INTEGRATED OPEN CANOPY™ (IOC™) COFFEE (*COFFEA ARABICA*) AS A CONSERVATION TOOL FOR NEARCTIC-NEOTROPICAL MIGRATORY AND RESIDENT BIRDS IN YORO, HONDURAS

David Murillo[1] Darío Alvarado[2] Fabiola Rodríguez[3] Caz Taylor[3] David King[4]

[1]University of Massachusetts, Amherst, USA, dmurillobust@umass.edu

[2]Mesoamerican Development Institute, Lowell, USA,.

[3]Department of Ecology and Evolutionary Biology, Tulane University, New Orleans, USA.

[4]US Forest Service, North l Research Station, University of Massachusetts, Amherst, USA.

Abstract

Honduras possesses 349,510 hectares of coffee crops (Coffea arabica), of which most are shaded and sun coffee farms, with a smaller number of Integrated Open Canopy (IOC) coffee farms. The IOC coffee system consists of coffee crops surrounded by forest in a ≥1:1 ratio, allowing preservation and restoration of native ecosystems. The objective of our investigation was to evaluate the IOC system as an alternative conservation tool for Neotropical migratory and resident birds. We evaluated ecological characteristics like species richness and abundance of individual species from November 2018 to April 2019 by establishing 75 points count survey stations in a coffee-growing region in Yoro, Honduras. The results of this investigation support those conducted at IOC farms in Costa Rica – where this agroforestry land-sparing approach was first introduced. We show that IOC coffee is an alternative for the conservation of Nearctic-Neotropical migratory and resident birds, especially for the forest-dependent species.

Introduction

Integrated Open Canopy™ System (IOC™). IOC™ has been recognized as a conservation alternative for birds in coffee producing countries (Chandler et al. 2013, Ritterson et al. 2021). Our research contributes to the knowledge of ornithology and conservation in Honduras in a productive landscape, where our objectives were to 1) Assess the richness and diversity of bird species in coffee production systems and forest fragments, 2) Compare the abundance of some of these bird species in coffee production systems and forest fragments, and 3) Determine the dissimilarity between coffee production systems and forest fragments based on the bird community.

Methods

Study area: The study was conducted in northeastern Honduras, Central America, in a coffee-growing area comprised of the villages of Subirana, Las Flores, and Las Vegas (15.20 ° N, 87.45 ° W).

Data collection: We conducted avian point counts (Fig. 1) at 75 selected sites from November 2018 to April 2019.

Figure 1. David Murillo (left), Denis Velasquez (middle), and David King (right) carrying point count in a shade coffee crop.

Statistical analysis: Avian species richness was compared between the systems using the rarefaction method. To evaluate whether the abundance of species differed among sites, we used generalized linear models with Poisson links. The dissimilarity of communities between systems was evaluated using MRPP and PERMANOVA. Finally, we performed a multilevel analysis of patterns to determine which species were system indicators.

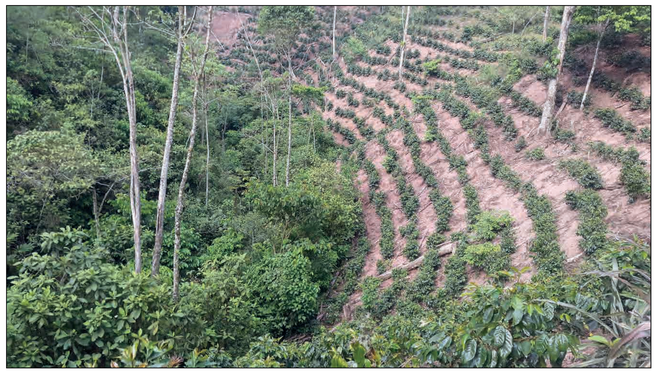

Figure 2. Three coffee crop systems: Sun (left), IOC (top), and Shade (right).

Results

The richness of all species, resident and migratory, was lowest in the Sun coffee system (Fig.3, and 4).

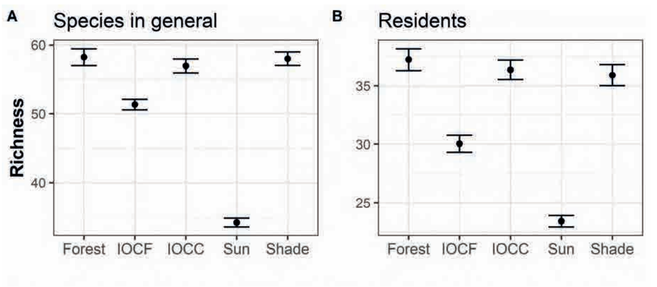

Figure 3. The richness of general, and resident birds by the system, using the confidence intervals at 95%.

The richness of forest-dependent species was highest in IOC forest and Forest, and lowest in the Sun coffee system (Fig. 4 D).

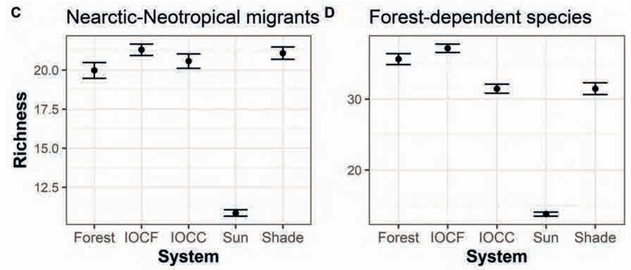

Figure 4. The richness of Neartic-Neotropical migrants, and forest-dependent species by the system, using the confidence intervals at 95%.

The abundance of *Mniotilta varia*, *Vireo philadelphicus*, and *Setophaga pensylvanica* were significantly lower ($p < 0.05$) in the Sun coffee system (Fig 5. J and L). Additionally, the abundance of some forest-dependent birds, such as *Myioborus miniatus* and *Mionectes oleagineus,* were significantly higher ($p < 0.05$) in Forest and IOC forest than in Sun coffee, Shade coffee, and IOC coffee systems (Fig 5. A and B).

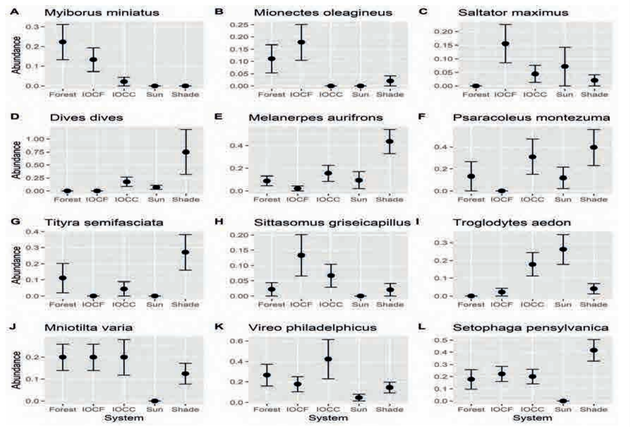

Figure 5. The abundance of birds by the system, plots using the mean of the abundance and the standard error.

Figure 6. Forest-dependent species, *Myioborus miniatus (left)* and *Mionectes oleagineus* (right), source: eBird.org,

The MRPP indicates that the Forest and IOC™ forest systems are the least dissimilar (0.732; Fig. 6). These findings are reinforced by the results of the PERMANOVA, which indicated that these dissimilarities are statistically significant (Table 1). In addition, the multilevel analysis of patterns determined that the species *Mionectes oleagineus*, *Myiborus miniatus,* and *Hylocaris leucotis* are indicator species for IOC forest and Forest systems (Table 2).

Table 1. Dissimilarity results.

	Dissimilarity	P value
Shade-Sun	0.804	0.01
Shade-IOCC	0.783	0.02
Shade-IOCF	0.786	0.01
Shade-Forest	0.753	0.01
Sun-IOCC	0.785	0.02
Sun-IOCF	0.800	0.01
Sun-Forest	0.790	0.01
IOCC-IOCF	0.774	0.12
IOCC-Forest	0.771	0.01
IOCF-Forest	0.732	0.06

Table 2. Indicator species and significance

System	Indicator Species	P value
IOCF	Saltator maximus	0.02
IOCC	Setophaga virens	0.015
	Psarocolius wagleri	0.032
Shade	Tityra semifasciata	0.013
Forest + IOCF	Myioborus miniatus	0.006
	Mionectes oleagineus	0.03
	Hylocaris leucotis	0.048
IOCF + IOCC	Cardellina pusilla	0.001
IOCC + Sun	Troglodytes aedon	0.001
IOCC + Shade	Melanerpes aurifrons	0.038
	Dives dives	0.034

Conclusion

We conclude that the IOC™ system is a viable alternative in coffee plantations to conserve Nearctic-Neotropical migratory and resident birds. This is especially true for forest-dependent birds, as this system provides habitat that would otherwise be scarce or absent within these productive landscapes dedicated to the cultivating coffee.

Acknowledgments

This study was supported by the US National Science Foundation (Grant No. 2120948) as well as funding from Tulane University, James S. McDonnell Foundation; US Forest Service Northern Research Center; the US Forest Service International Programs Migratory Bird Program; and the Mesoamerican Development Institute, the proponent of the Yoro Biological Corridor. We thank the coffee producers in the area for allowing us to develop this project on their farms and our colleagues Denis Ramos, Farlem España, and Martín Murillo for their support in the study area.