

Population growth model and landscape characteristics analysis of the Sarus crane (*Grus antigone sharpii*) in Tram Chim National Park, Vietnam

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Abstract: Vietnam Tram Chim National Park is the main distribution site of *Grus antigone sharpii* in Vietnam, and also the rewilding site of Chinese Sarus Crane population before reintroduction. However, the population of Sarus Cranes in this area has been declining since it was discovered in 1986, which is not encouraging. In order to explore the reasons for population decline of Sarus Cranes in Tram Chim National Park, this study started from the two aspects of population internal factors and external landscape environmental factors, used logistic equation, Malthus equation and circumferent growth rate to fit the growth models of overlapping population in finite environment, non-overlapping population in infinite environment and overlapping population in infinite environment respectively. ENVI5.3, ArcGIS10.5 and Landsat remote sensing images from 1988 to 2022 were used to analyze the environmental resistance to the population growth of Sarus Crane from the level of land use type and landscape characteristics. The results showed that: (1) the population size of Sarus Crane population declined during 1988-2022 until it reached zero. (2) Three methods were used to fit the population growth model of Sarus Crane. Under the premise of overlapping generations, in a finite environment, the logistic equation showed that the population fitting curve of Sarus Crane was relatively flat on the whole, and did not overlap with the observed population curve. In 2000, the two curves crossed. Under the premise of overlapping generations, the Malthusian equation showed that the population fitting curve and the observed population curve had a certain synchronization during 1988-2000, but the fluctuation was not as obvious as that of the observed population. After 2000, the fitted population curve was stable and the fitted population size was significantly higher than the observed population size. Under the condition of non-overlapping generations, the average circumferential growth rate of the population was 0.89 in an infinite environment. In the fitted population curve, the observed population in 1992 and 1996 deviated significantly from the fitted population, and the observed population fluctuated around the fitted population curve in other years, showing a certain degree of synchro. (3) The plant communities in the park include *melaleuca* biome, *Nelumbo* biome, *Panicum repens* - *Oryza* biome, *Eleocharis* biome, mixed plant biome, water canal (especially artificial canals), and water area (seasonal surface water); The dominant plant communities were *Panicum repens* - *Oryza* biome and *melaleuca* biome, and the biome area of *melaleuca* biome was negatively correlated with the population of Sarus Crane. The area of *Eleocharis* biome fluctuated greatly, which was positively correlated with the population of Sarus Crane. (4) Both patch type level and landscape level affected the population of Sarus Crane. At the level of patch type, the population of Sarus Crane was positively correlated with the area of *Eleocharis* biome, the perimeter integral dimension of *Nelumbo*, and the maximum

patch index of mixed plants. There was a significant or extremely significant negative correlation with *melaleuca* biome area and the distribution index of *Panicum repens* - *Oryza*. At the landscape level, the population of Sarus Crane was positively correlated with the integral dimension of its perimeter. Further analysis shows that the observed population of Sarus Cranes was subjected to the limitation of environmental resources in the park from 1988 to 2000, and there is a delay effect in the environmental resistance.

The decrease of the population was influenced by the significant decrease of the *Eleocharis* biome and the significant increase of the *melaleuca* biome. Based on this, it is suggested that the biome of *Eleocharis* biome and *melaleuca* biome should be properly managed according to the needs.

Key words: Population growth model; Land use type; Landscape characteristic; Sarus crane; Tram Chim National Park