Relationship between habitat characteristics and acoustic ecological indicators in cocoa agroforestry systems of Ghana

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Abstract

West African cocoa makes up 70 % of the world market, including 25 % grown by Ghanaian smallholder farmers. Nearly 2 million farmers grow cocoa (*Theobroma cacao*) in West Africa and a high percentage live in poverty. Increased cocoa production has resulted in major forest loss and species population declines in Ghana. Therefore, the sustainable production of cocoa is critical to provide the greatest benefit through economic viability while maintaining biodiversity and ecosystem services. Growing cocoa with shade trees in agroforestry systems has been proposed as a suitable way to maintain habitat on cocoa farms while providing other benefits such as food and timber. The relationships between cocoa yield, water usage, nutrient balances, and shade trees have been widely established in the literature. However, there is a significant knowledge gap in understanding the relationships between cocoa agroforestry habitat characteristics and biodiversity. Birds and bats are commonly used ecological indicators because of their sensitivity to changes in their environment and correlation to biodiversity in other taxonomic groups. This study uses bioacoustic monitoring and indices for the first time to study actors influencing biodiversity on West African cocoa farms. We carried out cocoa farm tree inventories and 24-hour bioacoustic sound recordings from November 2022 – February 2023 on 119 cocoa farms in four regions across the moist semi-deciduous forest zone of Ghana. We estimated landscape-level tree cover using the NDVI from satellite imagery. A general linear mixed-effects model was used to determine the effects of on-farm habitat characteristics and landscape-level tree cover on the Bioacoustic Index (BI) and Acoustic Complexity Index (ACI); bird richness, abundance, and species composition; and bat occupancy. We hypothesise that the BI and ACI will be positively associated with farm-level herbaceous cover, crown area, and landscape-level tree cover. In addition, we hypothesise that bird richness and bat occupancy will be more positively associated with landscape-level tree cover than farm-level habitat characteristics due to their larger ranges. The results of this study will provide valuable insights into how cocoa farm habitat and landscape-level tree cover affect biodiversity on cocoa farms, including implications for farm- and landscape-level conservation policy and cocoa production.

Keywords: Bat occupancy, bioacoustics, bird species richness, cocoa agroforestry

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