



Short communication

Selecting flagship species to solve a biodiversity conservation conundrum


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ARTICLE INFO

Article history:

Received 16 October 2020

Received in revised form

14 January 2021

Accepted 15 January 2021

Available online 29 January 2021

Keywords:

Flagship species

Selection criteria

Biodiversity conservation

Proposed program

ABSTRACT

The difficulty of effectively monitoring and managing the environment to conserve biodiversity is as yet an unsolved conundrum. A project of the Chinese Academy of Sciences has concluded that progress can be made through the use of flagship species selected using criteria drawn from conservation biology, ecosystem function, socio-economics, and cultural importance. Inclusion of the latter three criteria will help attract and maintain the commitment of the public to play full parts in carrying out any conservation measures needed. A system is proposed for scoring species to select those that are most suitable as flagships. This method can be used regardless of the size of the area chosen for attention, whether it is a region, a country, or a particular protected area.

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Biodiversity conservation has become the most important common responsibility in the world. Maintaining biodiversity can effectively reduce the risk of diseases for humans, wild animals, and domestic animals (Rottstock et al., 2014; Han et al., 2015; Keesing, 2015). The latest attempt to define biodiversity (Pavid, 2020) has drawn attention to its complex nature, which raises questions about how best to respond to the challenges of biodiversity management and monitoring. Recently, scientists have proposed choosing a total of no more than 20 species each year to be rescued from pathways of extinction (Mark et al., 2020). Although conservation science can be used to draw up such lists of species based on threatened status, endemism and rarity, it remains unclear which species will become most vulnerable to extinction in any particular year.

By analyzing big data, we can adopt the concept of flagship species as the entry point to select indicative key species, monitor the changes of biodiversity through those limited number of key species, reveal the mechanism of changes in biodiversity, and effectively manage and protect biodiversity. The concept of

“flagship species” currently refers to endangered species that have been selected to represent a special habitat that needs to be protected. It is typically a large charismatic vertebrate used to gain public support (Zacharias and Roff, 2001). Some good examples have made important contributions to the public's biodiversity protection, such as the giant panda in China and the kangaroo in Australia. However, the concept of flagship species is still unclear at present, and its criteria are very controversial. We propose the inclusion of other criteria, additional to those based on conservation science as above, with the aim of linking the virtues of simplicity inherent in the use of such categories as ‘critically endangered’ and ‘country endemic’ in conservation science, with the complex systems with which the concept of biodiversity must engage in the real world.

1. The definition of flagship species needs to be updated

Scientists have adopted various concepts to help people understand the problem of biodiversity loss. Within conservation biology, the concepts of indicator, umbrella, focal, and keystone species all can be useful for identifying and monitoring changes in the amounts, types, and composition of biodiversity. However,

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Peer review under responsibility of Editorial Office of Plant Diversity.

these concepts are often confused and misused, even in the scientific literature (Caro et al., 2005; Isasi-Catala, 2011; Verissimo et al., 2011). It is not easy for the general public to understand what these concepts mean and why they are useful for the protection of biodiversity, and even harder to draw continued attention to related issues. The concept of flagship species can help solve this problem, mainly because it is not purely a concept that makes reference to science, but has rich societal and cultural connotations. Many theoretical analyses and practical conservation achievements have shown the usefulness of publicizing species that arouse the interest of all sections of society and support the conservation actions that need to be undertaken (Caro and O'Doherty, 1999; Barua, 2011; Verissimo et al., 2011).

The concept of a flagship species in conservation biology has two meanings. The first refers to species that are restricted to certain specific ecosystems. Their presence is taken to be a sign that the ecosystem exists. Focusing on the conservation of this type of flagship species facilitates the management and control of large areas of habitat, not only protecting flagship species, but many other less well-known species as well. The second meaning refers to those species that have strong spiritual, aesthetic, or cultural values. They have the potential to attract public attention, in the same way as do celebrities when they become engaged in campaigns of environmental protection.

2. Criteria for selecting flagship species

Many scientists have made suggestions about how to select flagship species. There is general agreement that the choice of criteria to be used in selection should be rigorous and systematic (Simberloff, 1998; Lindenmayer et al., 2002; Sitas et al., 2009; Caro, 2010; Verissimo et al., 2011; Jepson and Barua, 2015; Service, 2015; McGowan et al., 2020). The Chinese Academy of Sciences has launched a project to determine how flagship species should be selected for use in major projects and in priority countries. The project falls under a program called Pan-Third Pole Environment Study for a Green Silk Road (Pan-TPE), one of the Strategic Priority Research Programs of the academy. The Pan-TPE Region radiates from the Qinghai-Tibet Plateau to the surrounding areas, covering 65 countries along the "Belt and Road", and is the core area of the "Belt and Road" initiative. Intensive field surveys and other investigations, as well as interrogations of big data, have been undertaken to provide information for use in the project. Two symposia have been held to exchange ideas and discuss the selection criteria of flagship species. The scientists in the program have established a database on big data of biodiversity, and selected, investigated and catalogued flagship species in the Pan-TPE region.

In this short communication, we describe the six criteria that have been established as a result of the information collected and analyses made under the project. We also list eight species that we consider candidate flagship species for the Pan-TPE region (Table 1). Rules for allocating scores to species are also described. There are four possible scores that a species can receive for each criterion, except for one (Criterion 6 – Cultural or socio-economic value), which is considered especially important and can receive double the score of the other five criteria. Scores for each criterion include 0, 2, 5 and 10, with the maximum possible score being 70. Three of the criteria (conservation status, endemism and rarity) relate to conservation biology, one (ecological function) to environmental economics and two (degree of public attention, socio-economic and cultural value) to social marketing. The scores of selected species are shown in Table 2. If the candidate flagship species is qualified for 4 out of 6 indicators in the following list, we consider it an appropriate flagship species.

The six criteria are:

1. Conservation status of the species, according to IUCN endangerment categories, grouped further into 3 categories and scored as follows: (1) Critically Endangered (CR) and Endangered (EN) – 10 points; (2) Vulnerable (VU) – 5 points; (3) Near Threatened (NT) – 2 points. IUCN's criteria are clear and objective.
2. The endemic status of the species, divided into 2 categories scored as follows: (1) endemic to the country – 10 points; (2) endemic to the region – 5 points.
3. Rarity of the species, divided into 3 categories and scored as follows: (1) small population size and existing in a very limited area – 10 points; (2) small population, but having a large distribution range – 5 points; (3) relatively large population, but existing in a very limited total area – 2 points.
4. Ecological function value. Species that have been chosen as umbrella or focal species are good candidates in this respect. The idea of an umbrella species is of a single species that has the potential to signal to the people who benefit from the presence of the ecosystem in which it occurs the value of conserving that ecosystem. The idea of a focal species is that it is one of a suite of species that represent a pool of more species that are present in a habitat. Many other species will be protected if a focal species is successfully protected. Two scoring categories are proposed for this criterion: (1) those considered to be umbrella species – 10 points; (2) those regarded as focal species – 5 points.
5. Public interest. A high degree of public interest in a species has proved useful in many nature conservation projects. These high public profile species are sometimes described as being charismatic or ambassadorial. They can act as symbols and rallying points for conservation projects, issues, or wider conservation campaigns. Three categories are proposed for this criterion: (1) high – 10 points; (2) medium – 5 points; (3) low – 2 points.
6. Socio-economic and cultural values. Considerations here are the expected value of using the species in field projects and the positioning of species in markets and their degree of differentiation from possible alternative species. This category is divided into two categories, (1) high cultural value and (2) high socio-economic value, each of which can be awarded 10 points. This means that the total score for this criterion can be 20 points, rather than 10 points as with the other criteria.

3. Mutual effort for better biodiversity conservation

Simberloff (1998) believes that indicator species, umbrella species, and flagship species are all protected by a single species, and there are problems with huge protection costs and poor overall effect in biodiversity conservation. However, he ignores the improvements that can be made by choosing flagship species based on a combination of criteria, some relating to the traditional biological and ecological ways of prioritizing species and others relating to the roles of species in socio-economic systems and cultures. The inclusion of social and cultural criteria adds value in terms of fundraising efforts and in securing policy change, but, more importantly, it is a recognition of the conservation actions already being practiced by communities. The combination of this internal support for conservation with external support received in terms of personnel, finance and materials has the potential to achieve better conservation results (Verissimo et al., 2011; Jepson and Barua, 2015). We believe that the global adoption of our proposal to integrate biological and ecological criteria with elements selected through the social sciences has the potential to achieve historic advances in biodiversity conservation, including in making conservation systems more sustainable.

The United Nations has confirmed in its 2020 Global Biodiversity Outlook report that the world has failed yet again to achieve its

Table 1
List of the candidate flagship species for the Pan-TPE region.

Scientific Name	English Name	Type	Distribution	Key factors for flagship species
<i>Panthera uncia</i>	Snow leopard	Mammal	Twelve countries and regions, including China, Kazakhstan, Mongolia, Afghanistan, India, Nepal, Pakistan, Kyrgyzstan	VU; small population, but having a large range; representative highland animal; 'star' big cat that has received widespread international attention
<i>Capra falconeri</i>	Markhor	Mammal	Two countries: Uzbekistan and Tajikistan	CR; small population, and existing in a very limited area; endemic species in the region; high public attention; has great cultural influence among local people
<i>Saussurea medusa</i>	Snow lotus	Plant	Endemic species of the Qinghai-Tibet Plateau	NT; National Key Protected Wild Plants (Class II); whole herb is used as medicine with high economic value; high public attention
<i>Picea likiangensis</i> var. <i>rubescens</i>	Spruce	Plant	Endemic species of the Qinghai-Tibet Plateau	Relatively large population, but existing in a very limited area; both umbrella species and focal species; good wood texture with high economic value
<i>Aspiorhynchus laticeps</i>	Big-headed schizothoracin	Fish	Endemic to Tarim River, Xinjiang, China	National Key Protected Wild Animals (Class I); rare, single species in <i>Schizothorax</i> , with high academic and economic value
<i>Tor putitora</i>	Golden mahseer	Fish	Distributed in the Asian Himalayas and South Asian region, including Afghanistan, Pakistan, Bhutan, Iran, Sri Lanka, Thailand, Bangladesh, India, Myanmar, Nepal and China	EN; small population, but having a large range; named as National Treasure of the Indian Royal Family with high cultural and economic value, and public attention
<i>Grus nigricollis</i>	Black-necked crane	Bird	Mainly distributed in China's Qinghai-Tibet Plateau and Yunnan-Guizhou Plateau (Sanjiangyuan National Park Area), but also in Bhutan, India, Vietnam and Nepal	VU; small population, but having a large range; the only crane in the world that lives and reproduces on the Qinghai-Tibet plateau; high profile in Tibetan culture and Buddhist beliefs
<i>Aquila chrysaetos</i>	Golden eagle	Bird	Mainly distributed in the Central Asian region	VU; small population, and existing in a very limited area; large raptor, the national bird of Kazakhstan

Table 2
Scores of candidate flagship species for the Pan-TPE region.

Species Name	1.IUCN conservation status			2.Species endemism		3. Species rarity			4.Ecological function		5.Degree of public attention			6.Socio-economic values		Total score
	CR & EN	VU	NT	National based	Regional based	Category 1	Category 2	Category 3	Umbrella species	Focal species	High	Medium	Low	Cultural values	Economic values	
<i>Panthera uncia</i>	0	5	0	0	5	0	5	0	10	0	10	0	0	10	0	45
<i>Capra falconeri</i>	10	0	0	0	5	10	0	0	0	0	10	0	0	10	0	45
<i>Saussurea medusa</i>	0	0	2	0	5	0	5	0	0	5	10	0	0	10	10	47
<i>Picea likiangensis</i> var. <i>rubescens</i>	0	0	0	10	5	0	0	2	10	5	0	5	0	0	10	47
<i>Aspiorhynchus laticeps</i>	0	0	0	10	0	10	0	0	0	5	10	0	0	10	10	55
<i>Tor putitora</i>	10	0	0	0	0	0	5	0	0	5	10	0	0	10	10	50
<i>Grus nigricollis</i>	0	5	0	0	5	0	5	0	0	5	10	0	0	10	10	50
<i>Aquila chrysaetos</i>	0	5	0	0	5	10	0	0	10	0	10	0	0	10	10	60

conservation targets. China's researchers need to be at the table to ensure that their knowledge and talents contribute fully to advancing the cause of good governance of global biodiversity (Editorials, 2020). We propose the following actions be undertaken globally in a coordinated way, each involving different types of stakeholders:

1. Select flagship species for use in different geographical contexts, these including flagship species for use in particular countries, regions, biodiversity hotspots and key protected areas.
2. Establish a website to allow information about the flagship species to be shared internationally and to monitor and learn lessons from how well their selection as flagships has proved useful in practice.
3. Initiate public education campaigns, using flagship species to raise global awareness of the consequences of biodiversity loss and to provide information for fundraisers.
4. Initiate local community development projects that combine improvements in local economic development together with enhanced conservation of biological diversity. The objective is to link the promotion of local interests with feelings of

enhanced collective responsibility for conserving habitats and wildlife.

Author contribution

Jie Qian and Yuhua Wang wrote the initial manuscript. Huifu Zhuang, Weikang Yang, Yifeng Chen, Shilong Chen, Yanhua Qu, Yuanming Zhang and Yongping Yang collected and analyzed the data. Huifu Zhuang and Yongping Yang revised the manuscript.

Declaration of competing interest

All authors declare there are no conflict of interest, and agree to submit the paper.

Acknowledgements

This research was funded by grants from Pan-Third Pole Environment Study for a Green Silk Road (Pan-TPE), Strategic Priority Research Program of Chinese Academy of Sciences (XDA20050204).

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