

# 中国自然保护地鸟类被动声学监测、分析与评估框架初探

## A Preliminary Study on the Framework for Passive Acoustic Monitoring, Analysis, and Assessment of Birds in China's Nature Reserves

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### 摘要

被动声学监测 (Passive Acoustic Monitoring, PAM) 作为一种新兴的生物多样性监测技术, 在鸟类生态学与保护研究中展现出巨大潜力。现有PAM技术框架主要源自欧美发达国家, 因此, 在中国自然保护地实践过程中面临设备参数不统一、数据格式各异、评估标准缺失等本地化适配难题, 难以有效支撑国土空间规划、生态红线监管及国家公园管理政策等需求。系统梳理PAM技术的理论基础、方法演进与综合评估体系。通过对比传统鸟类调查方法与PAM在种群与群落监测层面的差异性与互补性, 揭示PAM在时间连续性、物种检出率和成本效益上的显著优势。并基于现有国际规范及相关文献的系统综述, 系统总结了核心监测目标、设备布设要点、设备布设目标、鸣声量化技术、监测框架等方面要点, 进一步构建涵盖“个体-种群-群落”多层级、融合声学活动、物种识别、声景特征与管理评估等多功能的PAM综合评估框架。研究表明: (1) PAM技术正推动鸟类监测从单一物种向群落与生态系统尺度转变; (2) 现有国际框架需结合中国保护地分区管控、生态修复成效评估等具体场景进行本土化调整; (3) 建议建立全国统一的设备参数标准、数据采集规范及共享机制, 为生态红线监管、保护地成效评估及声景遗产保护提供系统性技术支撑。旨在为中国自然保护地鸟类被动式声学监测指南等制定提供理论依据与实践参考。

### 关键词

被动声学监测; 鸟类多样性; 评估框架; 鸟类活跃度; 声景; 中国自然保护地

### Abstract

Passive Acoustic Monitoring (PAM), an emerging technology in biodiversity monitoring, exhibited considerable potential for research in avian ecology and conservation. The prevailing technical framework for PAM primarily originates from developed nations in Europe and the United States; consequently, its application within our country's nature reserves faces challenges in adequately supporting land and spatial planning, ecological red-line oversight, and the management policies of national parks. This paper systematically examines the theoretical basis, methodological evolution, and comprehensive evaluation system of PAM technology. By comparing the differences and complementarities between traditional bird survey methods and PAM at the population and community monitoring levels, the significant advantages of PAM in terms of time continuity, species detection rate, and cost-effectiveness are revealed. Based on the systematic review of existing international norms and related literature, this paper systematically summarizes the key points of core monitoring objectives, equipment deployment points, equipment deployment objectives, sound quantification technology, monitoring framework, etc., and further constructs a multi-functional PAM comprehensive evaluation framework covering “individual-population-community” multi-level, integrated acoustic activities, species identification, soundscape characteristics and management evaluation. The results show that: (1) PAM technology is promoting the transformation of bird monitoring from a single species to a community and ecosystem scale. (2) The existing international framework needs to be localized in combination with specific scenarios, such as zoning control of protected areas and ecological restoration effectiveness evaluation in our country. (3) It is recommended to establish a national unified equipment parameter standard, data collection specification, and sharing mechanism to provide systematic technical support for ecological red line supervision, evaluation of the effectiveness of protected areas, and protection of soundscape heritage. This paper aims to provide a theoretical basis and practical reference for formulating passive acoustic monitoring guidelines for birds in nature reserves in our country.

### Keywords

passive acoustic monitoring; bird diversity; evaluation framework; bird activity; soundscape; China's nature reserve

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