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Organic sugarcane fields with agroecological management and sustainable faunal biodiversity

Canaviais orgânicos com manejo agroecológico e biodiversidade faunística sustentável

Cañavales orgánicos con gestión agroecológica y biodiversidad faunística sostenible

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José Roberto Miranda
Doctor of Ecosystem Ecology
Institution: Empresa Brasileira de Pesquisa Agropecuária (Embrapa)
Address: Campinas, São Paulo, Brazil
E-mail: jose-roberto.miranda@embrapa.br

Carlos Alberto de Carvalho
Master in Strategic Territorial Intelligence
Institution: Empresa Brasileira de Pesquisa Agropecuária (Embrapa)
Address: Campinas, São Paulo, Brazil
E-mail: carlos-alberto.carvalho@embrapa.br

ABSTRACT

Studies on the agricultural areas role in wildlife conservation are still quite incipient. The kind of management employed in these systems can promote a differentiated discrimination on the composition of faunal settlement. This project was developed by EMBRAPA Territorial team and collaborating researchers, specialized in wildlife. It aims to detect and to characterize the vertebrates' biodiversity in a defined territory. The study area includes a 7,868 acres group of farms under organic cultivation and ecological management, situated in Sertãozinho, Southestern Brazil. More than three decades ago, the Usina São Francisco staff began the restoration processes of the natural environment around the organic sugar cane planted areas and also preserved the native remnants. The significant increase of biodiversity along the years was a result of the spatial flora emergence and the restored vegetation complexity in the so-called Permanent Protection Areas. The present results were obtained through regular maintenance and sampling efforts. Data collection and wildlife monitoring campaigns were held over the years and in the course of each year. And the results confirmed that the employed methods were effective. A total of 341 wild vertebrates species were registered and identified in the ten sites studied altogether (27 amphibians, 25 reptiles, 246 birds and 43 mammals). Among those, 49 species are considered under extinction risk or threat, in São Paulo State's Red List. The methodological itinerary adopted to assess the faunal biodiversity allowed to achieve the research

objectives; proved itself fully adequate and confirmed its effectiveness. The results obtained so far indicate that organic farming systems associated with the suitable ecological management favors the increase of faunal biodiversity.

Keywords: Organic Agriculture. Wildlife. Endangered Species. Biodiversity.

RESUMO

Pesquisas e estudos direcionados para avaliar o papel desempenhado pelos territórios do agro na conservação da fauna silvestre ainda são escassos. As espécies cultivadas e as diferentes tecnologias utilizadas nos sistemas de produção agrícola promovem efeitos diferenciados sobre a composição dos povoamentos da fauna silvestre. As novas técnicas agrícolas como o plantio direto, agricultura orgânica e controle biológico de pragas estão ampliando a oferta de recursos e de nichos ecológicos nos sistemas produtivos. O CAR (Cadastro Ambiental Rural) reza que no estado de São Paulo as propriedades rurais devem possuir pelo menos 20% de seus territórios ocupados por vegetação florestal, seja nativa ou restaurada, incluindo as APP's, e devem gerar um ganho para a fauna silvestre e aumento da biodiversidade. Esse projeto de pesquisa foi desenvolvido pela equipe da EMBRAPA Territorial, e vem conduzindo estudos para detectar e caracterizar a biodiversidade de vertebrados em territórios de fazendas cultivadas com cana-de-açúcar. A área de estudo compreende um conjunto de fazendas com 7.868 hectares sob cultivo orgânico e manejo ecológico da paisagem, elas estão localizadas na região de Sertãozinho, SP. A Usina São Francisco iniciou há quase quatro décadas processos de restauração ecológica dos ambientes circunvizinhos as áreas de plantio de cana-de-açúcar orgânica, preservando os remanescentes florestais nativos. O aumento significativo da biodiversidade faunística ao longo dos anos foi impulsionado pela emergência espacial e aumento da complexidade na vegetação restaurada nas Áreas de Proteção Permanente (APP's). Uma série de campanhas de levantamentos de dados e monitoramento da fauna foram realizadas ao longo dos anos. Os resultados obtidos confirmaram a eficácia dos protocolos e métodos empregados na avaliação da riqueza específica. As espécies registradas e identificadas somam 341 espécies de vertebrados silvestres no conjunto dos dez ambientes amostrados (27 anfíbios, 25 répteis, 246 aves e 43 mamíferos), dentre as quais 49 se encontram sob algum risco ou ameaça de extinção no estado de São Paulo. Os resultados obtidos até o momento indicam que o cultivo de cana-de-açúcar em sistemas orgânicos, associado ao manejo ecológico da paisagem tem auxiliado na ampliação e manutenção da biodiversidade faunística.

Palavras-chave: Agricultura Orgânica. Fauna Silvestre. Espécies Ameaçadas. Biodiversidade.

RESUMEN

Las investigaciones y los estudios destinados a evaluar el papel que desempeñan los territorios agrícolas en la conservación de la fauna silvestre aún son escasos. Las especies cultivadas y las diferentes tecnologías utilizadas en los sistemas de producción agrícola tienen efectos diferenciados sobre la composición de las poblaciones de fauna silvestre. Las nuevas técnicas agrícolas, como la siembra directa, la agricultura orgánica y el control biológico de plagas, están ampliando la oferta de recursos y nichos ecológicos en los sistemas productivos. El CAR

(Registro Ambiental Rural) establece que, en el estado de São Paulo, las propiedades rurales deben tener al menos el 20 % de su territorio ocupado por vegetación forestal, ya sea nativa o restaurada, incluidas las APP, y deben generar un beneficio para la fauna silvestre y un aumento de la biodiversidad. Este proyecto de investigación fue desarrollado por el equipo de EMBRAPA Territorial y ha llevado a cabo estudios para detectar y caracterizar la biodiversidad de vertebrados en territorios de fincas cultivadas con caña de azúcar. El área de estudio comprende un conjunto de fincas con 7868 hectáreas bajo cultivo orgánico y manejo ecológico del paisaje, ubicadas en la región de Sertãozinho, SP. La planta São Francisco inició hace casi cuatro décadas procesos de restauración ecológica de los entornos circundantes a las áreas de cultivo de caña de azúcar orgánica, preservando los remanentes forestales nativos. El aumento significativo de la biodiversidad faunística a lo largo de los años fue impulsado por la emergencia espacial y el aumento de la complejidad de la vegetación restaurada en las Áreas de Protección Permanente (APP). A lo largo de los años se llevaron a cabo una serie de campañas de recopilación de datos y seguimiento de la fauna. Los resultados obtenidos confirmaron la eficacia de los protocolos y métodos empleados en la evaluación de la riqueza específica. Las especies registradas e identificadas suman 341 especies de vertebrados silvestres en el conjunto de los diez entornos muestreados (27 anfibios, 25 reptiles, 246 aves y 43 mamíferos), de las cuales 49 se encuentran en peligro o bajo amenaza de extinción en el estado de São Paulo. Los resultados obtenidos hasta el momento indican que el cultivo de caña de azúcar en sistemas orgánicos, asociado al manejo ecológico del paisaje, ha contribuido a la ampliación y el mantenimiento de la biodiversidad faunística.

Palabras clave: Agricultura Orgánica. Fauna Silvestre. Especies Amenazadas. Biodiversidad.

1 INTRODUCTION

The conservation of faunal biodiversity contributes to the maintenance of vegetation, as the fundamental role that vertebrates play in seed dispersal and even in the pollination of plant species present in forest remnants is well known (Brazil, 1967; SMA-SP, 2010 a). Primates, bats, agoutis, and hummingbirds are some of these vectors and can be considered "forest planters." The occurrence of wild vertebrate species in agricultural systems has yet to be studied in depth. The "new forest code" governed by Law No. 12,651 of 2012 establishes standards for the protection of native vegetation on rural properties, ranging from 20 to 80% of the surface area of farms depending on the biome in which they are located. There are also rules for Permanent Preservation Areas (APPs), focusing on the protection of springs, dams, and the entire hydrographic network. These measures

will significantly increase forest cover in rural areas, in addition to creating greater connectivity between natural environments, which will serve as habitats and ecological corridors for wildlife. Despite this development, little attention has been paid to the effective role of agroecosystems in the conservation of faunal biodiversity (Beca *et al*., 2017). The type of management and technification employed in these production systems can be more or less selective about the composition and structure of faunal populations. Researchers from EMBRAPA Territorial, collaborators, and wildlife experts have been conducting research aimed at understanding these ecosystem services and the degree of sustainability generated by different production systems in relation to the maintenance and preservation of wild vertebrate populations and communities. A study has been monitoring for almost two decades to qualify and quantify the evolution of wildlife biodiversity in organic sugarcane production systems in the region of Sertãozinho, SP. The study area covers a group of seven farms totaling 7,868 hectares with ecological management of preserved and restored environments and other locations adjacent to cultivated areas, with about 80% of this territory represented by sugarcane fields (Miranda & Miranda, 2004; Miranda, 2010; Miranda *et al*., 2011 (a, b); Miranda *et al*., 2012 (a, b, c); Miranda & Ariedi Jr, 2013 (a, b)).

2 OBJECTIVES

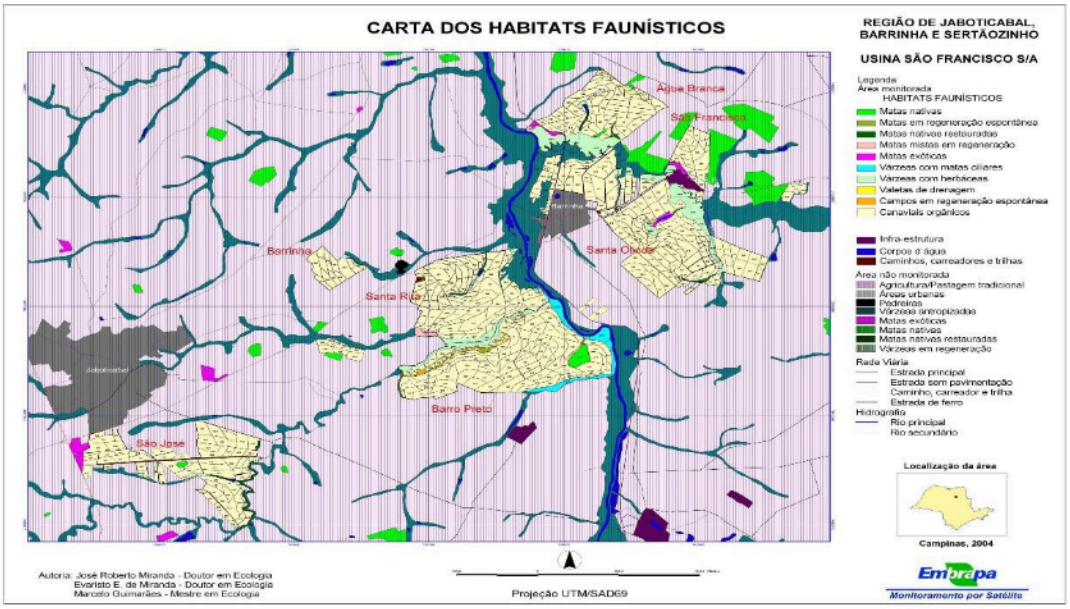
This study had multiple objectives, which were to develop, test, adapt, and confirm the effectiveness of a methodological itinerary to characterize the composition of terrestrial vertebrate populations through indicators of richness and diversity within the pilot territories. However, the mosaic of faunal macrohabitats offered in the perimeters delimited by the seven farms of the mill could not be neglected. It also aimed to objectively qualify and quantify the richness of the wild vertebrate fauna present on these organic sugarcane properties. It is necessary to consider the set of diverse environments adjacent to the crops, as the natural resources offered in this complex landscape often encompass the various ecological dimensions necessary for the maintenance of these animal populations. Special attention was also given to the occurrence of wild vertebrate species considered at risk or threatened with extinction in the state of São Paulo and which,

in a way, can be considered biological indicators that enhance certain environmental conditions in the studied territories.

3 MATERIALS AND METHODS

The study area comprises agricultural areas that are 100% certified for organic production, preserved and restored natural environments associated with the São Francisco Plant. The farms are located in the Pardo and Mogi-Guaçu river basins, tributaries of the Paraná River (Miranda & Miranda, 2004). Analogical interpretation of QuickBird satellite images revealed approximately ten macro-habitats for wildlife in the territory of the seven farms listed for this study. The level of spatial perception defined for the cartographic expression of these macrohabitats was on a scale of 1:25,000. Land use and occupation categories served as the basis for classifying these ten types of environments, which provide the livelihood for terrestrial vertebrate populations. The following are the ten types of macro-environments detected and mapped: 1. Organic sugarcane fields; 2. Exotic forests; 3. Floodplains with herbaceous vegetation; 4. Floodplains with riparian forests; 5. Restored native forests; 6. Mixed forests in regeneration; 7. Native forests; 8. Drainage ditches; 9. Forests in spontaneous regeneration; 10. Fields in spontaneous regeneration. Each macrohabitat offers relatively specific ecological conditions, with different natural resources for fauna, playing a very decisive role in the spatial distribution of many species and directly interfering in the composition (specific richness) of the fauna populations of the macroenvironments shown (Figure 1).

Figure 1. Map of the 10 fauna macrohabitats present on the seven farms of the São Francisco Plant in Sertãozinho-SP.



Source: Miranda & Miranda, 2004.

The stratified random sampling strategy was chosen because it considers the spatial heterogeneity of the intrinsic use and occupation of farms (macrohabitats). This made it possible to perform a judicious qualitative comparison between the composition of fauna populations in the different environments studied and the contributions in terms of richness and animal species occurring exclusively in each macrohabitat. It was balanced by a relatively equivalent number of surveys in these various macro-ecological situations, without taking into account the size of their area or surface dimension, ensuring an equitable sampling effort in the different sampling strata (Frontier, 1983). The fact that the surveys were distributed randomly within each stratum offered the same probability of occurrence for all species and allowed the elaboration of relative frequency profiles of presence for each of them. This highlighted the composition and provided an idea of the structure of the different animal populations, making it possible to highlight the specific richness of each faunal macrohabitat and the total richness of the territory formed by the seven farms as a whole (Daget and Godron, 1982).

Due to the variability of the dynamic ecological conditions of the environments during the different seasons of the year, surveys of terrestrial vertebrate fauna were carried out over the years. The cycle of seasonal variations, mainly in humidity, temperature, and food, was considered in conjunction with

possible fluctuations in the composition of the populations, for example in terms of biological activity and migratory behavior of certain bird species in the sampled strata (Billaud, 2002). All surveys for the field species inventory were conducted following pre-established criteria and methodological itineraries, using a previously prepared form, and regular campaigns between 2002 and 2012, in the 10 mapped environments (macro-habitats) available to wildlife on the farms of the São Francisco Plant.

In the zoo-ecological surveys carried out in the field, a pre-coded form was used to collect various information regarding the prospecting site, describing the existing environmental conditions. This form allowed for the collection of homogeneous and objective data about the surveyed site, the physical environment, the spatial structure of the vegetation, dominant plant species, degree of anthropization, and finally, the vertebrate species detected and identified, as well as the number of individuals observed along the transects or sampled plots.

This information was initially treated in a more qualitative manner, focusing mainly on aspects of composition, characterizing the specific richness of the populations in each sample stratum (macrohabitat). Among the parameters related to the composition of a faunal population, specific richness is what allows for an initial assessment of the size and peculiarities of the species found in a given type of environment. It can be broken down into four main types: total richness, average richness, accumulated richness, and exclusive richness, each of which has its own characteristics and provides information on the composition and originality of animal populations (Blondel, 1979). The data on environmental variables are being processed and compared with the occurrences of species in the form of varied ecological profiles, and the values of the relationship between each species and the set of environmental parameters are being determined using the equation of Mathematical Information Theory (Shannon, 1948).

Fauna groups were sampled using combinations of techniques that did not harm the animals, with almost no capture or collection of individuals, widely used in ecological studies of wildlife. The techniques used in the study consisted of visual and auditory searches, searching for traces such as burrows, nests, feces, footprints, traveling by vehicle in search of occasional encounters, and the use of

trail cameras. Due to the daily activity behavior of the species, surveys and observations were carried out at different times, in the morning, twilight, and nighttime periods. Similarly, other animals, such as migratory birds, were observed only during their periods of movement, seeking places to feed, rest, and even reproduce. Given this particularity, campaigns were carried out throughout the different seasons of the year to maximize the detection of temporary species (Miranda & Miranda, 2004; Miranda & Ariedi Jr, 2013 b).

This mosaic of environments influenced the formulation of some hypotheses and, above all, the definition of some of the objectives of this study. These were multiple and aimed to test, adapt, and develop a methodological itinerary for assessing the biodiversity of wild vertebrates in a defined territory. It also aimed to analyze the quality of the fauna richness of wild vertebrates existing on properties cultivated with organic sugarcane and in the various environments adjacent to and associated with the ecological management of the landscapes. Special attention was given to the occurrence of wild vertebrate species considered at risk or threatened with extinction in the state of São Paulo.

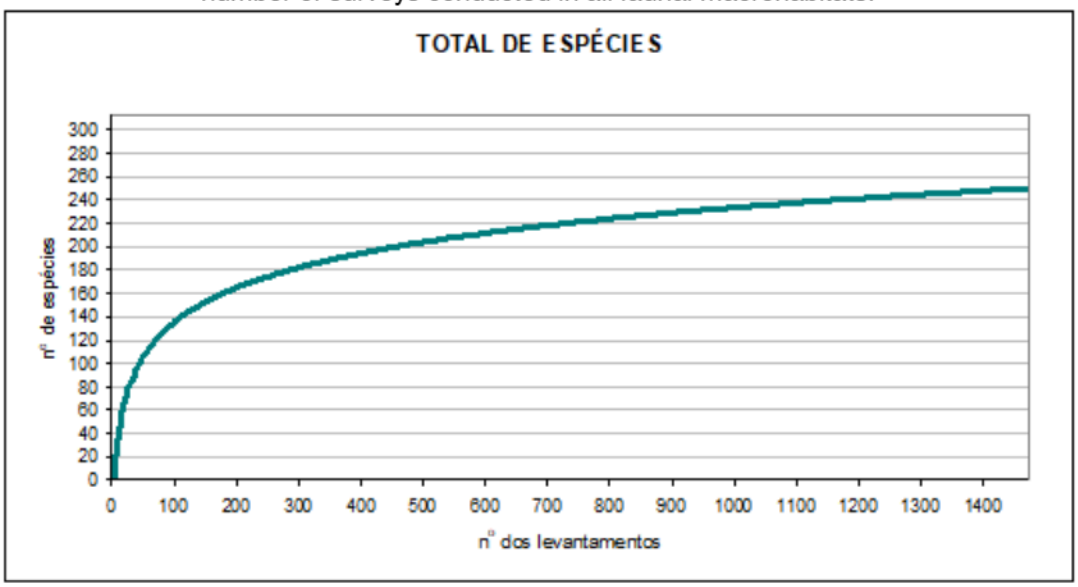
4 RESULTS AND DISCUSSION

As a result of maintaining regular sampling efforts, between 2002 and 2016, 341 species of wild vertebrates were recorded and identified in the ten environments sampled on the seven farms (27 amphibians, 25 reptiles, 246 birds, and 43 mammals), of which 49 were in a situation of ecological fragility and were at risk or threatened with extinction in the state of São Paulo, according to State Decree No. 56,031 (SMA-SP, 2010 b). Examples of these endangered species include the anhuma (*Anhima cornuta*), the gavião-belo (*Busarellus nigricollis*), the maguari (*Ciconia maguari*), and the suiriri-cinzento (*Suiriri suiriri*); the rufous-tailed hawk (*Falco rufigularis*), the long-billed chorozinho (*Herpsilochmus longirostris*), the jabiru (*Jabiru mycteria*), the collared sanhaçu (*Schistoclamys melanopis*), the joão-grilo (*Synallaxis hypospodia*), and the black starling (*Synallaxis scutata*); the maned wolf (*Chrysocyon brachyurus*), the ocelot (*Leopardus pardalis*), the red brocket deer (*Mazama americana*), the giant anteater (*Myrmecophaga tridactyla*) and the puma (*Puma concolor*), among several other species. For example, the

number of birds recorded in the study area represents about 30% of the bird species listed in all biomes in the state of São Paulo and about 14% of all Brazilian bird species.

The accumulated wealth curve illustrates a sharp slowdown in the discovery of new species since 1400 surveys and indicates that almost all species have been detected (Figure 2). Only in organic sugarcane fields were approximately one hundred species of wild vertebrates recorded. This is due to mechanized harvesting without burning the straw, raw cane, no use of agrochemicals, among other favorable factors related to organic farming and ecological landscape management. In addition, after harvesting, approximately 20 tons of dry matter per hectare/year of plant biomass remains on the soil, which will be decomposed by the soil biota, also protecting it from solar radiation and erosion processes generated by the kinetic energy of rainfall, while facilitating water infiltration and good moisture retention in the soil, which is essential for regrowth. Among the decomposers of straw, it is worth highlighting the mesofauna composed of earthworms and insect larvae, which help consolidate the base of a food pyramid or web and considerably increase the supply of prey to feed various wild vertebrates.

Figure 2. Accumulated richness curve expressing the number of species detected in the total number of surveys conducted in all faunal macrohabitats.



Source: Miranda, 2010.

The total richness value can be considered significant. Approximately one hundred species of wild vertebrates were recorded within the organic sugarcane fields. This is largely due to the use of harvesters for almost four decades, without burning, raw sugarcane cultivated without any use of agrochemicals, as well as other factors resulting from organic cultivation and ecological management of other environments present in the landscapes of the mill's farms. After harvesting, approximately 20 tons of plant biomass per hectare/year remains on the soil, which will be decomposed by the soil biota, preventing the incidence of solar radiation, as well as facilitating infiltration, moisture retention, and erosion caused by rainfall on bare soils (Cortez, 2010). These decomposers, especially mesofauna, are responsible for forming the base of a food pyramid, which contributes substantially to meeting the food needs of the ecological niche of various vertebrates.

The other macrohabitats also offer the ecological conditions and resources necessary for the reproduction and shelter of wild animals, fully or partially satisfying the needs of wild vertebrates.

Table 1. Total, average, and exclusive richness values in the ten wildlife habitats of the São Francisco Plant, SP.

	HABITATS											
RIQUEZAS	1	2	3	4	5	6	7	8	9	10	TOTAIS	%
Riqueza Total	121	93	171	138	161	92	143	134	100	92	**341**	100
Riqueza Média	0,364	0,338	0,538	0,527	0,441	0,368	0,444	0,438	0,4	0,367	-	-
Riqueza Exclusiva	12	3	26	11	16	4	15	8	5	2	102	37

Legend:

Habitat 1 - Organic Sugarcane Fields;
Habitat 2 - Exotic Forests;
Habitat 3 - Floodplains with Herbaceous Plants;
Habitat 4 - Floodplains with Riparian Forests;
Habitat 5 - Restored Native Forests;
Habitat 6 - Mixed Forests in Regeneration;
Habitat 7 - Native Forests;
Habitat 8 - Drainage Ditches;
Habitat 9 - Spontaneously Regenerating Forests;
Habitat 10 - Spontaneously Regenerating Fields.

Source: Miranda & Carvalho, 2024.

All biological richness indices (total, average, and exclusive) showed great variability across habitats (Table 1). Total richness was highest in Herbaceous Floodplains, with 171 species. In descending order were: Restored Native Forests, 161 species; Native Forests, 143 species; Floodplains with Riparian Forests, 138 species; drainage ditches, 134 species; spontaneously regenerating forests and exotic forests were the habitats with the lowest species richness, with 92 species each, a number lower than the 121 found in areas occupied by organic sugarcane fields.

Macrohabitat No. 3, Herbaceous Floodplains, brings together a series of natural microenvironments mainly associated with the Onça stream, a tributary of the Mogi-Guaçú River, which flows through an extensive plain. In addition to the main channel of the stream, there are marginal lagoons formed by old abandoned meanders, where over thousands of years, sediments carried by the water have been deposited. These floodplains are complex environments formed by abandoned meanders, marshes, wetlands, ponds, dikes, and a range of similar environments naturally covered by various grasses such as jaraguá grass (*Hyparrhenia rufa*), razor grass (*Echinochloa polystachya*), and brachiaria grass (*Brachiaria decumbens*), among others, all of which are herbaceous (less than 0.50 meters tall), with some shrubs and trees scattered along the banks. In some permanently flooded areas, the vegetation cover is dominated by cattails (*Typha domingensis*). However, the main similarity between the various micro-environments of the floodplains is characterized mainly by the predominance of the vertical structure of the vegetation cover, which is predominantly low, and by the large production of plant biomass generated by grasses. This biomass plays a

key role in the food chains of herbivorous wildlife, as well as serving as shelter and breeding grounds for numerous vertebrate species. Several species of marsh and limicolous birds, whether resident or migratory, build their nests in aquatic vegetation, such as the jacana (*Jacana jacana*), the moorhen (*Gallinula chloropus*), the garibaldi (*Chrysomus ruficapillus*), the little suiriri (*Satrapa icterophrys*), the marsh tern (*Gubernetes yetapa*), the freirinha (*Arundinicola leucocephala*), the three-pot saracura (*Aramides cajanea*), the spoonbill (*Platalea ajaja*), etc. It is also the most favorable environment for shelter and foraging for most amphibian species. More than 90% of the species detected were found in this macrohabitat, partly because these floodplains are fundamental to the reproductive cycle of these vertebrates, whose evolution has not redeemed them from an ambiguous life between water and land.

Although these environments cover a relatively small area on the São Francisco Plant farms, they are home to about 48% of all vertebrate biodiversity detected in the 10 wildlife habitats. Not only is it the habitat with the greatest specific richness, but it was also where the highest value of exclusive richness occurred, that is, 26 species of vertebrates adapted to the ecological conditions offered in the floodplains of rivers and streams. The largest area of floodplains with herbaceous vegetation is found in the Onça stream. From its headwaters in the Luis Antonio region, almost 70 kilometers in a straight line from its mouth on the Mogi Guaçu River, it covers more than twice that distance due to its great sinuosity, shaped by the plain where its bed rests. In the Ribeirão Preto region, excluding the Mogi Guaçu River, the Onça stream is the largest river with herbaceous vegetation and represents a source of vertebrate propagules for the repopulation of other environments in the regional context and functions as a large corridor for wildlife.

5 CONCLUSIONS

The processes initiated by Usina São Francisco more than three decades ago, aimed at restoring the riparian vegetation cover of Permanent Protection Areas, preserving native Forest Reserves and other environments surrounding sugarcane fields, have driven the process of expanding wildlife diversity. The significant increase in vertebrate species over the years of this research is due to

several environmental factors, especially those that enabled the colonization and establishment of new species in view of the increased availability of food resources, shelters, and breeding conditions, which created a diversification of ecological niches available to animals (Soares *et al*. 2010). The complexity of plant formations is due to the spatial emergence and phenology of the plant species used in the restoration of APPs, which also contributes to the increase in faunal biodiversity. The restored areas continue to be enriched by seeds disseminated mainly by birds and frugivorous mammals, true "forest planters," facilitating the emergence of new ecological interactions between the fauna and floristic composition of the APPs. The forest cover along watercourses has facilitated connectivity with forest remnants and other types of environments that make up the landscapes of these agroecosystems. It is worth noting the active surveillance carried out by groups of employees to curb hunting or animal trapping activities within the farm perimeters.

The methodological approach adopted to assess fauna richness enabled the basic research objectives to be achieved and proved suitable for studies conducted in a defined territory. The results were obtained by maintaining regular sampling efforts, in which data collection and fauna monitoring campaigns were carried out during all seasons of the year and over the years. This confirms the effectiveness of the methods used to detect and identify species, as well as the specific richness of 341 species of wild vertebrates recorded in this production system. Among them, 49 are at some risk or threat of extinction in the state of São Paulo and are biological indicators of the significant quality of natural resources offered in this agricultural system. Everything indicates that wildlife is in the process of integrating into the production system, interacting with the mosaic of environments present on the plant's farms.

The results indicate more conciliatory relationships between wildlife conservation and organic production systems, contributing to the preservation of wildlife. The diachronic approach of this research, over almost two decades, has consolidated the understanding of the evolution of faunal biodiversity in agroecosystems, without prejudice to crop production and productivity. Every year, new species are being added to the fauna population through natural processes, and some of them may find conditions to settle permanently, forming populations

and occupying new ecological niches.

The adoption of agroecological landscape management, combined with organic farming practices and mechanized harvesting of raw sugarcane, has facilitated an increase in terrestrial vertebrate biodiversity. Everything indicates that the farming areas are perceived by the fauna as an extension of their feeding, breeding, and refuge territories, in addition to being used as corridors for their movements in this mosaic of land uses and occupation. The corridors where grasses were planted to prevent soil erosion now represent more than 700 hectares of pasture available to herbivorous vertebrates. The results obtained indicate that the plant biomass left on the soil after harvest, about 20 tons per hectare, ensures a food source, represented by decomposer mesofauna, for wild insectivorous vertebrates.

The results effectively illustrate the evolution of species richness and biodiversity over time on these agroecologically managed farms, favoring the connection between forest remnants and other natural habitats in agricultural areas.

This study in no way intends to exhaust the issue of wild animals on agricultural properties. Quite the contrary, the idea is simply to introduce researchers to a field of study that has been little explored. The generation of scientific knowledge in this field can contribute to understanding the complementary role played by rural production systems in preserving the wildlife heritage present in legalized natural protection areas, such as parks, forest reserves, and other environments under municipal, state, and federal protection. Today, with the Forest Code (Law No. 12,651/2012) establishing the Rural Environmental Registry (CAR) and the Environmental Restoration Plan (PRA), there is no denying the preservationist aspect attributed to rural properties, representing about 20% of the national territory, intended for the preservation of vegetation on rural properties. Studies and research can make a major contribution to this forest restoration process if they include fruit-bearing plant species to attract and nourish wild animals. This would represent a gain in terms of faunal biodiversity, as well as generating ecological interactions between wildlife and restored forest areas. The fauna would perform a function of pollination, seed dispersal, and floristic enrichment of these new habitats and would provide a

greater ecosystem service for agricultural properties in terms of contributing to "Conservationist Public Policies."

Academic research has a vast universe to explore, not only in terms of the wealth of species present in agro-ecosystems, but also in terms of the structure, stability, and possibilities for fostering better conditions for the establishment and constitution of viable populations, including through habitat improvement techniques, regardless of the dimensions of the species' ecological niches. Studies on population demographics, sex ratio, age structure, among other topics, open up a considerable range of research necessary for the evaluation and conceptualization of vertebrate communities. In addition, the knowledge generated should promote greater harmonization of interactions between fauna and agricultural production systems. In the near future, faunal biodiversity could be a marketing differential for Brazilian agribusiness products.

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