation of protecting the plants only by its priority index. According the relation between the year of the spending, we may find out the spending is like a positive proportional function, and because the outliers such as plant-415, it has a long tail in the graph. Because of these characteristics of this graph, we may find out that arrange the time only with priority index is not practical.

3.3 Assignment of Fund

The first model has stated that protect all of the 48 plants in the same time is not practicable, so we should start the protection project of all 48 threatened plant in different time instead of pile the projects one on another in the same year. By using this value data table, we many create an algorithm to firstly protect valuable plants (presented in the graph) and then balance each year cost.

Firstly, we suggested that in order to get a stable spending plans, we first need to spend money on plants such as P48 (plant-415), since this plant protection duration takes 20 years. There is also a plant P34 which takes 24 years to protect, so we also need to spend money on this plant. Giving these plants priority protection can maintain long-term stability of the investment. Besides this, other plants requiring shorter periods of protection may be protected in order of importance. The larger the calculated PRI number is; the more endangered plants will be protected first. When this plant is out of danger, another plant will be protected later. In this way, more endangered plants can be protected with limited funds in the shortest time.

In Table 4, we calculate in periods of 5 years. 4 plants that needs protection of over 15 years are listed as objects to be protected for a long time. Because of the huge amount of upfront investment, we can maintain only those four plants for the first five years. Between year six and year twenty-four, we start to protect plants that take less time to get out of danger. We combine plants with large and small PR_i values to ensure that the fluctuations of the investment amount are not too large. From year six to year fifteen, all plants with high PR_i and several plants with minimum PR_i began to under protection. In the period from year sixteen to year fifteen, we decide to begin to protect the plants with low PR_i, since the first four plants were near the end of their protection. We allocate the capital reasonably. The investment amount will rise every five years, and then gradually decrease. The annual investment amount, except for the last 5 years, is basically maintained at 2-3million.

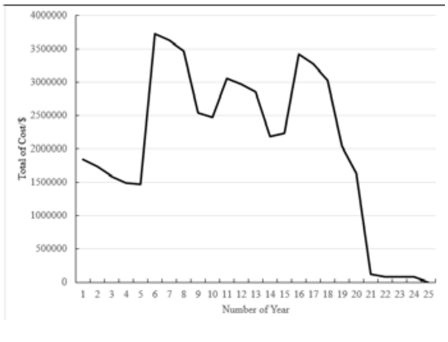

Fig.2 Changing in Total Cost

Table 4 the Detailed Cost of Each Year

Number of Year	1	2	3	4	5
Cost/$	1844031.52	1733104.76	1588693.25	1488432.61	1473695.65
Number of Year	6	7	8	9	10
Cost/$	3722102.29	3624884.43	3475456.27	2534691.83	2471687.15
Number of Year	11	12	13	14	15
Cost/$	3062767.48	2972529.27	2854585.39	2190391.63	2231573.13
Number of Year	16	17	18	19	20

Cost/$	3416892.1	3278306.08	3032637.3	2039322.47	1622983.238
Number of Year	21	22	23	24	25
Cost/$	114397.06	75516.31	74768.63	74028.34	0

In the graph we show above, we will first protect the four long duration plants besides its preciousness, since this is used to stabilize the annual cost. Therefore, the first five years' costs are steady, and is decreasing with a constant difference.

On the second five-year stage, we will begin sixteen conservation projects at the same, which cause a great leap of the annual cost. The cost each year even multiplied. However, since the conservation project with high priority index usually have a short period of project duration, there is a slight decrease on the third year of this stage. Beside this, the trend of total spending of the second stage is still decreasing.

On the third five-year stage, we will start fourteen projects in the first year, and it also led to an increase in the annual cost. However, since most of the project which start in the second stage have already finish before this stage, there will be only a relatively small increment in the spending. Same as the project in the stage two, the project starts in the stage three have a three-year duration or five-year duration, which cause a decrease in the third year because the third-year duration project cease to cost money. The tendency of spending in this stage is also decreasing.

On the fourth-year stage, we will start the last fourteen projects. By the same reason, there is a decreasing in the annual spending. However, since it is the last stage of investment, and most of the projects start before stop in the fourth sage, so there is a prodigious decrease in the end of the stage four. On the other hand, because the outliers, plants-415, do not need to be protected after the fourth stage, the annual cost decrease significantly.

On the last part of the graph, we may found that the aggregate cost of these projects turn to be very small, because there is only some project that start in the stage four have nine-year duration, and also the plant-186 takes 24 years to be protected, so the annual cost become very small.

It takes twenty-four years to protect all these plants in our program, and twenty-four years is also the minimum time to protect all the plants, because of the existence of plant-186. On the other hand, compare this graph to the graph in the first model, we may find out that there is a huge difference between them. Compare with that graph, our graph shows a stable curve, which demonstrate that our new model improved the cost spending strategy comparing to simply protect all the plants in the same time.

In addition, according to the graph, we may find out that we should set up the annual collection of funds in to 2,800,000 dollars. By accumulating funds in this speed, we can protect all the project without debt. It is true that there will be some deficits in some year, but the money we accumulate before will make up for this deficit and left some extra money for the emergencies.

4. Strength and Weaknesses

There are many characteristics of our model, since our model calculate and summarize the priority of being protected of these plants and the distribution of our funds. We all know that if there is a model and it is trying to analyze some problems, there must be some advantages of this model, and there must be some disadvantages to be improved.

In this section, we are going to analyze the advantages and the disadvantages of our model.

4.1 Strengths

There are mainly three advantages of our programs. The first one is about we set up different models and then analyze the characteristic of our models. The second one is about the adjusting of the cost and benefits data by time. The third one is about we suggest the stability of our annual spending.

We provide two model to assign our money by time. The first one is about begin the project of protecting all plants in the same time, and the second one is allocating the money by its projects' duration and its preciousness in spending. In each of the section, we analyze its characteristics about the cost, the benefits of following the model, and the feasibility of each model. By introducing two methods, the committee may compare these two models and then have a clear cognition about the spending program, and then think out a doable assignment.

We use some findings in psychology, that the prospection of spending money and gaining in different time is different. We use an equation to adjust this money cost. Therefore, we change the program more realistic. On the other hand, we also use this to regulate the benefits by time and proclaim that the benefits also decrease as the time passes. This makes our project and calculation of the priority more professional and practical.

We also suggest that there will be a roughly equal funds collection and money spending each year, because people's mind on environmental protecting will not change so quickly. Therefore, by setting the stability of funds gain in the assumption and our model's goal, we may find out that our model perfectly stimulates the reality.

4.2 Weaknesses

When there is a model, there must be some disadvantages. We suggest that there are two main disadvantages in our model, the first one is the over simplification of the calculation, and then the second one is that the calculation is mostly on our own model, and our result is heavily depending on our references received.

Our model is a simple model, it is only about the arithmetic and other things. For example, we simply multiply the three index and suggest it is the determine factors of benefits. We do not set up a fully logical weighting method and in turn results in a similar output. As you can see, the outcome of our calculation, PR_i, is really like each other, which demonstrate the defect of our model.

Because the only thing we can know is the data table, so our outcome and suggestions is heavily depending on the data we received. We calculate the index and then assign the order of conservation by the references, so if there is a mistake in our reference, then there will be an extremely effect on our conclusion.

Our programs have much more disadvantages, but we believe that if there is enough time, we will be able to improve our methods.

4.3 Model Improvement

This part is mainly about our suggestions of improving our methods if there is sufficient time.

Firstly, we will deeply analyze the index the preference provided and use mathematical methods to suggest about the weighting. For example, we may use the cluster method to separate all of the 48 plants into several clusters, and also use entropy weight method to decide the coefficient of each factors. Using these mathematical analyses brings about better assumption of the benefits of plants protection. Therefore, there will be no bias about our personal perceptions.

Second me may use a better algorithm to assure that annual cost will be equal. In our own model, we did improve the spending strategy to make sure that the annual cost is stable in some extent, but in fact, the improved annual method does not very stable. In the graph, we may find that the curve of this relationship is like a roller-coaster, which is higher and lower than the average cost. By using an effective algorithm, we may find a way to conserve the endangered species by spending almost equivalent amount of money and follow the rules we stated.

These are the two basic improvement we suggest changing if there is no time limit. There are also many ways to improve our method, but I will not introduce here.

5. Conclusion

We build an algorithm to analyze the protection program of all species of endangered plants. We use two models to illustrate the spending of completing all of these 48-conservation program. The first model stimulates a simplified situation, and the second model measures the cost, benefits, and the cost of protecting threatened plants each year to analyze a useful plan to distribute the funds. We also write a note to the FRPCE, to analyze and describe our methods. Of course, our model is not the best one, with a simplified method and some perceived data.

We introduce an equation to calculate the priority of protection by its benefits and cost, which means that the whether we firstly protect the threatened plants is primary depends on its taxonomic uniqueness, benefits and feasibility of success. By using this method, we analyze the data and produce a list of protection priorities.

According to our model, we assume that the annual funds collection should be 2,800,000 dollars. By accumulating fund at this speed, we may successfully invest all the 48 endangered plants program, and then protect these by the sequence of protection priorities. We first take notice of programs which take very long time to accomplish, and there are four programs that is suitable to this criterion. Second, we assign these projects by its priority index and their cost, to decide which stage they are going to be protected. After the arrangement, we create a list of protecting order and the annual cost of the aggregate spending program. By following the output of our model, FRPCE can efficiently protect all of the threatened plants.

6. Acknowledgment

Ruihan Wang,Xinran Gao,Chang Sun, The three authors contributed the same to this article, and they are ranked in no particular order.

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