Village Fengshui Forests Facilitate Biodiversity Conservation in Mountainous Rural Areas: A Case Study of Pseudolarix amabilis Postprint

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Abstract

Pseudolarix amabilis is one of China's most internationally influential ancient relict plants, currently facing multiple threats including habitat fragmentation, scattered populations, and declining individual numbers. Fortunately, existing research has indicated that village feng shui forests provide refuge for natural populations of Pseudolarix amabilis; however, the mechanisms through which these feng shui forests exert their protective effects remain to be thoroughly explored. Therefore, this study conducted a comprehensive investigation of the regeneration status, conservation practices, and disturbance levels of all natural populations of Pseudolarix amabilis through field surveys and community interviews, and elucidated the conservation and management model of Pseudolarix amabilis village feng shui forests using the natural population in Linjiatang Village as a case study. The results demonstrated that: (1) Compared with other habitat types, natural populations of Pseudolarix amabilis in village feng shui forest habitats exhibited a continuous diameter class structure and higher seedling density; (2) The feng shui and taboo culture embodied in "water mouth" forests, cemetery forests, and Yangji trees constitute the intrinsic reasons for the effective protection of natural populations of Pseudolarix amabilis by village feng shui forests; (3) The development of rural tourism in the new era has further promoted villagers' conservation of Pseudolarix amabilis village feng shui forests. In summary, against the backdrop of rural revitalization, the village feng shui forest conservation and management model based on feng shui and taboo culture represents an excellent model for the protection of natural populations of Pseudolarix amabilis.

Full Text

Village Fengshui Forests Contribute to Biodiversity Conservation in Mountainous Villages: A Case Study of *Pseudolarix amabilis*

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Abstract

Pseudolarix amabilis is one of the most internationally influential ancient relict plants in China, facing a multitude of threats including habitat fragmentation, population isolation, and declining individual numbers. Fortunately, Village Fengshui forests—sacred forests protected by Fengshui culture—have emerged as potential refuges for natural populations of *P. amabilis*. Nonetheless, the underlying mechanisms by which Village Fengshui forests safeguard these natural populations warrant in-depth exploration. To address this research gap, this study employed rigorous field investigations and community interviews to comprehensively assess the recruitment status, conservation behaviors, and disturbance extent for natural populations of *P. amabilis*. Moreover, we selected the *P. amabilis* population in Linjiatang as a representative case study to elucidate the protective and management paradigm of *P. amabilis* Village Fengshui forests. The results were as follows: (1) The diameter at breast height (DBH) structure of *P. amabilis* in Village Fengshui forests exhibited continuity, and seedling density was higher compared to other habitat types. (2) The effectiveness of Village Fengshui forests in protecting natural populations of *P. amabilis* can be attributed to the Fengshui and taboo culture associated with Shuikou forest (Village Fengshui forests near water sources), cemetery forest, and Yangji tree (heritage trees near residential houses). (3) The development of rural tourism has further contributed to the preservation of *P. amabilis* Village Fengshui forests. In conclusion, the protection and management approach based on Fengshui and taboo cultures in Village Fengshui forests presents an effective paradigm for safeguarding natural populations of *P. amabilis*.

Key words: *Pseudolarix amabilis*, Village Fengshui forest, conservation behavior, management paradigm, OECMs, rural revitalization

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Introduction

The rural revitalization strategy, proposed in the report of the 19th National Congress of the Communist Party of China, identifies ecological revitalization as its prerequisite and foundation, with biodiversity conservation and

sustainable utilization serving as crucial components (Zhang & Wang, 2021). Village Fengshui forests represent a typical example of rural biodiversity conservation and sustainable utilization (Teather & Chow, 2000; Yuan & Liu, 2009; Huang et al., 2020). Most Village Fengshui forests have survived to the present day under local protection and utilization, and with the vigorous development of rural tourism, they have been endowed with a new function—as tourism landscape resources (Tang et al., 2012, 2013; Chen et al., 2018; Zeng et al., 2018). Furthermore, the Kunming-Montreal Global Biodiversity Framework's "30$\times$30$target"proposesthatOtherEffectiveArea-basedConservationMeasures(OECMs)offerhopeforglobalachievementofthisgoal(L,2022).Sacrednaturals$ target" (Yuan & Liu, 2009; Hu et al., 2011; Lü, 2022). In summary, Village Fengshui forests are of great importance for both rural revitalization and rural biodiversity conservation.

Pseudolarix amabilis, a monotypic genus endemic to China, is one of the country's most internationally influential ancient relict plants. Listed in China's Rare and Endangered Protected Plants Catalogue, it is classified as a nationally second-class protected species (National Forestry and Grassland Administration & Ministry of Agriculture and Rural Affairs, 2021). *P. amabilis* currently faces numerous threats including habitat fragmentation, population isolation, and declining individual numbers, yet conservation efforts remain limited (Yang & Christian, 2013; Zhou et al., 2022). Fortunately, previous research has confirmed that Village Fengshui forests can effectively protect natural populations of *P. amabilis* (Zhou et al., 2022). At present, only five natural populations exist, all located in the Yangtze River Basin: Tianmu Mountain National Nature Reserve (hereafter "Tianmu Mountain NNR") in Zhejiang Province, Linjiatang Village in Hangzhou's Lin'an District, Maohuo Ancient Village in Haishu District of Ningbo, Shuanglian Village in Yixian County of Huangshan City in Anhui Province, and Qingtangpu Town in Anhua County of Yiyang City in Hunan Province (Pan, 2000; Wu et al., 2012; Zhou et al., 2022). The habitats of these natural populations can be categorized into four types: natural forests, Village Fengshui forests, abandoned farmland secondary forests, and bamboo forests. Each population faces different threats and employs varying protection and management behaviors across these habitat types (Wang, 2014; Xie et al., 2018; Zhou et al., 2022). Comparatively, natural populations in Village Fengshui forest habitats exhibit good seedling regeneration and more complete population structure (Zhou et al., 2022). However, the specific protection and management models of Village Fengshui forests and how they function in protecting natural populations of *P. amabilis* remain unknown.

Natural populations of *P. amabilis* preserved as Village Fengshui forests are distributed in Linjiatang Village, Maohuo Ancient Village, and Qingtangpu Town. Among these, Linjiatang Village harbors the largest natural population outside nature reserves, with its core distribution area located in the Village Fengshui forest. This population retains numerous ancient individuals, exhibits stable population structure, continuous diameter classes, and good regeneration (Zhou et al., 2022). Therefore, Linjiatang Village represents an excellent sub-

ject for exploring the protection and management model of *P. amabilis* Village Fengshui forests and holds high conservation value. Based on this, our study focused on natural populations of *P. amabilis*, employing a combination of field investigations and community interviews to clarify the regeneration status, conservation behaviors, and disturbance extent across different habitats, and using the Linjiatang Village population as a case study to explore the protection and management model of *P. amabilis* Village Fengshui forests. This study aims to answer: (1) Do Village Fengshui forests provide effective protection for natural populations of *P. amabilis* compared to other habitats? (2) How do Village Fengshui forests function in protecting natural populations of *P. amabilis* under the background of rural revitalization? Our findings can contribute to constructing effective conservation models for some rare and endangered plants and developing OECM-based conservation systems in China.

Methods

1.1 Study Area

The five distribution sites of natural *P. amabilis* populations are Tianmu Mountain NNR, Linjiatang Village, Maohuo Ancient Village, Shuanglian Village, and Qingtangpu Town. Based on vegetation characteristics, site conditions, and human disturbance, habitats can be classified into four types: natural forests, Village Fengshui forests, abandoned farmland secondary forests, and bamboo forests. The Tianmu Mountain NNR population occurs in "natural forest" habitat; the Linjiatang Village population occurs in both "Village Fengshui forest" and "bamboo forest" habitats; the Maohuo Ancient Village population also occurs in "Village Fengshui forest" and "bamboo forest" habitats; the Shuanglian Village population occurs in "abandoned farmland secondary forest" habitat (farmland abandoned in the late 1970s); and the Qingtangpu Town population occurs in "Village Fengshui forest" habitat (Table 1).

The primary study area, Linjiatang Village, is located on the mountainside of Caogang Mountain at 800–1,000 m elevation. With a mild climate, abundant sunlight, and beautiful natural scenery, it is one of the famous traditional villages in Lin'an District. The village has a history of over 300 years, with more than 100 households and over 360 residents. The main ethnic group is Han, with the Lin clan as the principal family. The village's primary income sources are operating agritourism businesses, followed by selling bamboo shoots and tea. Linjiatang Village possesses the largest natural *P. amabilis* population outside nature reserves, with its core distribution area located in the Village Fengshui forest. This population has formed an ancient *P. amabilis* community designated as a provincial key protection area, officially named "Linjiatang *Pseudolarix amabilis* Provincial Key Protection Area" (Figure 1 [Figure 1: see original paper]).

1.2.1 Community Plot Survey

A total of 26 plots were established across the five distribution sites, with plot sizes of 20 m × 20 m or 20 m × 30 m. Complete enumeration was used to survey all woody plants ≥ 1.3 m in height, recording species name, height (H, m), and diameter at breast height (DBH, cm). For woody plants < 1.3 m height, species name, height (H, m), and coverage (%) were recorded. Within each plot, a 5 m × 5 m subplot was established to measure *P. amabilis* seedlings (H < 1.3 m), recording height (H, m) for each seedling. Plot coordinates, elevation, aspect, and slope were also recorded. We defined individuals as seedlings (H < 1.3 m), saplings (1.3 m ≤ H ≤ 8 m), and adults (H > 8 m).

1.2.2 Investigation of Conservation Behaviors and Disturbance Extent

Information on conservation behaviors and disturbance extent was obtained primarily through community interviews, supplemented by field observations. At each distribution site, key informant interviews (3–5 people) were conducted using semi-structured interviews focusing on conservation behaviors and disturbance patterns for each habitat type. Key informants varied by location—for example, nature reserve managers were selected for Tianmu Mountain NNR, while descendants of local Fengshui masters (the Fengshui master himself had passed away), village committee members, and elders with extensive traditional knowledge were selected for Linjiatang Village. Following interviews, we summarized human disturbance levels for each habitat type based on field observations. Notably, disturbance levels were relative, derived from comparative analysis across habitat types.

1.2.3 Investigation of Retention Reasons for Linjiatang Village Fengshui Forest

Retention reasons for the Linjiatang Village Fengshui forest were also investigated through community interviews using key informant interviews with one descendant of the Fengshui master, one village committee member, and three elders with extensive traditional knowledge. Additionally, information on the uses of the Linjiatang Village Fengshui forest was collected through sampling interviews. With over 100 households in the village, we sampled 30 households (30%) for interviews, with 1–3 people interviewed per household. Responses were compiled into effective questionnaires, yielding 30 valid questionnaires.

Results

2.1 Population Structure of *P. amabilis*

The DBH structure of natural *P. amabilis* populations varied across habitats. In natural forests, the DBH distribution was discontinuous, ranging from 10–115 cm, with large-diameter individuals dominant and individuals in the 0–10 cm size class absent (Figure 2 [Figure 2: see original paper]: A). In Village Fengshui

forests, the DBH distribution showed an "L-shaped" pattern, typical of growing populations, with the highest number of individuals in the 0–10 cm size class. Individuals with DBH < 40 cm accounted for 67% of the total population, with the largest individual reaching 127.7 cm DBH (Figure 2: B). In abandoned farmland secondary forests, the DBH distribution was relatively uniform but dominated by 0–30 cm size classes, with generally smaller DBH and maximum size not exceeding 60 cm (Figure 2: C). In bamboo forests, the DBH distribution was discontinuous with multiple gaps, lacking individuals in the 0–10 cm and 110–120 cm size classes, and dominated by 20–40 cm size classes (Figure 2: D).

Seedling density also differed across habitats. Natural forests had low seedling density at approximately 0.44 individuals $\cdot$ m^{-2}. Village Fengshui forests showed good seedling regeneration with high density at approximately 5.4 individuals $\cdot$ m^{-2}. Abandoned farmland secondary forests had low seedling density at approximately 0.81 individuals $\cdot$ m^{-2}, while bamboo forests also had low density at approximately 0.98 individuals $\cdot$ m^{-2} (Figure 3 [Figure 3: see original paper]).

2.2 Conservation Behaviors and Disturbance Extent

Conservation behaviors and disturbance extent varied across habitats. In natural forest habitats, *P. amabilis* populations primarily occurred on slopes along valley sides and on terrain transition lines from valley to ridge, with relatively poor habitat stability and some natural disturbance. The understory contained many broadleaf species. As a designated nature reserve, this habitat employed strict protection measures including fencing to eliminate human disturbance, resulting in low disturbance intensity and frequency. In Village Fengshui forest habitats, *P. amabilis* populations occurred around villages, near houses, water sources, or ancestral cemeteries, with good understory light conditions and relatively stable habitats. These habitats were managed autonomously by local villagers with moderate timber thinning or canopy pruning, strictly prohibiting severe human disturbance activities. Most Village Fengshui forests also prohibited damage to saplings, and almost all large-diameter individuals were protected as ancient and famous trees, resulting in moderate disturbance intensity and frequency. In abandoned farmland secondary forest habitats, *P. amabilis* populations occurred on abandoned farmland on both sides of mid-slope valleys, far from villages on high mountain gentle slopes. These communities were undergoing rapid succession with many understory broadleaf species. Being far from villages with rare villager presence, disturbance intensity and frequency were low. In bamboo forest habitats, *P. amabilis* populations were scattered within bamboo forests on gentle mid-slopes near farmland or villages. Bamboo forests had extremely high density, poor understory light conditions, and thick ground litter layers. Periodic bamboo shoot harvesting and mature bamboo cutting activities created high-intensity and high-frequency surface disturbance, causing substantial seedling mortality and severely hindering seedling establishment. Additionally, the high canopy density limited understory light, inhibiting early-stage seedling survival (Xu et al., 1982; Yu et al., 2003).

2.3 Retention Reasons for Linjiatang Village Fengshui Forest

The core distribution area of the natural *P. amabilis* population in Linjiatang Village is a typical Village Fengshui forest, representing a triple-layered *Pseudolarix* forest combining Shuikou forest (Fengshui forest at the village water source), cemetery forest, and Yangji tree (large trees around houses). The forest is collectively owned and has remained unchanged despite economic and forestry policy changes (Figure 4 [Figure 4: see original paper]: A, C, D). The forest features many ancient *P. amabilis* trees and has been developed into a *Pseudolarix* Park, becoming one of the area's famous tourist attractions (Figure 4: B, E). The Village Fengshui forest allows collection of firewood and other resources (such as medicinal materials) but prohibits damage to large-diameter individuals, primarily due to taboo culture surrounding Yangji trees. Overall, the Linjiatang Village Fengshui forest was initially preserved as Yangji trees and later maintained due to water source conservation and ancestral cemeteries. Notably, although the forest carries triple meanings, Shuikou forest is the most important to villagers, followed by Yangji trees and cemetery forests, because before tap water was available, the two ancient wells located in the *Pseudolarix* Fengshui forest were the village's sole water source, intimately connected to the entire village's production and daily life (Table 2).

Discussion

3.1 Protective Role of Village Fengshui Forests for *P. amabilis*

Our findings indicate that disturbance extent across different habitats is a crucial factor affecting *P. amabilis* population regeneration and maintenance. Relatively speaking, Village Fengshui forest habitats are more conducive to population regeneration, while the other three habitat types exert certain inhibitory effects on regeneration. This is because *P. amabilis* is a light-demanding and water-requiring species, yet it faces competitive disadvantages compared to broadleaf species in acquiring light and water resources (Yang & Christian, 2013; Zhou et al., 2022). Therefore, *P. amabilis* regeneration requires heterogeneous habitats such as forest gaps and edges created by moderate disturbance to balance the negative impacts of interspecific competitive disadvantages (Tang et al., 2013; Song et al., 2019; Zhou et al., 2022). Among the four habitat types, natural forests and abandoned farmland secondary forests contain numerous broadleaf companion species (Yang & Christian, 2013; Zhou et al., 2022). Under low disturbance conditions, *P. amabilis* seedlings are at a significant competitive disadvantage in the understory, with few seedlings currently found and potential difficulties in future regeneration. Bamboo forests experience periodic bamboo shoot collection and mature bamboo cutting activities, subjecting *P. amabilis* seedlings to high-intensity and high-frequency surface disturbance that causes substantial seedling mortality and severely hinders seedling establishment. Additionally, the high canopy density limits understory light, inhibiting early-stage seedling survival (Xu et al., 1982; Yu et al., 2003). In contrast, moderate human disturbance in Village Fengshui forests effectively eliminates *P. amabilis*' inter-

specific competitive disadvantages while creating heterogeneous environments and improving understory light conditions, thereby promoting population regeneration and maintenance. In summary, the protection and management model of Village Fengshui forest habitats represents an excellent paradigm for conserving natural populations of *P. amabilis*.

Beyond *P. amabilis*, Fengshui forests also provide habitats for many other rare and endangered tree species, such as *Liriodendron chinense*, *Sinojackia huangmeiensis*, *Phoebe zhennan*, *Taxus wallichiana* var. *mairei*, and *Ginkgo biloba* (Jiang & Zhang, 2011; Tang et al., 2012, 2013; Wang et al., 2018). Natural populations of these rare and endangered species are scattered, and current nature reserves cannot fully cover them. Fengshui forests thus play a protective role where nature reserves are absent (Tang et al., 2012, 2013; Wang et al., 2018). This highlights the importance of investigating the rare and endangered plant protection model in Fengshui forests. However, since Fengshui forests provide different protective effects for different rare and endangered species, more species-specific studies are needed to summarize commonalities in the rare and endangered plant protection model of Fengshui forests.

3.2.1 Faith- and Taboo-Based Conservation Approach

China's traditional culture is rich and diverse, and under the influence of Fengshui thought in natural and social development, a complex socio-cultural phenomenon of faith and taboos has spontaneously formed (Colding & Folke, 2001; Hu et al., 2011; Chen et al., 2018). Traditionally held beliefs passed down through generations hold that destroying Village Fengshui forests will incur divine punishment and misfortune, while protecting them will bring good fortune (Huang et al., 2020). This faith and taboo culture plays a crucial role in environmental and biodiversity conservation in Linjiatang Village, even exerting positive effects beyond what laws and regulations can achieve (Yuan & Liu, 2009; Hu et al., 2011; Tang et al., 2012, 2013). This study explains the protective role of faith and taboo culture on Linjiatang Village Fengshui forests from three aspects: Shuikou forest, cemetery forest, and Yangji tree. First, *P. amabilis* in the Linjiatang Village Fengshui forest is mainly distributed around an ancient well, with good population regeneration and vigorous growth. The well is still used by villagers today, supporting village vitality while playing important roles in water conservation and microclimate regulation (Wang, 2014; Cheung & Hui, 2018), thus creating a harmonious state of mutualistic coexistence between *P. amabilis* and local villagers. Second, multiple ancient tombs of the Lin clan (the principal clan in Linjiatang Village) are located under the Fengshui forest canopy. Villagers believe that protecting cemetery Fengshui forests can bless descendants and signify family prosperity (Cheng et al., 2009). Third, taboo culture surrounding Yangji trees also ensures strict protection of ancient individuals in the Linjiatang Village Fengshui forest. Local stories circulate about retribution for damaging Yangji trees, with such "punishment" affecting not only individuals but also their descendants, exerting powerful behavioral

constraints on villagers. These beliefs rooted in villagers' hearts create stronger willingness to participate in protecting *P. amabilis* Village Fengshui forests, resulting in effective protection of this population. This traditional faith-based approach to forest conservation holds important value for biodiversity conservation in this region.

The faith- and taboo-based conservation approach of Village Fengshui forests in this study is similar to sacred natural sites in other parts of the world. Although different regions have different types of sacred natural sites (with different cultural types playing roles)—such as church forests in central Italy, northwestern Greece, and central and northern Ethiopia; cemetery forests in Istanbul, Turkey, and Berlin, Germany; sacred mountain forests in Tibet, China; "Longshan" forests in Xishuangbanna, China; and Village Fengshui forests in this study (Salick et al., 2007; Frascaroli, 2013; Aerts et al., 2016; Frascaroli et al., 2016; Kowarik et al., 2016; Yilmaz et al., 2018)—all sacred natural sites are community-based natural protected areas founded on traditional cultural beliefs (Verschuuren, 2010). These traditional cultures give local communities strong willingness to protect their sacred natural sites, making such community-based conservation approaches more effective than externally imposed measures. The effective protection of *P. amabilis* natural populations by Village Fengshui forests in this study provides strong empirical evidence for this.

3.2.2 Economic Development-Based Conservation Approach

The Linjiatang Village Fengshui forest retains over 180 ancient trees including *P. amabilis*, which have been officially protected by the Lin'an District government. With the rise of tourism, this ancient tree community has become a new emblem for Linjiatang Village, attracting numerous visitors. Moreover, as a typical colorful-leaf species with tall, straight trunks and neat, beautiful form, *P. amabilis* transforms from light green to golden yellow in autumn, creating a spectacular landscape that draws visitors from far and wide. To protect *P. amabilis* and attract tourists, Linjiatang Village has established a *Pseudolarix* appreciation theme park—*Pseudolarix* Park—through joint efforts of local government and villagers. Tourism development has not only increased villagers' income but also subtly promoted their protection of *P. amabilis* Village Fengshui forests.

The Linjiatang Village Fengshui forest receives spontaneous protection from villagers, forming an interdependent relationship through long-term coexistence. By leveraging the intrinsic attributes of *P. amabilis* as a conservation target, Linjiatang Village has developed a characteristic tourism industry centered on *Pseudolarix*. This approach has established a regionally distinctive tourism industry, created a local plant culture symbol, and promoted the conservation and awareness of the rare and endangered *P. amabilis*, holding significant educational value. Furthermore, developing agritourism based on *Pseudolarix* sightseeing has facilitated the transformation of traditional agriculture to new forms of tourism in rural areas, solving employment issues while increasing villagers'

income, effectively promoting community economic development and enhancing villagers' enthusiasm for conservation. This win-win synergistic model of species conservation and community development represents a successful paradigm for rare and endangered species protection.

Conclusion

This study systematically explored the effective protection model of Village Fengshui forests for natural populations of *P. amabilis*. Throughout history, the Fengshui and taboo culture embodied by Village Fengshui forests has led to strict protection of *P. amabilis* natural populations by local villagers. Under the recent background of rural revitalization, *P. amabilis* natural populations in Village Fengshui forests have served as high-quality landscape resources, providing substantial support for rural tourism development, which has further promoted local villagers' protection of these populations. Overall, the protection and management model of Village Fengshui forests represents a win-win synergistic model for both *P. amabilis* natural population conservation and community development, offering a reference for protecting similar rare and endangered plants distributed in human settlement areas.

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Note: Figure translations are in progress. See original paper for figures.