

附录3 基于被动声学监测的鸟类多样性与生态系统质量评估指标体系

Table 3 Assessment indicator system for avian diversity and ecosystem quality based on passive acoustic monitoring

评估维度 EBV class	关键变量 EBV name	声学替代指标 Acoustic proxies	评估目标与判读方法 Target & interpretation
物种种群 Species populations	物种分布 Species distributions	声学占域率 Acoustic occupancy	目标: 监测旗舰种/濒危种的时空分布格局。Target: Monitor spatiotemporal distribution patterns of flagship/endangered species. 判读: 比较当前占域率与历史基线。若关键物种在原分布区内的声学占域率检出率显著下降或归零, 提示分布范围收缩或发生局部灭绝 (Campos-Cerqueira & Aide, 2016)。Interpretation: Compare current occupancy rates with historical baselines. A significant decline or drop to zero in the acoustic detection/occupancy rates of key species within their original range indicates range contraction or local extinction (extirpation).
	种群丰度 Species abundances	鸣叫计数/强度 Call rate/Intensity	目标: 评估目标种群的数量变化趋势。Target: Assess population abundance trends of target species. 判读: 构建单位时间鸣叫密度的时间序列。若鸣声密度呈显著持续下降趋势, 指示种群数量衰退或生境承载力下降(P érez-Granados & Traba, 2021)。Interpretation: Construct time series of call density per unit time. A significant, sustained declining trend in vocalization density indicates population decline or reduced habitat carrying capacity.
群落组成 Community composition	群落多样性 Taxonomic diversity	声学多样性指数 Acoustic index	目标: 评估群落结构的复杂性与丰富度。Target: Assess the complexity and richness of community structure. 判读: 指数值与物种丰富度呈正相关。若数值长期维持低位, 指示群落结构简单化或生物多样性丧失。Interpretation: Index values are positively correlated with species richness. Persistently low values indicate community simplification or biodiversity loss.

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生态系统功能 Ecosystem function	时空动态 Spatio-temporal dynamics	声学相异度 Acoustic dissimilarity	目标：监测群落演替方向与时空异质性。Target: Monitor the direction of community succession and spatiotemporal heterogeneity. 判读：时间维度：若非季节性的声学指纹发生剧烈更替，提示群落稳定性受损；空间维度：若不同样点间的声学相异度显著降低，则存在生物均质化风险(Lellouch et al., 2014)。Interpretation: Temporal Dimension: Drastic non-seasonal shifts in acoustic fingerprints indicate compromised community stability; Spatial Dimension: A significant decrease in acoustic dissimilarity between sampling sites suggests a risk of biotic homogenization.
	生态系统干扰 Ecosystem disturbances	人为噪声 Anthrophony level	目标：评估鸟类发声空间质量。Target: Evaluate soundscape quality. 判读：监测1–8 kHz频段内的信噪比。若人为噪声频域对生物声构成显著遮蔽，表明声学空间质量下降，阻碍物种正常通讯(Barber et al., 2010)。Interpretation: Monitor the signal-to-noise ratio (SNR) within the 1–8 kHz band. If anthrophony significantly masks biophony in the frequency domain, it indicates degraded acoustic space quality and hinders normal species communication.
	生态功能完整性 Functional integrity	声学生态位 Acoustic niche	目标：评估生态系统对声学资源的利用效率与功能完整性。Target: Assess the utilization efficiency of acoustic resources and functional integrity of the ecosystem. 判读：基于声学生态位假说(ANH)，健康的生态系统应具有较高且和谐的频带占用情况(Burivalova et al., 2018)。Interpretation: Based on the acoustic niche hypothesis (ANH), healthy ecosystems should exhibit high and coordinated spectral occupancy.

参考文献 References

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