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Inventory

The butterflies (Lepidoptera, Papilionoidea) of the Parque Estadual Intervales and surroundings, São Paulo, Brazil

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Abstract: The Global South has witnessed increasing sampling of its immense biological diversity during the past century. However, the diversity of many regions remains unknown, even at pristine and highly threatened places, such as in the Atlantic Forest; and for bioindicator, umbrella, and flagship groups. The present study reports the first butterfly list of the *Parque Estadual Intervales*, São Paulo, Brazil and surroundings, a key protected area in the last massive continuous of the Atlantic Forest. We compiled data from museums and four years of field work, under three sampling methods. We also aimed at providing resources to support conservation efforts by analyzing 27 years of climatic data (detailed in the Supplementary Material, in English and in Portuguese), discussing our results also for non-academics, and producing scientific outreach and educational material. A companion article dealt with the experiences of science outreach and capacity development, and illustrated the butterfly catalogue of the species sampled in the park. We found 312 species that sum to 2,139 records. The museum had 229 species (432 records), and we sampled 142 species (1,682 individuals), in a total effort of 36,679 sampling hours (36,432 trap and 247 net and observation hours). The richest families were Nymphalidae (148 species) and Hesperiidae (100 species). Most species were sampled exclusively by active methods (79.8%), but other sources (passive sampling, citizen science, etc.) also found unique records. We found the highest diversity metrics from January to May, and we demonstrated that winter months had less richness and abundance. We illustrated the 20 species common to all regions, and listed those that were found more than seven months in the year, as well as the most abundant species in trap sampling, with forest dwellers as well as species common to open and fragmented areas. The dominant species in our trap datasets was the iridescent white morpho, *Morpho epistrophus* (Fabricius, 1796), and we suggest it to become the park butterfly mascot.
Keywords: *Species list; Paranapiacaba continuum; fish carrion bait; biodiversity knowledge shortfalls.*

As borboletas (Lepidoptera, Papilionoidea) do Parque Estadual Intervales e arredores, São Paulo, Brasil

Resumo: O Sul Global testemunhou crescente amostragem de sua imensa diversidade biológica durante o século passado. Entretanto, a diversidade de muitas regiões permanece desconhecida, mesmo em locais pristinos e altamente ameaçados, como na Mata Atlântica; e para grupos bioindicadores, guarda-chuva e emblemáticos. O presente estudo reporta a primeira lista de borboletas do Parque Estadual Intervales, São Paulo, Brasil e arredores, uma unidade de conservação chave no último maciço contínuo de Mata Atlântica. Compilamos dados de museus e quatro anos de campo, sob três métodos de amostragem. Também visamos oferecer recursos para apoiar os esforços de conservação, analisando 27 anos de dados climáticos (detalhados no Material Suplementar, em inglês e em português), discutindo nossos resultados numa linguagem também para não acadêmicos, e produzindo material de divulgação científica e educativos. Um artigo irmão tratou das experiências de divulgação científica e capacitação, e ilustrou o catálogo de borboletas das espécies amostradas no parque. Encontramos 312 espécies em 2.139 registros. O museu tinha 229 espécies (432 registros), e amostramos 142 espécies (1.682 indivíduos), em um esforço total de 36.679 horas de amostragem (36.432 armadilhas e 247 horas de rede e observação). As famílias mais ricas foram Nymphalidae (148 espécies) e Hesperiidae (100 espécies). A maioria das espécies foi amostrada exclusivamente por métodos ativos (79,8%), mas outras fontes (passiva, ciência cidadã, etc.) também encontraram registros únicos. Encontramos as maiores métricas de diversidade de janeiro a maio, e demonstramos que os meses de inverno tiveram menos riqueza e abundância. Ilustramos as 20 espécies comuns a todas as regiões, e listamos aquelas que foram encontradas em mais de sete meses no ano, bem como as espécies mais abundantes em armadilhas, com espécies florestais e também comuns em áreas abertas e fragmentadas. A espécie dominante em nossas armadilhas foi a morfo branca iridescente, *Morpho epistrophus* (Fabricius, 1796), e sugerimos que se torne a borboleta mascote do parque.

Palavras-chave: *Lista de espécies; contínuo de Paranapiacaba; isca de peixe; deficit de conhecimento da biodiversidade.*

Introduction

Biodiversity studies are of central importance for the future, and inventories are one of their building blocks. Sampling distribution is, however, far from homogeneous, with most knowledge concentrated in the wealthiest, temperate, countries of the world (*e.g.* Girardello *et al*. 2019). The unequal sampling effort increases the relevance of carrying out inventories in the richest and megadiverse regions on Earth, usually found in the tropics, especially in those countries threatened by governments openly against science and the preservation of its environment (Myers *et al.* 2000, Alves *et al*. 2018, Andrade 2019, Angelo 2019, Tollefson 2019, Ferrante & Fearnside 2021, Hipólito *et al*. 2021). Despite an increase in sampling in the Global South during the past century (Girardello *et al*. 2019), it is remarkable that some regions with pristine natural environments remain unsampled, even at highly diverse and threatened regions, such as in the Atlantic Forest (Myers *et al*. 2000); and for biological groups that are relevant for conservation, such as bioindicator, umbrella, and flagship groups.

Bioindicator and umbrella groups are particularly useful for conservation planning and future attempts to understand what has been lost because they provide snapshots of the plant, animal or fungal species at a given time. The information they provide is more useful when inventories are performed according to best practices and standards. For example, to assess the fauna of a given location, it is important to use different sampling methods, to collect periodically (*e.g.* monthly) and for many years, to span different environments and altitudes, and to be careful with specimen and data curation (Santos *et al*. 2008, Shirai *et al*. 2019). That is rarely the case for several reasons, namely the financial and temporal availability of trained people, aggravated in

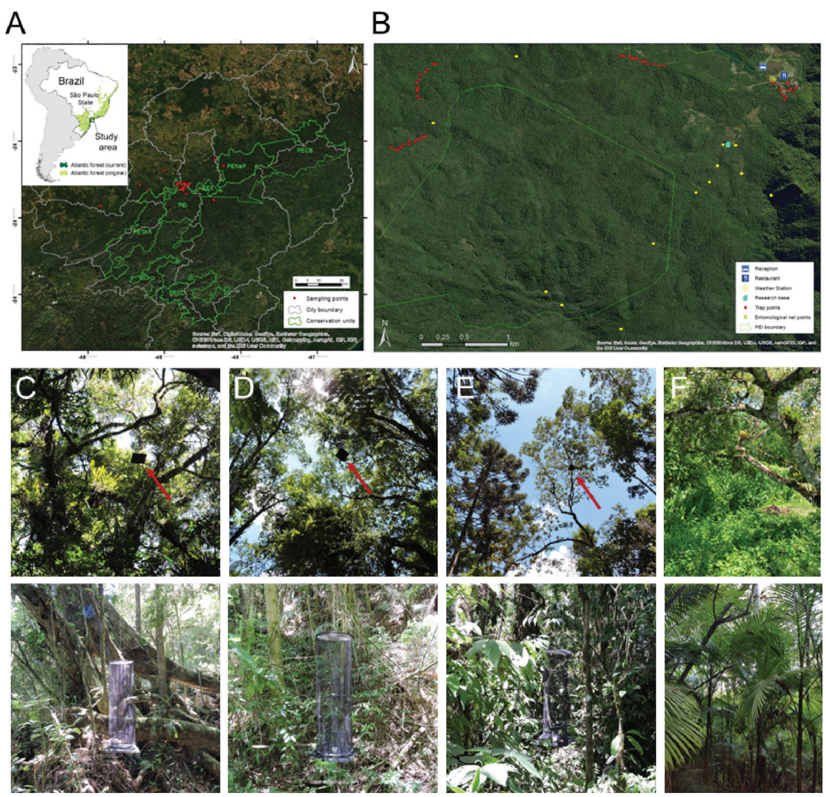

Figure 1. Study area: (a) map of the Paranapiacaba Continuum: Intervales (PEI), *Parque Estadual Carlos Botelho* (PECB), *Parque Estadual Turístico do Alto da Ribeira* (PETAR), and *Parque Estadual Nascentes do Paranapanema* (PENaP), and *Estação Ecológica Xitué* (EEX); together with nearby *Parque Estadual Cavernas do Diabo* (PECD). The inset map shows the original distribution of the Atlantic Forest in light green and in dark green the remaining fragments, highlighting the importance of this Continuum, the largest continuous forest remanent; (b) map of sampling points by traps and net inside the PEI, showing some of its infrastructure; and representative images of canopy (above) and understory (below) traps of the PEI dataset: (c) "Minotauro" primary forest, (d) "Cidreira" secondary forest, and (e) "Guapiara" open road, with edge effect. (f) strategic traps set at PEI's infrastructure for the PEI 1y dataset.

places like South America (Elliot *et al*. 2018). However, in taxa that are easy to collect and identify even by non-specialists, approaches like citizen science and capacity development can be powerful allies to complement collection by scientists (Uehara-Prado *et al.* 2007, Davis 2015, Santos *et al*. 2016, Elliot *et al*. 2018, Mota *et al*. 2022, Shirai *et al*. 2022). It also helps when the bioindicator or umbrella group is aesthetically appealing, which is the case of most butterflies (Lepidoptera, Papilionoidea: Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, and Riodinidae).

Here we provide the first butterfly list of Intervales state park (*Parque Estadual Intervales* or PEI), a protected area located in the last massive continuous of the Atlantic Forest (Figure 1a). Despite the importance of this area, and associated environmental and social threats (see Methods), it is remarkable that we did not find any study sampling this bioindicator group, butterflies, although some works report the collection of focal taxa at the region (listed in Methods). The PEI boundaries were not determined for biological reasons, so we searched for inventories in the surrounding municipalities, all of which are in the state of São Paulo, Brazil (Figure 1a). The only published inventories near or at the PEI either collected all butterflies and did not report the species list (Brown & Freitas 1999) or had a species list but of a single tribe (Ithomiini, Shirai *et al*. 2017) or of a single guild on specific flowers (nectar-feeding butterflies on *Lantana* L. (Verbenaceae), Santos *et al*. 2015).

We report the butterflies of the PEI and surroundings with data compiled from museums and four years of field work by us, under three sampling methods. Our aims were to contribute to the scientific community, but also to the local community, supporting conservation efforts in different ways. Here, we provide the butterfly list, discussing it academically but also in a language accessible for non-academics. We also analyzed 27 years of climatic data collected at the park but so far without any formal synthesis. This climatic profile can be reported by the protected area to support decision-makers to conserve the area with robust data, so we present it in the Supplementary Material both in English and in Portuguese. Some of the spread individuals returned to the park and are in display for visitors, along with informative posters with the results of this study (http://doi.org/10.5281/zenodo.5893810, press release available at https://www.infraestruturameioambiente.sp.gov.br/fundacaoflorestal/2022/02/parque-estadual-intervales-realiza-primeiro-plantio-coletivo-de-mudas/). Also, the "Butterflies of Intervales" outreach booklet is publicly available (http://doi.org/10.5281/zenodo.5068939). Finally, the experiences of science outreach and capacity development with the PEI staff, and an illustrated butterfly catalogue of species sampled here can be found in the companion publication (Shirai *et al*. 2022).

Material and Methods

1. Study area

The *Parque Estadual Intervales* (hereafter PEI, 41,704 ha) is part of the largest continuous of the Atlantic Forest at the *Serra do Mar* (1,109,546 ha, Ribeiro *et al.* 2009, inset of Figure 1a). The PEI is located within the Paranapiacaba Continuum (*ca*. 140,000 ha *c.f.* decrees) which, along with the contiguous ecological station Xitué and *Parque Estadual Carlos Botelho* (PECB), *Parque Estadual Turístico do Alto da Ribeira* (PETAR), and *Parque Estadual Nascentes do Paranapanema* (PENaP) (Figure 1a), is a UNESCO Biosphere Reserve and a World Heritage Site. This Continuum plays a central role in conserving one of the five hottest world hotspots (*cf.* Myers *et al.* 2000), due to its unique extension of continuous forest. For example, the Continuum is one of the last three areas capable of hosting viable populations of the biome's top predator, the jaguar (*Panthera onca* (Linnaeus, 1758)), which is vulnerable to extinction (ICMBio 2018) due to hunting and habitat loss (Beisiegel & Nakano-Oliveira 2020)

It is estimated that 85% of the PEI still has well preserved old growth forest with very low levels of disturbance (Nisi 2006), which is predominantly dense montane ombrophilous forest (Leonel 2010). Intervales means "between valleys," in reference to the hills that range from 140 m to 1,200 m. The complex landscape with vast intact forest hosts important remnants of wild life, for instances, 9.2% of the PEI fauna of 532 species preliminarily inventoried in the 1990's was threatened (Nisi 2006). Particularly, several arthropods in the Red List (ICMBio 2018) were found at the calcareous caves of the region, some exclusively at the PEI. The pristine forest, the caves and the almost 400 species of birds (an international hotspot for birdwatching) are among the main attractions of the park. Illegal hunting, mining, and overexploitation of juçara palm (*Euterpe edulis* Mart.) are among the main threats to the life it preserves (Shirai *et al*. 2022).

The climate of the region can be classified as dry-winter subtropical highland, or Cwb in the Köppen-Geiger system (*c.f.* Beck *et al*. 2018), with rainy summers (December to March) and a noticeable, dry, winter (June to September). The PEI has, however, different stations with distinct climatic profiles. At the PEI main station (ca. 800 m.a.s.l), the annual precipitation is of 1,400 mm, with the summer having an average precipitation of 187 ± 30 mm, and the wettest month (January) having 208 mm (WorldClim 2.5' data from 1970–2000, for 24°15'56" S 48°24'48" W, 841 m a.s.l., which is the coordinate of the "reception" in Figure 1b; Fick & Hijmans 2017, www.worldclim.org/data/worldclim21.html, see also Figure 2 of Leonel 2010). During winter, the average precipitation is 66 ± 21 mm, with the driest month (August) having 49 mm (WorldClim *op. cit*.). At another PEI station in the lowland (*ca*. 150 m a.s.l.), at Saibadela, the picture can be very different as its nonseasonal tropical rainy climate reaches 4,000 mm annual precipitation, with the rainy season always with > 200 mm/month, frequently > 400 mm/month, and the driest period (May to August) with > 100 mm/month (Morellato *et al.* 2000).

We had access to 27 years of maximum and minimum temperature and relative humidity data from the weather station located near the PEI reception (Figure 1b). Data collection began in April 1992 and, although it is collected until the present time, we analyzed it until June 2019. The weather station was visited three times a day (08h, 14h, and 20h), every day, resulting in 28,990 measurements (9,663 at 08h, 9,676 at 14h, 9,651 at 20h), spread in 9,722 days of 320 months of 27 years (Tables S2–S4). More details of the data and its analyses are provided in the Supplementary Material. This data showed high correlation with the temperature and humidity data we measured at the PEI trap sampling (Table S6).

2. Butterfly data sampling

This study joins datasets from museums (*Museu de Diversidade Biológica* of the University of Campinas, ZUEC-LEP and the Zoology Museum of the University of São Paulo, MZUSP, having also consulted the *Coleção Entomológica Padre Jesus Santiago Moure*, Zoology Department of the Federal University of Paraná, DZUP; and the National Museum at Rio de Janeiro, MNUFRJ) and sampling by the authors (referred by our initials) from different locations, under different methods.

In the Supplementary Material we describe the material and methods of each dataset (summarized in Table 1), including coordinates, method(s), collectors, specialists who identified the material, aim, sampling effort, and design. We organized them as follows: 1. museum data, and 2. sampling data by us (with PEI species fully illustrated in Shirai *et al*. 2022). We divided the museum data in: **1.1**. PEI ZUEC dataset, and **1.2.** PENaP dataset (*Parque Estadual Nascentes do Paranapanema*) – both datasets used the entomological net as the sampling method (communicated by the collectors). We divided the sampling data in: **2.1.** PEI dataset; **2.2.** PEI fish dataset (carrion bait test in the Atlantic Forest); **2.3.** PEI 1y dataset (one-year monitoring for capacity development and science outreach); **2.4.** AG dataset (Apiaí and Guapiara sampling); and **2.5.** Other.

Our sampling was carried out in the following periods: **2.1.** PEI dataset (illustrated in Shirai *et al*. 2022) at 14 to 18.III.2016 (pilot), 06 to 13.III.2017, 07 to 12.IV.2017, 11 to 16.VI.2017, 21 to 23.VII.2017, 10 to 14.IV.2018, 26 to 29.VII.2018 with sampling effort of 5,760 trap hours (16 days * 30 traps * 12 trap hours/day), and ca. 76 net hours; **2.2.** PEI fish dataset (07 to 12.III.2018 and 09 to 15.XII.2018) with sampling effort of 3,456 trap hours (8 days * 36 traps * 12 trap hours/day), and ca. 15 net hours; **2.3.** PEI 1y dataset 14 to 17.I.2019, 18 to 21.II.2019, 18 to 21.III.2019, 15 to 18.IV.2019, 27 to 30.V.2019, 17 to 20.VI.2019, 16 to 19.VII.2019, 20 to 23.VIII.2019, 17 to 20.IX.2019, 14 to 17.X.2019, 25 to 28.XI.2019, 09 to 12.XII.2019 with sampling effort of 4,752 trap hours (36 days * 11 traps * 12 trap hours/day); and **2.4.** AG dataset XII.2014, 06 to 19.VIII.2017, 18 to 27.XI.2017, 17 to 26.II.2018, 17 to 25.V.2018, 25.VIII to 03.IX.2018, 14 to 23.XII.2018, 08 to 17.III.2019, 02 to 12.VII.2019, 19 to 29.IX.2019 with sampling effort of 22,464 trap hours (39 days * 48 traps * 12 trap hours/day) and 156 hours of active search.

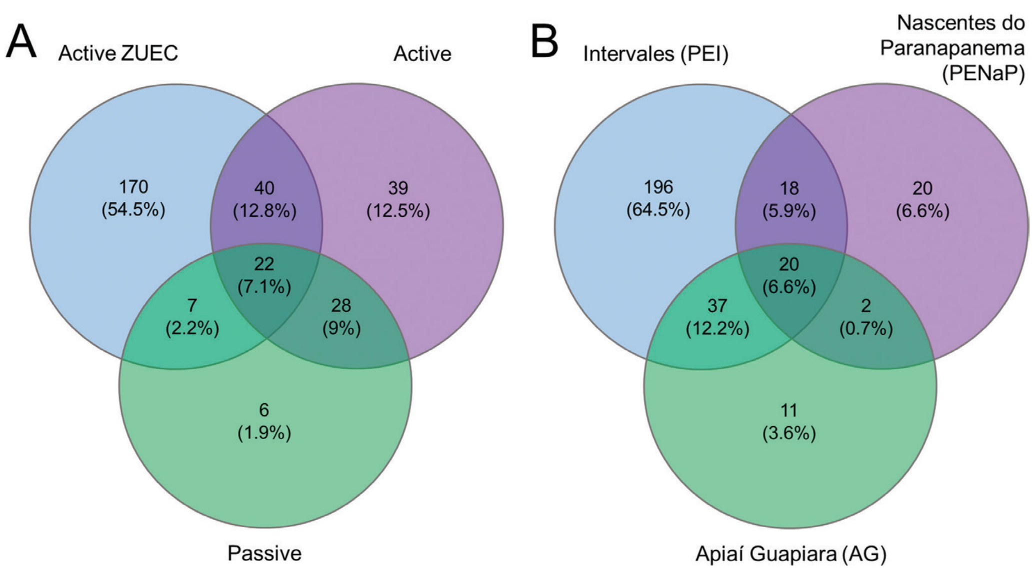

Figure 2. Venn diagrams of (a) sampling methods (active *versus* passive), separating the sampling from the ZUEC museum and our study for the active search method; and (b) different regions (PEI, PENaP, AG) – the 20 species common to all regions illustrated in Figure 3.

Table 1. Summary of each dataset, with information of when they were sampled (month and year), how (method and details of trap studies), and sampling effort. Museum data: PEI ZUEC (*Parque Estadual Intervales* in the ZUEC collection) and PENaP (*Parque Estadual Nascentes do Paranapanema*). Sampled in this study: PEI, PEI fish (carrion bait test in the Atlantic Forest), PEI 1y (one-year monitoring for capacity development and science outreach), and AG (Apiaí and Guapiara). Full sampling data is in the Supplementary Material.

Dataset	Months	Year(s)	Sampling effort	Method(s)	No. Traps	Bait	Stratum(a)
PEI ZUEC	I, II, IV, VIII, XI, XII	1992, 2000–2003, 2007–2010, 2013	NA	net	NA	NA	NA
PENAP	III, IV	2012	NA	net	NA	NA	NA
PEI	III, IV, VI, VII	2016–2018	5,760 trap h; 76 net h	net, trap	30	banana	understory, canopy
PEI fish	III, XII	2018	3,456 trap h; 15 net h	trap	36	banana x fish	understory, canopy
PEI 1y	I to XII	2019	4,752 trap h	trap	11	banana	understory
AG	all but I, IV, VI, X	2014, 2017–2019	22,464 trap h; 156 net/obs h	net, trap, obs	48	banana	understory

We classified species in subfamilies and used the phylogenetic hypotheses of Warren *et al*. (2008, 2009), Wahlberg *et al*. (2009, 2014), Seraphim *et al*. (2018), Li *et al*. (2019), and Dias *et al*. (2019). We based the identification of specimens on the specialized literature (*e.g.* Brown 1992, Uehara-Prado *et al*. 2004, Warren *et al*. 2016, Lamas 2022), and on the collections of the ZUEC-LEP and MZUSP. These are also the entomological collections where we housed the specimens collected by us, with material from LTS at Unicamp (ZUEC–LEP 10.018–10.070, 10.253–10.262, 11.312–11.445) and ROS at MZUSP. Part of the Unicamp material (~10%) has a pair of legs stored in EtOH and is available to the scientific community upon request.

We searched for information about the butterflies of the region by looking at the literature, asking specialists, and consulting a database with the state of the art of species lists in Brazil (Shirai *et al*. 2019). We found only three studies (Brown & Freitas 1999, Santos *et al*. 2015, Shirai *et al*. 2017), none of which had a species list for more than a tribe. Other studies reported the collection of focal taxa at the PEI (*e.g*. *Forsterinaria pronophila* (A. Butler, 1867) in Freitas & Peña 2006, *Blepolenis bassus* (C. Felder & R. Felder, 1867) in Penz *et al.* 2013, *Taygetis ypthima* (Hübner, [1821]) and *T. rectifascia* (Weymer, 1907) in Siewert *et al.* 2013, *Godartiana muscosa* (A. Butler, 1870) in Zacca *et al*. 2016, *T. acuta* Weymer, 1910 in Freitas 2017, *T. yphtima* in Uehara-Prado & Freitas 2019), and the referred specimens belong to ZUEC-LEP and ZUEC-AVLF private collection.

Except from ZUEC-LEP, other large butterfly collections in the country did not have material from the PEI: MZUSP (ROS pers. obs.); DZUP (O. H. H. Mielke, pers. comm.); the MNUFRJ probably did not have material from the region but even if it had, it would be reduced to ashes due to the fire in September 2018. In the 30 years and 300 research projects in the park, no foreign institution has had an official project that collected butterflies (T. B. Conforti, pers. comm.). Therefore, the museum data reported below belonged solely to ZUEC-LEP (now MZUSP has sampled material by ROS, and DZUP and MNRJ entomological collections also house PEI specimens donated by us).

We consulted ZUEC-LEP by the online database available at the SpeciesLink website (www.splink.org.br) at the very beginning and end of this study, filtering by the collection (ZUEC-LEP) and the municipalities of and around PEI (Capão Bonito, Eldorado, Guapiara, Iporanga, Ribeirão Grande, Sete Barras), returning results only for Ribeirão Grande and Sete Barras. We searched the Nymphalidae specimens with missing IDs in the database and checked every drawer of the collection to update the online database by including their identity.

3. *Data treatment*

We counted the number of individuals found at the ZUEC-LEP, those sampled by us under active searches and other sources (here referred as records), as well as under baited traps designs (here referred as abundance). The number of records and abundance are not comparable because specimens deposited in a museum, sampled with the net by different observers, or observational records (such as citizen science) do not reflect biological abundance. We also counted the number of species (richness), excluding genera not identified to the species level due to taxonomic issues (*e.g., Hermeuptychia* sp. Forster, 1964, Tan *et al*. 2021) or museum specimens identified as such (*e.g*., *Actinote* sp. Hübner, [1819], *Adelpha* sp. Hübner, [1819], etc); except from *Autochton* sp. Hübner, 1823, *Ochlodes* sp. Scudder, 1872, *Emesis* sp. Fabricius, 1807, and *Mesene* sp. E. Doubleday, 1847 because no other species of the same genus were in the list.

We reported the species lists by dataset (Table 2) and explored how many and which species belong to each dataset, or are shared among datasets, with Venn diagrams (using online tool Venny, https://bioinfogp.cnb.csic.es/tools/venny/). We also looked at the species assembly (presence/absence) by sampling method and by region. We then collapsed datasets in a single list to analyze richness (whole data, as well as PEI traps: PEI trap, PEI fish, and PEI 1y datasets) and abundance (only PEI traps) per month and per season. For PEI traps, we separated the lists by datasets and divided the diversity metrics by the number of traps and trap days.

Lastly, focusing on baited traps (PEI traps and AG traps), to understand how the richness distribution match what has been found in other trap studies in the Atlantic Forest, we used a database of Nymphalidae species lists in Brazil called DnB (Shirai *et al*. 2019, downloaded from https://doi.org/10.5281/zenodo.2561408), filtering studies that exclusively used baited traps, exclusively at the Atlantic Forest. That is, we did not include studies of the DnB database that used *e.g.* active searches or active search plus traps; or done in other biomes or the Atlantic Forest plus other biomes, because the lists would not be strictly comparable. The DnB study used the same source for phylogenetic arrangement as ours (Wahlberg *et al.* 2009). In relation to species identities, we filtered species considered valid by Lamas (2004) which, despite being outdated, standardizes the taxonomy to a single source. To counterbalance this compromise, we also consulted the largest database of fruit-feeding butterflies in the Atlantic Forest (Santos *et al.* 2018), that has an updated taxonomy. Using Santos *et al.* (2018) classification of tribes, we compared our totals per tribe with their data (Figure 3 of Santos *et al.* 2018).

Results

In total, we found 312 species for PEI and surroundings (Table 2) that sum to 2,139 records (1,605 in active search, 509 in traps, 25 other). The museum contributed with 432 records for 229 species. We sampled 1,682 specimens belonging to 142 species, in a total effort of 36,679 sampling hours (36,432 trap and 247 net and observation hours, Table 1).

The richest families were Nymphalidae (148 species), the single family caught by all sampling methods, and Hesperiidae (100), followed by Riodinidae (23 species), Lycaenidae (19 species), Pieridae (14 species), and Papilionidae (8 species). Within nymphalids, the richest subfamily was Satyrinae (58 species), followed by Danainae (23), Heliconiinae (18), Biblidinae (16), Nymphalinae (13), Charaxinae (12), Limenitidinae (6), and Apaturinae (2). Within skippers, the richest subfamily was Hesperiinae (54 species), followed by Pyrginae (24), Eudaminae (16), Pyrrhopyginae (4), and Tagiadinae (2). None of the species were among the 63 threatened (that is, critically endangered, endangered, or vulnerable) butterfly species (ICMBio 2018, updated by Augusto H. B. Rosa).

The great majority of species was sampled exclusively by active methods (79.8%), with 18.3% having been collected by both active and passive methods, and only 1.9% sampled in traps only (Figure 2a). Additionally, the citizen science, iNaturalist and Santos *et al*. (2015)

Table 2. Butterfly species of PEI and surroundings per dataset. Museum data: PEI ZUEC (*Parque Estadual Intervales* in the ZUEC collection) and PENaP (*Parque Estadual Nascentes do Paranapanema*). Sampled in this study: PEI, PEI fish (carrion bait test in the Atlantic Forest), PEI 1y (one-year monitoring for capacity development and science outreach), and AG (Apiaí and Guapiara). "Other" refers to citizen science, iNaturalist and Santos *et al*. (2015) sources. Numbers are either the number of records or the abundance (only for standardized method of baited traps), while "x" denotes presence. In the "Month caught" column, PENaP did not have specify collection dates, only III–IV. This table is available at 10.5281/zenodo.7429126.

Family	Subfamily	Tribe	Taxon	Species description	PEI ZUEC	PENaP	PEI	AG	PEI	PEI fish	PEI 1y	AG	other	Month caught
					entomological net				baited traps					
Hesperiidae	Eudaminae		*Autochton* sp.	NA	x									NA
Hesperiidae	Eudaminae		*Cecropterus albimargo*	(Mabille, 1876)	1									I
Hesperiidae	Eudaminae		*Cecropterus zarex*	(Hübner, 1818)	2		1							I, III
Hesperiidae	Eudaminae		*Oechydrus chersis*	(Herrich-Schäffer, 1869)			1							IV
Hesperiidae	Eudaminae		*Perichares seneca*	(Latreille, [1824])			1							VII
Hesperiidae	Eudaminae		*Phanus australis*	L. Miller, 1965	2									I
Hesperiidae	Eudaminae		*Phocides pialia*	(Hewitson, 1857)	x									NA
Hesperiidae	Eudaminae		*Polygonus savigny*	(Latreille, [1824])	1									I
Hesperiidae	Eudaminae		*Spicauda procne*	(Plötz, 1881)			1							III
Hesperiidae	Eudaminae		*Spicauda simplicius*	(Stoll, 1790)			2							III, IV
Hesperiidae	Eudaminae		*Spicauda teleus*	(Hübner, 1821)		4								III–IV, IV
Hesperiidae	Eudaminae		*Telegonus alardus*	(Stoll, 1790)	1									I
Hesperiidae	Eudaminae		*Typhedanus aziris*	(Hewitson, 1867)	1									XII
Hesperiidae	Eudaminae		*Typhedanus stylites*	(Herrich-Schäffer, 1869)			1			1				XII
Hesperiidae	Eudaminae		*Urbanus esmeraldus*	(A. Butler, 1877)	2									I
Hesperiidae	Eudaminae		*Urbanus pronta*	Evans, 1952			3							III
Hesperiidae	Hesperiinae		*Anthoptus epictetus*	(Fabricius, 1793)	3									XII
Hesperiidae	Hesperiinae		*Callimormus rivera*	(Plötz, 1882)	2									XII
Hesperiidae	Hesperiinae		*Carystoides sicania*	(Hewitson, 1876)	x									NA
Hesperiidae	Hesperiinae		*Cobalopsis brema*	E. Bell, 1959	1									I
Hesperiidae	Hesperiinae		*Cobalopsis vorgia*	(Schaus, 1902)	1									I
Hesperiidae	Hesperiinae		*Conga immaculata*	(E. Bell, 1930)			1							XII
Hesperiidae	Hesperiinae		*Corticea lysias*	Evans, 1955	x									NA
Hesperiidae	Hesperiinae		*Corticea oblinita*	(Mabille, 1891)			1							III
Hesperiidae	Hesperiinae		*Decinea dama*	(Herrich-Schäffer, 1869)						1				III
Hesperiidae	Hesperiinae		*Decinea decinea*	(Hewitson, 1876)	1									I
Hesperiidae	Hesperiinae		*Enosis schausi*	O. Mielke & Casagrande, 2002	1									I
Hesperiidae	Hesperiinae		*Eutocus matildae*	(Hayward, 1941)	x									NA
Hesperiidae	Hesperiinae		*Eutychide physcella*	(Hewitson, 1866)	x									NA

Hesperiidae	Hesperiinae	*Lamponia lamponia*	(Hewitson, 1876)	x				NA
Hesperiidae	Hesperiinae	*Lerema duroca*	Evans, 1955	x				NA
Hesperiidae	Hesperiinae	*Levina levina*	(Plötz, 1884)	1				XII
Hesperiidae	Hesperiinae	*Libra aligula*	(Schaus, 1902)	2				II
Hesperiidae	Hesperiinae	*Lucida lucia*	(Capronnier, 1874)	x				NA
Hesperiidae	Hesperiinae	*Lucida ranesus*	(Schaus, 1902)	1				II
Hesperiidae	Hesperiinae	*Lucida schmithi*	(E. Bell, 1930)	1				XII
Hesperiidae	Hesperiinae	*Lychnuchoides ozias*	(Hewitson, 1878)	x				NA
Hesperiidae	Hesperiinae	*Lychnuchus celsus*	(Fabricius, 1793)	1	3			I, IV
Hesperiidae	Hesperiinae	*Metron oropa*	(Hewitson, 1877)	3				II, XII
Hesperiidae	Hesperiinae	*Miltomiges cinnamomea*	(Herrich-Schäffer, 1869)	1	3	4		I, III, IV, VII
Hesperiidae	Hesperiinae	*Mnasitheus ritans*	(Schaus, 1902)			3		IV, VII, XII
Hesperiidae	Hesperiinae	*Moeris remus*	(Fabricius, 1798)		1			IV
Hesperiidae	Hesperiinae	*Naevolus orius*	(Mabille, 1883)	x				NA
Hesperiidae	Hesperiinae	*Nastra lurida*	(Herrich-Schäffer, 1869)	1				XII
Hesperiidae	Hesperiinae	*Niconiades cydia*	(Hewitson, 1876)	4				I
Hesperiidae	Hesperiinae	*Niconiades merenda*	(Mabille, 1878)	1				I
Hesperiidae	Hesperiinae	*Ochlodes* sp.	NA	x				NA
Hesperiidae	Hesperiinae	*Papias phainis*	Godman, 1900				x	XII
Hesperiidae	Hesperiinae	*Perichares philetes*	(Gmelin, [1790])	x				NA
Hesperiidae	Hesperiinae	*Pheraeus fastus*	(Hayward, 1939)				x	NA
Hesperiidae	Hesperiinae	*Pheraeus odilia*	(Plötz, 1884)	1				XII
Hesperiidae	Hesperiinae	*Polites vibex*	(Geyer, 1832)				x	XII
Hesperiidae	Hesperiinae	*Pompeius pompeius*	(Latreille, [1824])	x				NA
Hesperiidae	Hesperiinae	*Psoralis coyana*	(Schaus, 1902)			1		VII
Hesperiidae	Hesperiinae	*Psoralis stacara*	(Schaus, 1902)		3	1		IV, VII
Hesperiidae	Hesperiinae	*Quasimellana nicomedes*	(Mabille, 1883)	2				I
Hesperiidae	Hesperiinae	*Saliana esperi*	Evans, 1955	x				NA
Hesperiidae	Hesperiinae	*Saliana saladin*	Evans, 1955	x				NA
Hesperiidae	Hesperiinae	*Sodalia dimassa*	(Hewitson, 1876)	1				XII
Hesperiidae	Hesperiinae	*Talides sergestus*	(Cramer, 1775)	x				NA
Hesperiidae	Hesperiinae	*Tirynthia conflua*	(Herrich-Schäffer, 1869)	2				I
Hesperiidae	Hesperiinae	*Vehilius clavicula*	(Plötz, 1884)	1	2	2		III, III–IV, XII
Hesperiidae	Hesperiinae	*Vehilius stictomenes*	(A. Butler, 1877)	1				I
Hesperiidae	Hesperiinae	*Vettius diana*	(Plötz, 1886)	x				NA
Hesperiidae	Hesperiinae	*Vettius lucretius*	(Latreille, [1824])	x				NA

Continue...

...Continuation

Family	Subfamily	Tribe	Taxon	Species description	PEI ZUEC	PENaP	PEI	AG	PEI	PEI fish	PEI 1y	AG	other	Month caught
					entomological net				baited traps					
Hesperiidae	Hesperiinae		*Vettius phyllus*	Evans, 1955	x									NA
Hesperiidae	Hesperiinae		*Vettius umbrata*	(Erschoff, 1876)	2		3							II, VII
Hesperiidae	Hesperiinae		*Vinius letis*	(Plötz, 1883)	1									XII
Hesperiidae	Hesperiinae		*Zariaspes mys*	(Hübner, [1808])		5								III–IV, IV
Hesperiidae	Hesperiinae		*Zenis jebus*	(Plötz, 1882)	x									NA
Hesperiidae	Pyrginae		*Achlyodes mithridates*	(Fabricius, 1793)	1									I
Hesperiidae	Pyrginae		*Anastrus obscurus*	Hübner, [1824]	x									NA
Hesperiidae	Pyrginae		*Anastrus ulpianus*	Poey, 1832	x									NA
Hesperiidae	Pyrginae		*Bolla catharina*	(E. Bell, 1937)	1									I
Hesperiidae	Pyrginae		*Burnsius orcus*	(Stoll, 1780)		1		x						IV, XII
Hesperiidae	Pyrginae		*Diaeus lacaena*	(Hewitson, 1869)			1							XII
Hesperiidae	Pyrginae		*Diaeus* sp.	NA		1								III–IV
Hesperiidae	Pyrginae		*Ebrietas infanda*	(A. Butler, 1877)			1							III
Hesperiidae	Pyrginae		*Gindanes brebisson*	(Latreille, [1824])	x									NA
Hesperiidae	Pyrginae		*Heliopetes (Heliopetes) arsalte*	(Linnaeus, 1758)		1								IV
Hesperiidae	Pyrginae		*Heliopetes (Heliopetes) ochroleuca*	J. Zikán, 1938	1		1							VII, XII
Hesperiidae	Pyrginae		*Heliopetes (Heliopyrgus) americanus*	(Blanchard, 1852)			1							III
Hesperiidae	Pyrginae		*Heliopetes (Leucoscirtes) omrina*	(A. Butler, 1870)		1								IV
Hesperiidae	Pyrginae		*Heliopetes alana*	(Reakirt, 1868)	x									NA
Hesperiidae	Pyrginae		*Mylon maimon*	(Fabricius, 1775)	1									I
Hesperiidae	Pyrginae		*Nisoniades castolus*	(Hewitson, 1878)			1							III
Hesperiidae	Pyrginae		*Noctuana diurna*	(A. Butler, 1870)	1									I
Hesperiidae	Pyrginae		*Pythonides lancea*	(Hewitson, 1868)	1								x	I
Hesperiidae	Pyrginae		*Quadrus cerialis*	(Stoll, 1782)	1									XII
Hesperiidae	Pyrginae		*Theagenes dichrous*	(Mabille, 1878)			1							VII
Hesperiidae	Pyrginae		*Trina geometrina*	(C. Felder & R. Felder, 1867)	x									NA
Hesperiidae	Pyrginae		*Viola violella*	(Mabille, 1898)									x	XII
Hesperiidae	Pyrginae		*Xenophanes tryxus*	(Stoll, 1780)		5	3							III, III–IV, VII
Hesperiidae	Pyrginae		*Zera hyacinthinus*	(Mabille, 1877)	x									NA

Hesperiidae	Pyrginae	*Zera zera*	(A. Butler, 1870)	x								NA
Hesperiidae	Pyrrhopyginae	*Elbella lamprus*	(Hopffer, 1874)	x								NA
Hesperiidae	Pyrrhopyginae	*Mimoniades (Mahotis) versicolor*	(Latreille, [1824])	2								I
Hesperiidae	Pyrrhopyginae	*Myscelus amystis*	(Hewitson, 1867)	1								XII
Hesperiidae	Pyrrhopyginae	*Pyrrhopyge charybdis*	Westwood, 1852	x								NA
Hesperiidae	Tagiadinae	*Celaenorrhinus eligius*	(Stoll, 1781)	1								I
Hesperiidae	Tagiadinae	*Celaenorrhinus similis*	Hayward, 1933	x								NA
Lycaenidae	Polyommatinae	*Elkalyce cogina*	(Schaus, 1902)	1								I
Lycaenidae	Polyommatinae	*Hemiargus hanno*	(Stoll, 1790)		1							IV
Lycaenidae	Polyommatinae	*Leptotes cassius*	(Cramer, 1775)			1						III
Lycaenidae	Polyommatinae	*Zizula cyna*	(W. H. Edwards, 1881)		3							III–IV, IV
Lycaenidae	Theclinae	*Arawacus meliboeus*	(Fabricius, 1793)		1							III–IV
Lycaenidae	Theclinae	*Arzecla arza*	(Hewitson, 1874)	x								NA
Lycaenidae	Theclinae	*Aubergina vanessoides*	(Prittwitz, 1865)	x								NA
Lycaenidae	Theclinae	*Brangas silumena*	(Hewitson, 1867)	x								NA
Lycaenidae	Theclinae	*Calycopis janeirica*	(C. Felder, 1862)	x								NA
Lycaenidae	Theclinae	*Chalybs janias or C. chloris*	NA	x								NA
Lycaenidae	Theclinae	*Evenus satyroides*	(Hewitson, 1865)	x								NA
Lycaenidae	Theclinae	*Janthecla flosculus*	(H. Druce, 1907)			1						III
Lycaenidae	Theclinae	*Laothus phydela*	(Hewitson, 1867)		1							IV
Lycaenidae	Theclinae	*Ocaria thales*	(Fabricius, 1793)	x								NA
Lycaenidae	Theclinae	*Ostrinotes empusa*	(Hewitson, 1867)			1						XII
Lycaenidae	Theclinae	*Rekoa palegon*	(Cramer, 1780)	x								NA
Lycaenidae	Theclinae	*Strephonota elika*	(Hewitson, 1867)				x					XII
Lycaenidae	Theclinae	*Theritas hemon*	(Cramer, 1775)		1							III–IV
Lycaenidae	Theclinae	*Theritas lisus*	(Stoll, 1790)	x								NA
Nymphalidae	Apaturinae	*Doxocopa laurentia*	(Godart, [1824])			1						IV
Nymphalidae	Apaturinae	*Doxocopa zunilda*	(Godart, [1824])								x	NA
Nymphalidae	Biblidinae	*Catonephele acontius*	(Linnaeus, 1771)				1	1				II, III
Nymphalidae	Biblidinae	*Catonephele numilia*	(Cramer, 1775)				1	2	1	1		III, IV
Nymphalidae	Biblidinae	*Diaethria clymena*	(Cramer, 1775)				7	1	3	4		II, III, V, XII
Nymphalidae	Biblidinae	*Diaethria eluina*	(Hewitson, [1855])					1				III
Nymphalidae	Biblidinae	*Dynamine athemon*	(Linnaeus, 1758)	x								NA
Nymphalidae	Biblidinae	*Dynamine tithia*	(Hübner, 1823)	x								NA

Continue...

...Continuation

Family	Subfamily	Tribe	Taxon	Species description	entomological net				baited traps				other	Month caught
					PEI ZUEC	PENaP	PEI	AG	PEI	PEI fish	PEI 1y	AG		
Nymphalidae	Biblidinae		*Ectima thecla*	(Fabricius, 1796)				2				3		II, IX
Nymphalidae	Biblidinae		*Epiphile orea*	(Hübner, [1823])			1	4	2	2	1	1		II to V, IX, XI, XII
Nymphalidae	Biblidinae		*Haematera pyrame*	(Hübner, [1819])				2				1		II
Nymphalidae	Biblidinae		*Hamadryas amphinome*	(Linnaeus, 1767)				2		1		1		II, XII
Nymphalidae	Biblidinae		*Hamadryas epinome*	(C. Felder & R. Felder, 1867)				41				17		II, V, IX, XI
Nymphalidae	Biblidinae		*Hamadryas februa*	(Hübner, [1823])	1			2						II
Nymphalidae	Biblidinae		*Hamadryas feronia*	(Linnaeus, 1758)	x									NA
Nymphalidae	Biblidinae		*Hamadryas fornax*	(Hübner, [1823])			1	3				1		II, III, XI
Nymphalidae	Biblidinae		*Myscelia orsis*	(Drury, 1782)		2	1	33	1			18		II to V, VIII, IX, XI
Nymphalidae	Biblidinae		*Temenis laothoe*	(Cramer, 1777)				2		2		1		V, XII
Nymphalidae	Charaxinae		*Archaeoprepona amphimachus*	(Fabricius, 1775)	1			2	1			1		I to III, V
Nymphalidae	Charaxinae		*Archaeoprepona chalciope*	(Hübner, [1823])				5		2				II, III, XII
Nymphalidae	Charaxinae		*Archaeoprepona demophon*	(Linnaeus, 1758)	2			4				1		I, II, XI
Nymphalidae	Charaxinae		*Consul fabius*	(Cramer, 1776)	1			1						I, II
Nymphalidae	Charaxinae		*Fountainea ryphea*	(Cramer, 1775)			1	2	10	6	2	2		II to VI, XII
Nymphalidae	Charaxinae		*Hypna clytemnestra*	(Cramer, 1777)	1		1				1			I, III, V
Nymphalidae	Charaxinae		*Memphis acidalia*	(Hübner, [1819])		1			1		1			III–IV, IV, V
Nymphalidae	Charaxinae		*Memphis appias*	(Hübner, [1825])			2	5	51	8	1			II to IV, XII
Nymphalidae	Charaxinae		*Memphis moruus*	(Fabricius, 1775)					4		1			II, III
Nymphalidae	Charaxinae		*Memphis otrere*	(Hübner, [1825])				4	2	2		2		II to IV, XI
Nymphalidae	Charaxinae		*Siderone galanthis*	(Cramer, 1775)							1			IV
Nymphalidae	Charaxinae		*Zaretis strigosus*	(Gmelin, [1790])				2	3	1	3			II to V, XI
Nymphalidae	Danainae		*Aeria olena*	Weymer, 1875	x									NA
Nymphalidae	Danainae		*Callithomia lenea*	(Cramer, 1779)	1		3							I, III
Nymphalidae	Danainae		*Danaus erippus*	(Cramer, 1775)			8							III, IV, VII, XII
Nymphalidae	Danainae		*Danaus gilippus*	(Cramer, 1775)		1							x	IV
Nymphalidae	Danainae		*Dircenna dero*	(Hübner, 1823)	2									I
Nymphalidae	Danainae		*Episcada hymenaea*	(Prittwitz, 1865)			1							III

Nymphalidae	Danainae	*Episcada philoclea*	(Hewitson, [1855])	x								NA
Nymphalidae	Danainae	*Episcada striposis*	Haensch, 1909	x								NA
Nymphalidae	Danainae	*Episcada sylvo*	(Geyer, 1832)	2								I
Nymphalidae	Danainae	*Epityches eupompe*	(Geyer, 1832)	5	2	52					x	I, III, IV, VI, VII, XII
Nymphalidae	Danainae	*Hypoleria adasa*	(Hewitson, [1855])	x								NA
Nymphalidae	Danainae	*Hypothyris ninonia*	(Hübner, [1806])			4			1	1		III to VI
Nymphalidae	Danainae	*Ithomia agnosia*	Hewitson, [1855]			1						IV
Nymphalidae	Danainae	*Ithomia drymo*	Hübner, 1816	4	4	6	x	2			x	I, III, IV, VI, VII, XII
Nymphalidae	Danainae	*Ithomia lichyi*	R.F. d'Almeida, 1939			3						III
Nymphalidae	Danainae	*Lycorea halia*	(Hübner, 1816)								x	NA
Nymphalidae	Danainae	*Mechanitis lysimnia*	(Fabricius, 1793)	2	1	4	x					I, III, III–IV, VI, XII
Nymphalidae	Danainae	*Melinaea ethra*	(Godart, 1819)	x								NA
Nymphalidae	Danainae	*Melinaea ludovica*	(Cramer, 1780)	2								I
Nymphalidae	Danainae	*Oleria aquata*	(Weymer, 1875)	1		1						I, III
Nymphalidae	Danainae	*Placidina euryanassa*	(C. Felder & R. Felder, 1860)			1						III
Nymphalidae	Danainae	*Pseudoscada erruca*	(Hewitson, 1855)	6		2	x					I, III, XII
Nymphalidae	Danainae	*Pteronymia carlia*	Schaus, 1902	4	3	5						I, III, IV, XII
Nymphalidae	Heliconiinae	*Actinote carycina*	Jordan, 1913			1						IV
Nymphalidae	Heliconiinae	*Actinote dalmeidai*	Francini, 1996	1								XII
Nymphalidae	Heliconiinae	*Actinote genitrix*	R.F. d'Almeida, 1922	2								XII
Nymphalidae	Heliconiinae	*Actinote melanisans*	Oberthür, 1917			1						XII
Nymphalidae	Heliconiinae	*Actinote parapheles*	Jordan, 1913	1								XII
Nymphalidae	Heliconiinae	*Actinote pyrrha*	(Fabricius, 1775)		1	5	x					IV, XII
Nymphalidae	Heliconiinae	*Actinote* sp.	NA	4	10						x	III–IV, IV, XI, XII
Nymphalidae	Heliconiinae	*Agraulis vanillae*	(Linnaeus, 1758)	x								NA
Nymphalidae	Heliconiinae	*Dione juno*	(Cramer, 1779)	x								NA
Nymphalidae	Heliconiinae	*Dryadula phaetusa*	(Linnaeus, 1758)								x	NA
Nymphalidae	Heliconiinae	*Dryas iulia*	(Fabricius, 1775)	1		5					x	I, III, IV, VI
Nymphalidae	Heliconiinae	*Eueides aliphera*	(Godart, 1819)		2							III–IV
Nymphalidae	Heliconiinae	*Eueides isabella*	(Stoll, 1781)			1	x					IV, XII
Nymphalidae	Heliconiinae	*Eueides pavana*	Ménétriés, 1857		1							IV
Nymphalidae	Heliconiinae	*Heliconius besckei*	(Ménétriés, 1857)	3	1	8	x					I, III, IV, VII, XII

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...Continuation

Family	Subfamily	Tribe	Taxon	Species description	PEI ZUEC	PENaP	PEI	AG	PEI	PEI fish	PEI 1y	AG	other	Month caught
					entomological net				baited traps					
Nymphalidae	Heliconiinae		*Heliconius erato*	(Linnaeus, 1758)	3	1	10							I, III, IV, XII
Nymphalidae	Heliconiinae		*Heliconius ethilla*	(Godart, 1819)	1		4							III, VII, XII
Nymphalidae	Heliconiinae		*Heliconius sara*	(Fabricius, 1793)	1	2	1							III, III–IV, XII
Nymphalidae	Heliconiinae		*Philaethria wernickei*	(Röber, 1906)		1	3						x	III, IV
Nymphalidae	Limenitidinae		*Adelpha cocala*	(Cramer, 1779)	1									I
Nymphalidae	Limenitidinae		*Adelpha gavina*	Fruhstorfer, 1915	x									NA
Nymphalidae	Limenitidinae		*Adelpha lycorias*	(Godart, [1824])	x									NA
Nymphalidae	Limenitidinae		*Adelpha mythra*	(Godart, [1824])	1									I
Nymphalidae	Limenitidinae		*Adelpha serpa*	(Boisduval, 1836)	1			x						I, XII
Nymphalidae	Limenitidinae		*Adelpha* sp.	NA	1	3							x	III–IV, IV, XI
Nymphalidae	Limenitidinae		*Adelpha syma*	(Godart, [1824])			1							IV
Nymphalidae	Nymphalinae		*Anartia amathea*	(Linnaeus, 1758)	1	1	10	x					x	I, III, IV, XII
Nymphalidae	Nymphalinae		*Eresia lansdorfi*	(Godart, 1819)		1	1	x						III, III–IV, XII
Nymphalidae	Nymphalinae		*Eresia perna*	Hewitson, 1852	x									NA
Nymphalidae	Nymphalinae		*Historis odius*	(Fabricius, 1775)	1									I
Nymphalidae	Nymphalinae		*Hypanartia bella*	(Fabricius, 1793)		2	3							III–IV, XII
Nymphalidae	Nymphalinae		*Hypanartia lethe*	(Fabricius, 1793)	x									NA
Nymphalidae	Nymphalinae		*Junonia evarete*	(Cramer, 1779)			1	x						IV, XII
Nymphalidae	Nymphalinae		*Ortilia ithra*	(W. F. Kirby, 1900)		1								III–IV
Nymphalidae	Nymphalinae		*Siproeta epaphus*	(Latreille, [1813])	1			x						I, XII
Nymphalidae	Nymphalinae		*Smyrna blomfildia*	(Fabricius, 1781)	2				2					I, III
Nymphalidae	Nymphalinae		*Tegosa claudina*	(Eschscholtz, 1821)	1	1	3							III, IV, XII
Nymphalidae	Nymphalinae		*Tegosa* sp.	NA			2							III
Nymphalidae	Nymphalinae		*Telenassa teletusa*	(Godart, [1824])	3	4		x						I, III–IV, XII
Nymphalidae	Nymphalinae		*Vanessa braziliensis*	(Moore, 1883)	1		1							VII, XI
Nymphalidae	Satyrinae	Brassolini	*Blepolenis bassus*	(C. Felder & R. Felder, 1867)	5						1			I, II
Nymphalidae	Satyrinae	Brassolini	*Blepolenis batea*	(Hübner, [1821])	1	2	3		2		3	3		I to III, III–IV
Nymphalidae	Satyrinae	Brassolini	*Blepolenis catharinae*	(Stichel, 1902)				1				1		II
Nymphalidae	Satyrinae	Brassolini	*Caligo arisbe*	Hübner, [1822]								1		II
Nymphalidae	Satyrinae	Brassolini	*Caligo beltrao*	(Illiger, 1801)	1								x	XI
Nymphalidae	Satyrinae	Brassolini	*Caligo brasiliensis*	(C. Felder, 1862)	x									NA
Nymphalidae	Satyrinae	Brassolini	*Catoblepia amphirhoe*	(Hübner, [1825])				1						II

Nymphalidae	Satyrinae	Brassolini	*Dasyophthalma creusa*	(Hübner, [1821])			1	8				4		II, III
Nymphalidae	Satyrinae	Brassolini	*Dasyophthalma rusina*	(Godart, [1824])		1		1			1			II, IV
Nymphalidae	Satyrinae	Brassolini	*Eryphanis reevesii*	(E. Doubleday, [1849])	1			16	2		1	2		II, III, V, X to XII
Nymphalidae	Satyrinae	Brassolini	*Narope cyllene*	C. Felder & R. Felder, 1859				2	2	1		1		II to IV, XII
Nymphalidae	Satyrinae	Brassolini	*Opoptera aorsa*	(Godart, [1824])	1		3							III, XII
Nymphalidae	Satyrinae	Brassolini	*Opoptera sulcius*	(Staudinger, 1887)		1	2	12	1			2		II to IV
Nymphalidae	Satyrinae	Brassolini	*Opsiphanes cassiae*	(Linnaeus, 1758)	1									I
Nymphalidae	Satyrinae	Brassolini	*Opsiphanes invirae*	(Hübner, [1808])	1			4						I
Nymphalidae	Satyrinae	Haeterini	*Pierella lamia*	(Sulzer, 1776)	1									I
Nymphalidae	Satyrinae	Haeterini	*Pierella nereis*	(Drury, 1782)	1									XII
Nymphalidae	Satyrinae	Morphini	*Antirrhea archaea*	Hübner, [1822]	x									NA
Nymphalidae	Satyrinae	Morphini	*Morpho aega*	(Hübner, [1822])	3	1	2	80	1			10		all but VI, VII, IX, X
Nymphalidae	Satyrinae	Morphini	*Morpho anaxibia*	(Esper, [1801])		2	1							III–IV, IV
Nymphalidae	Satyrinae	Morphini	*Morpho epistrophus*	(Fabricius, 1796)			5	125	37	24	4	9	x	II to IV
Nymphalidae	Satyrinae	Morphini	*Morpho helenor*	(Cramer, 1776)		1	3	46				3		II, III, III–IV, XI
Nymphalidae	Satyrinae	Morphini	*Morpho hercules*	(Dalman, 1823)		1								IV
Nymphalidae	Satyrinae	Satyrini	*Archeuptychia cluena*	(Drury, 1782)	1									VIII
Nymphalidae	Satyrinae	Satyrini	*Capronnieria galesus*	(Godart, [1824])	2	2					2			I, III, IV
Nymphalidae	Satyrinae	Satyrini	*Carminda griseldis*	(Weymer, 1911)	2							1		I, II, XII
Nymphalidae	Satyrinae	Satyrini	*Carminda paeon*	(Godart, [1824])	2	5	5	7	2	1		8		all but VI, VII, X
Nymphalidae	Satyrinae	Satyrini	*Cissia eous*	(A. Butler, 1867)		3								III–IV
Nymphalidae	Satyrinae	Satyrini	*Cissia phronius*	(Godart, [1824])	4	3	6	10	1		7	4		I, III to V, IX, XII
Nymphalidae	Satyrinae	Satyrini	*Eteona tisiphone*	(Boisduval, 1836)				12	6		1	7		II to V, IX, XI
Nymphalidae	Satyrinae	Satyrini	*Euptychoides castrensis*	(Schaus, 1902)	3	2		16				8		I, II, III–IV, XI, XII
Nymphalidae	Satyrinae	Satyrini	*Forsterinaria necys*	(Godart, [1824])	1		4	115	10	2		12		all but VI, X
Nymphalidae	Satyrinae	Satyrini	*Forsterinaria pronophila*	(A. Butler, 1867)	1		1	44		3		11		I to III, V, VIII, IX, XI
Nymphalidae	Satyrinae	Satyrini	*Forsterinaria quantius*	(Godart, [1824])	4	2		52				2		all but III, VI, VII, X
Nymphalidae	Satyrinae	Satyrini	*Godartiana muscosa*	(A. Butler, 1870)	2		4	133	3			41		all but VII, X
Nymphalidae	Satyrinae	Satyrini	*Hermeuptychia aff. hermes*	NA			10		1					III, IV, VI, VII, XII

Continue...

...Continuation

Family	Subfamily	Tribe	Taxon	Species description	PEI ZUEC	PENaP	PEI	AG	PEI	PEI fish	PEI 1y	AG	other	Month caught
					entomological net				baited traps					
Nymphalidae	Satyrinae	Satyrini	*Hermeuptychia hermes*	(Fabricius, 1775)	2			33				14		I, II, XII
Nymphalidae	Satyrinae	Satyrini	*Hermeuptychia* sp.	NA			11				3			III to V
Nymphalidae	Satyrinae	Satyrini	*Moneuptychia soter*	(A. Butler, 1877)	1			3	1		4	2		I, III to VI, XI
Nymphalidae	Satyrinae	Satyrini	*Pareuptychia ocirrhoe*	(Fabricius, 1776)	1									IV
Nymphalidae	Satyrinae	Satyrini	*Paryphthimoides grimon*	(Godart, [1824])	1									IV
Nymphalidae	Satyrinae	Satyrini	*Paryphthimoides poltys*	(Prittwitz, 1865)	x									NA
Nymphalidae	Satyrinae	Satyrini	*Praepedaliodes phanias*	(Hewitson, 1862)			1					5		II, III, V
Nymphalidae	Satyrinae	Satyrini	*Praepedaliodes* sp.	NA	1									II
Nymphalidae	Satyrinae	Satyrini	*Pseudodebis celia*	(Cramer, 1779)				2	1	1				III, XI
Nymphalidae	Satyrinae	Satyrini	*Pseudodebis euptychidia*	(A. Butler, 1868)	5		3		8		10			all but II, VII, VIII
Nymphalidae	Satyrinae	Satyrini	*Splendeuptychia aff. boliviensis*	NA				6				18		V, VIII, IX, XI
Nymphalidae	Satyrinae	Satyrini	*Splendeuptychia ambra*	(Weymer, [1911])				11				2		XI
Nymphalidae	Satyrinae	Satyrini	*Splendeuptychia* sp.	NA	1									XII
Nymphalidae	Satyrinae	Satyrini	*Taygetina kerea*	(A. Butler, 1869)	x									NA
Nymphalidae	Satyrinae	Satyrini	*Taygetis acuta*	Weymer, 1910				1			1			II, V
Nymphalidae	Satyrinae	Satyrini	*Taygetis mermeria*	(Cramer, 1776)			2		3					III, VI
Nymphalidae	Satyrinae	Satyrini	*Taygetis rectifascia*	(Weymer, 1907)	14							1		I, II, XII
Nymphalidae	Satyrinae	Satyrini	*Taygetis rufomarginata*	Staudinger, 1888	x									NA
Nymphalidae	Satyrinae	Satyrini	*Taygetis sosis*	Hopffer, 1874	x									NA
Nymphalidae	Satyrinae	Satyrini	*Taygetis* sp.	NA	2									I
Nymphalidae	Satyrinae	Satyrini	*Taygetis tripunctata*	Weymer, 1907	x									NA
Nymphalidae	Satyrinae	Satyrini	*Taygetis ypthima*	(Hübner, [1821])	12					1	3			I to III, VI, XII
Nymphalidae	Satyrinae	Satyrini	*Yphthimoides affinis*	(A. Butler, 1867)	1									I
Nymphalidae	Satyrinae	Satyrini	*Yphthimoides ochracea*	(A. Butler, 1867)	1									IV
Nymphalidae	Satyrinae	Satyrini	*Yphthimoides ordinaria*	A.V.L. Freitas, L. Kaminski & O.H.H. Mielke, 2012	1									II
Nymphalidae	Satyrinae	Satyrini	*Zischkaia pacarus*	(Godart, [1824])								1		NA
Papilionidae	Papilioninae		*Eurytides bellerophon*	(Dalman, 1823)	1									I
Papilionidae	Papilioninae		*Heraclides thoas*	(Rothschild & Jordan, 1906)	x									NA
Papilionidae	Papilioninae		*Mimoides lysithous*	(Hübner, [1821])	1								x	I
Papilionidae	Papilioninae		*Mimoides protodamas*	(Godart, 1819)	1									I
Papilionidae	Papilioninae		*Parides agavus*	(Drury, 1782)			2							III
Papilionidae	Papilioninae		*Parides anchises*	(Linnaeus, 1758)	2									I
Papilionidae	Papilioninae		*Parides proneus*	(Hübner, [1831])	2									I
Papilionidae	Papilioninae		*Pterourus scamander*	(Boisduval, 1836)		1								IV

Pieridae	Coliadinae	*Eurema albula*	(Cramer, 1775)	1	5	5	x						III, IV, VI, XII
Pieridae	Coliadinae	*Phoebis argante*	(Fabricius, 1775)		3		x						III–IV, IV, XII
Pieridae	Coliadinae	*Phoebis philea*	(Linnaeus, 1763)	2	1	2	x					x	I, III, IV, XII
Pieridae	Coliadinae	*Phoebis sennae*	(Linnaeus, 1758)		1								IV
Pieridae	Coliadinae	*Pyrisitia nise*	(Cramer, 1775)		1								III–IV
Pieridae	Coliadinae	*Rhabdodryas trite*	(Linnaeus, 1758)	1	1	1	x					x	III, IV, XII
Pieridae	Dismorphiinae	*Dismorphia amphione*	(Cramer, 1779)			1							III
Pieridae	Dismorphiinae	*Dismorphia crisia*	(Drury, 1782)			2							III
Pieridae	Dismorphiinae	*Dismorphia thermesia*	(Godart, 1819)	1	1								I, III–IV
Pieridae	Dismorphiinae	*Enantia clarissa*	(Weymer, 1895)				x						XII
Pieridae	Dismorphiinae	*Pseudopieris nehemia*	(Boisduval, 1836)	1									XII
Pieridae	Pierinae	*Archonias brassolis*	(Fabricius, 1776)	1									I
Pieridae	Pierinae	*Melete lycimnia*	(Cramer, 1777)		2								IV
Pieridae	Pierinae	*Pereute swainsoni*	(G. Gray, 1832)			4						x	III
Riodinidae	Riodininae	*Adelotypa bolena*	(A. Butler, 1867)	x								x	NA
Riodinidae	Riodininae	*Ancyluris aulestes*	(Saunders, 1850)	x								x	NA
Riodinidae	Riodininae	*Calospila apotheta*	(H. Bates, 1868)	x									NA
Riodinidae	Riodininae	*Emesis* sp.	NA			1							III
Riodinidae	Riodininae	*Eurybia carolina*	Godart, [1824]			1							IV
Riodinidae	Riodininae	*Eurybia molochina*	Stichel, 1910	x									NA
Riodinidae	Riodininae	*Eurybia pergaea*	(Geyer, 1832)	1	2								IV, XII
Riodinidae	Riodininae	*Euselasia hygenius*	(Stoll, 1787)	x									NA
Riodinidae	Riodininae	*Ionotus alector*	(Geyer, 1837)	x									NA
Riodinidae	Riodininae	*Leucochimona icare*	(Hübner, [1819])			1							III
Riodinidae	Riodininae	*Mesene* sp.	NA	1									I
Riodinidae	Riodininae	*Mesosemia mayi*	Lathy, 1958	x									NA
Riodinidae	Riodininae	*Mesosemia odice*	(Godart, [1824])	4	1	1							I, IV, VI, XII
Riodinidae	Riodininae	*Mesosemia rhodia*	(Godart, [1824])	4									XII
Riodinidae	Riodininae	*Metacharis ptolomaeus*	(Fabricius, 1793)			1							III
Riodinidae	Riodininae	*Napaea elisae*	(J. Zikán, 1952)	x									XII
Riodinidae	Riodininae	*Napaea nepos*	(Fabricius, 1793)	1									XII
Riodinidae	Riodininae	*Panara soana*	Hewitson, 1875	x									NA
Riodinidae	Riodininae	*Rhetus periander*	(Cramer, 1777)			1							III
Riodinidae	Riodininae	*Rhetus arcius*	(Linnaeus, 1763)									x	NA
Riodinidae	Riodininae	*Stichelia bocchoris*	(Hewitson, 1876)	x									NA
Riodinidae	Riodininae	*Symmachia aconia*	Hewitson, 1876	x									NA
Riodinidae	Riodininae	*Voltinia cebrenia*	(Hewitson, [1873])	x									NA
			Total n	**230 + 74**	**128**	**288**	**866 + 19**	**165**	**64**	**53**	**227**	**25**	
			Total richness	**195**	**60**	**92**	**64**	**31**	**20**	**21**	**40**	**23**	

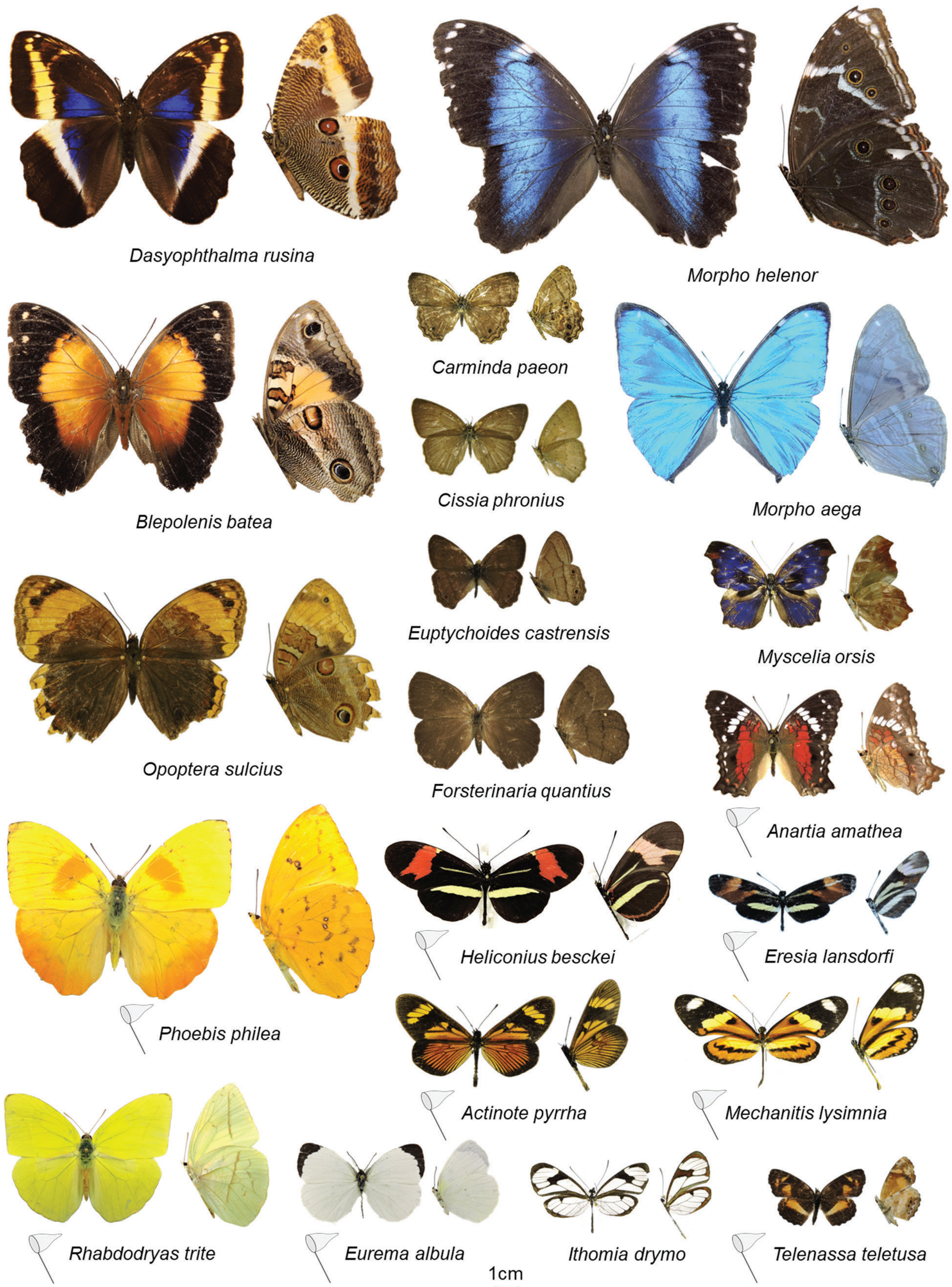

Figure 3. Butterfly species common to all sampling regions (intersection of PEI, PENaP, AG datasets in Figure 2). These are likely the species that any person will see at the PEI and surroundings. Sizes are proportional to their real size, with dorsal wing surfaces shown spread, and ventral surfaces tilted similar to the butterfly's resting position. The net symbol indicates species caught exclusively with the entomological net, while all others were caught with the net and traps. A more complete illustrated guide can be found in the companion paper (Shirai *et al*. 2022).

sources ("other" dataset, not included in Figure 2a due to the uncertain methodology) contributed with eight species not found by any of the active or passive methods: the skippers *Papias phainis* Godman, 1900, *Pheraeus fastus* (Hayward, 1939), *Polites vibex* (Geyer, 1832), and *Viola violella* (Mabille, 1898); the nymphalids *Doxocopa zunilda* (Godart, [1824]), *Lycorea halia* (Hübner, 1816), *Dryadula phaetusa* (Linnaeus, 1758); and the metalmark *Rhetus arcius* (Linnaeus, 1763).

The comparison by region (Figure 2b) showed, expectedly, that the majority was collected at the focal region (PEI, with 64.5% being exclusive). The 20 species common to all regions (Figure 3) included both forest dwellers and open area species.

We found the highest diversity in warmer months (Figure 4), as can be seen in the total richness (Figure 4a, using all data but not standardized by sampling effort). The information of which month each species was sampled (last column of Table 2) should, however, be used with caution because it does not necessarily reflect the true phenology of species due to sampling bias, such as the overrepresentation of summer months. Also, the number of individuals is subject to methodological bias, so looking at the PEI trap data, where we can compare abundance, March, April, and May outstood in both richness and abundance (Figure 4b). We would not biologically interpret the results in September since it seems an effect of statistic inflation: only 5 individuals of 4 species were sampled but, as they were caught only the PEI 1y dataset (3 days in 11 traps), the metrics end up higher than other datasets that sampled for more days in a higher number of traps.

As we sampled in every month of the year, we can demonstrate that winter months have lower richness compared to any other season in the whole dataset. We found in June: 13 species, July: 16 species, August: nine species, September: 13 species (Figure 4a); which is much lower compared to remaining seasons (average ± standard deviation 142.3 ± 47.2). This result can also be observed in the comparable data of baited traps (Figure 4b-c). Lastly, 15 out of the 19 Brassolini and Morphini species were reported exclusively from December to April.

Despite our sampling bias, we found that nine species should, with some certainty, be observed most of the year (species caught in seven-10 months in the year, Table 2): biblidines *Epiphile orea* (Hübner, [1823]) and *Myscelia orsis* (Drury, 1782), and satyrines *Carminda paeon* (Godart, [1824]), *Forsterinaria necys* (Godart, [1824]), *F. pronophila* (A. Butler, 1867), *F. quantius* (Godart, [1824]), *Godartiana muscosa* (A. Butler, 1870), *Morpho aega* (Hübner, [1822]), and *Pseudodebis euptychidia* (A. Butler, 1868). Except from *E. orea* and *F. quantius*, the remaining seven species also ranked among the 15 most abundant species the trap sampling.

Among trap datasets, we caught 505 individuals of 63 species. The richest and most abundant subfamily was Satyrinae, followed by Charaxinae, Biblidinae, and Nymphalinae (Table 3). We found that 51.3% of the individuals belong to seven species: *Morpho epistrophus* (Fabricius, 1796) (74), *Memphis appias* (Hübner, [1825]) (60), *G. muscosa* (44), *F. necys* (24), *Fountainea ryphea* (Cramer, 1775) (20), *M. orsis* (19), and *P. euptychidia* (18). On average, we caught 0.19 individuals/trap/day in the PEI (0.34), PEI-fish (0.22), PEI 1y (0.13) and AG (0.09) datasets. The comparison between PEI habitats and vertical stratification using the PEI and PEI fish datasets can be found in the Supplementary Material.

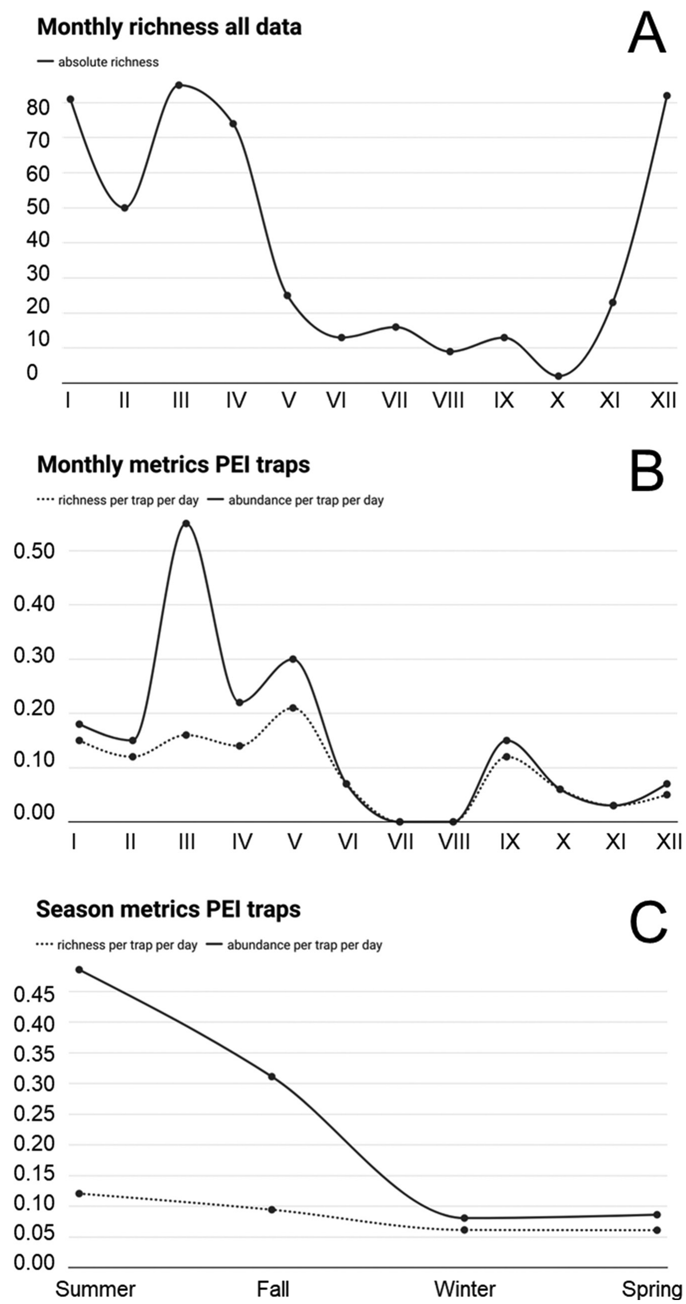

Figure 4. Diversity metrics for (a) all data, under the three sampling methods (absolute number of species) by month; and for PEI traps (richness, in dashed line, and abundance, in solid line, per trap and per trap day) reporting them by (b) month, and (c) by season.

Discussion

Butterflies are excellent model organisms for scientific research (reviewed in *e.g.* Brown & Freitas 1999, Santos *et al*. 2008, Sourakov & Shirai 2020) and for conservation purposes (see Introduction). However, even considering they are among the best-studied insects, important gaps in basic information still exist, such as for species description and mapping species distributions (Linnean and Wallacean shortfalls *c.f.* Hortal *et al*. 2015). That results in the exclusion of butterflies, as well as other invertebrates, from studies like those that established hotspots

Table 3. Richness and abundance of trap studies: "Our study" sums the trap individuals from the PEI, PEI fish, PEI 1y and AG datasets; "DnB" refers to "Database of nymphalids in Brazil" (Shirai *et al*. 2019), with species lists exclusively caught with traps at the Atlantic Forest (numbers are sums of 40 studies, see Material and Methods); and "Atl butterflies" refers to the "Atlantic Butterflies" database (Santos *et al*. 2018), the largest database for fruit-feeding butterflies. The number of individuals refers to abundance (our study) or to the number of records (= presence) in the literature (for DnB and Atl butterflies). Nymphalidae classification follows Wahlberg *et al*. 2009 (subfamilies) and Santos *et al*. 2018 (tribes).

Taxa	Richness			Abundance (our study)/records		
	Our study	DnB	Atl butterflies	Our study	DnB	Atl butterflies
Biblidinae	**12**	**45**	**63**	**66**	**513**	**2336**
Ageroniini	4	11	11	23	208	639
Biblidini	0	1	2	0	29	136
Callicorini	3	11	11	10	81	448
Epicaliini (Catonephilini)	3	5	6	24	79	244
Epiphilini	2	6	6	9	61	272
Eubagini	0	3	12	0	5	362
Eunicini	0	8	15	0	50	235
Charaxinae	**11**	**30**	**34**	**107**	**331**	**1010**
Anaeini	8	19	20	102	190	656
Preponini	3	11	14	5	141	354
Nymphalinae	**1**	**5**	**5**	**2**	**100**	**268**
Coeini	1	5	5	2	100	268
Satyrinae	**37**	**126**	**176**	**328**	**897**	**3434**
Brassolini	9	28	36	28	244	881
Haeterini	0	4	5	0	17	79
Morphini	3	12	9	88	73	354
Satyrini	25	82	126	212	563	2120
Total	**61**	**206**	**278**	**503**	**1841**	**7048**

(Myers *et al*. 2000) or other global conservation efforts (Bossart & Carlton 2002, Barua *et al.* 2012), even considering that butterflies are a bioindicator, flagship, and umbrella group. In this study, we aimed at filling this gap by inventorying butterfly diversity in a region within the Paranapiacaba Continuum, a key network of protected areas for the preservation of the Atlantic Forest hotspot. We also provided several resources to aid conservation efforts (see Introduction), and a discussion for both academics and non-academics.

Most of butterfly richness is in the tropics. While Nymphalidae diversified in the Asian, African and American tropics, several lineages of Hesperiidae and Riodinidae adaptive radiations happened exclusively in the Neotropics (Toussaint *et al.* 2018, Seraphim *et al*. 2018), with metalmarks being mainly Amazonian. Thus, it is not surprising that the richest families we found were Nymphalidae and Hesperiidae, frequently reported as the most diverse in the Atlantic Forest (Brown & Freitas 2000, Francini *et al*. 2011). Hesperiidae is probably the richest butterfly family in Brazil and the fact that we caught them less than Nymphalidae probably reflects the suggestion of Francini *et al.* (2011): in relatively complete inventories, the small and inconspicuous Hesperiidae are better sampled, but in short term studies, Nymphalidae appears with higher richness because they are easily captured, with both net and traps. Lycaenidae and Riodinidae, despite having less species in the Atlantic Forest than the two families above, equally suffer in shorter inventories by being harder to catch. Moreover, most Pieridae species we caught are found in open areas across the country but important species are expected to be caught only at the higher altitudes in the park, above 800 m a.s.l. (Francini *et al*. 2011).

Focusing on nymphalids, a review of species lists in Brazil (Shirai *et al.* 2019) listed the presence of 162-315 butterfly species in the top-10 richest places in the country. The corresponding biomes (Amazon, Atlantic Forest and one in the Cerrado) rank among the richest because 1) they are biologically rich but also, and importantly, 2) they were well-sampled (Shirai *et al.* 2019). The most complete dataset of a subset of Nymphalidae, fruit-feeding butterflies, listed 279 species for the whole Atlantic Forest (Santos *et al*. 2018), which is a substantial increment over previously available data, such as the 88–127 fruit-feeding species found in the same biome (Brown 2005). We were able to record 148 nymphalids (61 fruit-feeding), but these numbers as well as our total of 312 butterfly species are certainly not the true richness of the PEI and surroundings. The richness in the region could easily surpass 500 species or more, as compared to similar areas in the same region (Francini *et al*. 2011). More sampling, and sampling by different strategies (like comparing to an estimate of the "true richness" by maximized sampling, Uehara-Prado *et al*. 2007), are necessary to reflect the diversity of this region. Despite the attempt to combine different datasets to enhance this inventory, some obvious gaps remained, such as 1) a thorough expedition to the other PEI station at the East lowlands (Saibadela), that has a different climate and altitude (Morellato *et al.* 2000); 2) the most inaccessible and pristine region of the PEI, at the South, as well as the few but important high altitude sites in the park; 3) the contiguous protected areas PECB, PETAR and Xitué (see Figure 1); and 4) more sampling with different baits.

The use of different sampling methods certainly adds to more comprehensive inventories (*e.g*. Clench 1949, 1979, Brown 1972, Brown & Freitas 2000, Iserhard *et al.* 2013, Freitas *et al*. 2014, Checa *et al.* 2018). For example, most of the species we found were sampled by active methods (Figure 2a), collected by highly experienced people, during different years. However, despite having caught only about a fifth (63/312 species) of the total richness with traps, *Siderone galanthis* (Cramer 1775) was among the six trap-exclusive species (Figure 2a), caught by a recently trained PEI guide ("PEI 1y" dataset). *Decinea dama* (Herrich-Schäffer 1869) was also among the trap-exclusive species, only caught with fish carrion ("PEI fish" dataset). It is also worth mentioning that the citizen science approaches and a field course experiment ("other" dataset) contributed with eight species not found with neither active nor passive methods.

Including efforts of other places than the PEI also enhanced the inventory for the region adding, in our case, 33 species (20 exclusive of PENaP, 11 exclusive of AG, plus two in common, Figure 2b) not found at the park, that had much more sampling effort (Table 1). Several of the 20 species common to all regions (Figure 2b) are associated with open or fragmented areas; we illustrated them (Figure 3) because they are, aside from beautiful, colorful and diverse, likely the species that any person will observe at the region.

An interesting statistic, both biologically and in terms of planning, is the number of individuals caught per trap per day, as the 0.5 individuals/trap/day reported in an Amazonian *terra firme* site (Ribeiro & Freitas 2012). Traps at open and/or fragmented habitats tend to catch more individuals, but not species (*e.g*. Uehara-Prado *et al*. 2007). We caught 0.19 individuals/trap/day, but the highest values were not necessarily at the open, disturbed or fragmented sites, such as PEI 1y (0.13) and AG (0.09) datasets, but rather at the PEI (0.34) and PEI-fish (0.22). It would be interesting to gather more data like this to uncover differences, for instances, between environments and biomes.

The best months to collect in South Eastern Brazil are March to May (end of the rainy season, Ebert 1970, Brown 1972, 1992, Freitas *et al.* 2014) but other seasonal intervals are also relevant. Here, we chose when to collect aiming to span different seasons and months, complementing the effort from museum data at the same time as revisiting good months (like December and March) and we indeed found the highest diversity metrics in warmer months, particularly from March to May (Figure 4).

We thus reinforce a previous suggestion (Brown 1972, Uehara-Prado *et al*. 2007) that the best sampling months in the Atlantic Forest should be extended to the period between December to May (summer plus end of rainy season). The summer months of December to February are mandatory for tribes like Morphini and Brassolini that only fly in this period (Freitas *et al.* 2014). Here, we found 79% of brassolines and morphines within the months of December and April. However, winter months should not be completely disregarded since some species were exclusively caught in this season and, in the case of the PEI, it is the only season when an *Epityches eupompe* (Geyer, 1832) aggregation can be observed (Shirai *et al*. 2017, https://youtu.be/bUO4kpYS2uo).

For Brazilian rainforests standards, the PEI is chilly, partly because it has a lot of forest and in high altitudes, but also because it has a cold winter: the annual average temperature ranged from 15.1 to 19.2°C (Table S5), similar to what is reported in other sources (17.5°C from WorldClim and 17–18°C from Leonel 2010). More importantly, the temperature is seasonal, with a warm summer and a cold winter (Figure S1, Table S5): maximum temperatures of the warmest month (26–27°C) and minimum temperature of the coldest month (7.5–11°C), also like the WorldClim data.

The dominant species in our trap datasets was *Morpho epistrophus* (15%), the only *Morpho* species in the Atlantic Forest that is iridescent white (Pablos *et al.* 2021, Figure 5) – caught on traps with black mesh (see Freitas *et al*. 2014). Although we caught them in traps only from February to April (many of which with worn wings, LTS pers. obs.), this large butterfly is visible anywhere in the park since November. Butterflies are good flagship invertebrates because of their aesthetic appeal which, in

Figure 5. The emblematic white morpho, *Morpho epistrophus*, adult and caterpillar, that we suggest becoming the PEI invertebrate mascot. Images used with permission of the author Almir Cândido Almeida.

turn, relates to species attributes of size and brightness/color (Barua *et al.* 2012). The iridescent white color of *M. epistrophus* might seem dull to some visitors, but the fact that tourists in Neotropical forests are somewhat used to seeing, and being amused by, the blue morphos, might raise interest to their phylogenetic relationship, enhancing the color feature. Another important aspect of butterflies as invertebrate flagships is the fact that they are harmless. The elegant flight of *M. epistrophus* does not incite danger or disgust like wasps or mosquitoes might do. Although caterpillars are not always understood as an early stage of butterflies (Barua *et al.* 2012), they can trigger fear or dislike because of damage to crops. *M. epistrophus* harmless caterpillars are large, gregarious, bright red, and visible in many *Inga* Mill. tree trunks near the PEI reception (Figure 5). The contrasting effect of beauty and fear/disgust of these caterpillars could be used as an opportunity: the particularly skilled, enthusiastic and charismatic PEI staff could educate visitors about holometabolous life cycle, what makes a caterpillar harmful or harmless, what are aposematic colors, and warn visitors about moth caterpillars found at PEI (like *Megalopyge* Hübner 1820) that actually sting. Thus, the easy identification, large size, omnipresence in the park, relationship with famous blue morphos, elegant flight, and inciting caterpillars make *M. epistrophus* eligible to become the emblematic invertebrate mascot of the PEI.

Overexploitation of resources (like the juçara palm), illegal hunting and mining are permanent issues that endanger threatened species (such as the jaguar, Beisiegel & Nakano-Oliveira 2020) and a threatened biome (Tabarelli *et al*. 2005, Maxwell *et al.* 2016, ICMBio 2018). Even in the largest and strongest continuous of Atlantic Forest, we face the danger of (irreversibly) losing species and natural resources. More involvement and investment in the area would result in much more for the people and the planet than *e.g.* the end goals of several “perverse subsidies” (Myers 1998, Tabarelli *et al*. 2005). For example, investing in a geographically wider and temporally longer sampling of butterflies, together with more science outreach seminars and material, capacity development and teaching in local schools are ideas that need dedicated, almost exclusive, time of trained people but, surprisingly, they do not require a substantial financial investment (see Shirai *et al*. 2022). Another better idea, though, would be to invest in bioliteracy (*c.f.* Janzen 2010), which is a strong chance to save tropical diversity.

Supplementary Material

The following online material is available for this article:

A – Full description of our data.
B – Climatic data from the weather station at the PEI, in English and in Portuguese.
C – PEI trap datasets: habitats and vertical stratification in the PEI.

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Author Contributions

Leila T. Shirai: contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content; read and approved the manuscript; substantial contribution to the conception and design of the study; contribution to data collection; contribution to manuscript preparation.

Renato O. Silva: contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content; read and approved the manuscript; substantial contribution to the conception and design of the study; contribution to data collection.

Fernando M. S. Dias: contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content; read and approved the manuscript.

André L. C. Rochelle: contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content; read and approved the manuscript.

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Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript

Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

Data Availability

The primary data is reported in the main text as Table 2 and is also available at the public repository https://doi.org/10.5281/zenodo.7429126, with the metadata in the readme file available at https://doi.org/10.5281/zenodo.7439430.

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