

**1 Demography of the understory herb *Heliconia acuminata* (Heliconiaceae) in an  
2 experimentally fragmented tropical landscape**

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**15** *Open Research Statement:* Data are available as Supporting Information and are also  
**16** available in Dryad at <https://doi.org/----->

17

## Author Note

18       *Corresponding author:* Emilio M. Bruna (embruna@ufl.edu)19       *Word count:* 4798 (text), 1734 (references)

20       The authors made the following contributions. Emilio M. Bruna: Methodology, Data  
21 curation, Investigation, Funding acquisition, Conceptualization, Formal analysis,  
22 Methodology, Project administration, Resources, Software, Supervision, Validation,  
23 Visualization, Writing – original draft; Maria Uriarte: Methodology, Investigation, Funding  
24 acquisition, Conceptualization, Formal analysis, Methodology, Project administration,  
25 Resources, Software, Supervision, Validation, Visualization, Writing – review & editing;  
26 Maria Rosa Darrigo: Methodology, Investigation, Project administration, Writing – review &  
27 editing; Paulo Rubim: Methodology, Investigation, Project administration, Writing – review  
28 & editing; Cristiane F. Jurinitz: Methodology, Investigation, Project administration, Writing  
29 – review & editing; Eric R. Scott: Methodology, Data curation, Software, Validation,  
30 Visualization, Writing – review & editing; W. John Kress: Methodology, Investigation,  
31 Funding acquisition, Conceptualization, Methodology, Resources, Writing – review & editing.

32

## METADATA

33 **I. CLASS I. Data Set Descriptors**

34 **A. Data set identity:** Demographic data from populations of the understory herb  
35 *Heliconia acuminata* (Heliconiaceae) in an experimentally fragmented tropical landscape  
36 (1997-2009).

37 **B. Data set identification code:**

- 38 1. Dataset File 1: HDP\_plots.csv  
39 2. Dataset File 2: HDP\_1997\_2009.csv

40 **C. Data set description:**

41 **1. Originators:** Emilio M. Bruna, Department of Wildlife Ecology and Conservation,  
42 University of Florida, PO Box 110430, Gainesville, FL 32611-0430, USA and Center for  
43 Latin American Studies, University of Florida, PO Box 115530, Gainesville, FL 32611,  
44 USA.

45 **2. Abstract:** Habitat fragmentation is thought to be a leading cause of extinction, but  
46 the demography of species in fragmented landscapes remains poorly understood. This  
47 is particularly true in tropical ecosystems, where studies monitoring populations of  
48 species in both fragments and areas of continuous habitat across all life-history stages  
49 are virtually nonexistent. Here we report 12 years (1997-2009) of annual censuses of 13  
50 populations of the Amazonian understory herb *Heliconia acuminata* (LC Rich.). These  
51 surveys were conducted in plots established in the experimentally fragmented  
52 landscape of the Biological Dynamics of Forest Fragments Project, located north of  
53 Manaus, Brazil. The plots, each 50 × 100m, are located in forest fragments of different  
54 sizes (N = 4 plots in 1-ha fragments and N = 3 plots in 10-ha fragments) as well as  
55 continuous forest (N = 6 plots). The population in each plot was censused annually, at

which time we recorded, identified, marked, and measured new seedlings, identified any previously marked plants that had died, and recorded the size of individuals that survived. During the flowering season we conducted regular surveys to record the identity of flowering plants and the number of inflorescences each produced. The resulting dataset comprises >67000 plant×year records of 8586 plants, including 3464 seedlings that became established after the initial census. These data have been used in publications on topics ranging from how fragmentation-related reductions in germination influence population dynamics to tests of statistical methods for analyzing reproductive rates (see *Class V Supplemental Descriptors*, below) .

**D. Key words:** Amazon, Brazil, deforestation, demography, edge effects, flowering, forest fragments, habitat fragmentation, integral projection models, matrix models, population dynamics, vital rates.

## CLASS II. RESEARCH ORIGIN DESCRIPTORS

### A. Overall project description:

**1. Identity:** The *Heliconia* Demography Project

**2. Originators:** Emilio M. Bruna, W. John Kress, and María Uriarte

**3. Period of study:** 1997-2009

**4. Objectives:** Habitat fragmentation continues to be a major focus of research by ecologists (Didham et al. 2012, Haddad et al. 2015, Brudvig et al. 2017, Resasco et al. 2017, Fletcher et al. 2018) decades after it was first identified as a threat to the integrity of ecosystems (Harris 1984, Wilcove et al. 1986). A large body of empirical research has documented myriad biotic changes associated with fragmentation, including the local extinction of plant species from fragments (Harrison and Bruna 1999, Laurance et al. 2011). Although the demographic mechanisms underlying these

extinctions are rarely known (Bruna et al. 2009), they are often hypothesized to result from reduced rates of individual growth, reproduction, or survivorship in fragments (Laurance et al. 1998, Zartman et al. 2015). This is especially true in tropical forest fragments, where abiotic conditions can be dramatically different from those in primary forest (reviewed in Broadbent et al. 2008). Tests of this hypothesis remain limited, however, by the paucity of long-term demographic data collected in both tropical forest fragments and continuous forest sites (Bruna et al. 2009).

Most studies investigating the effects of forest fragmentation on tropical plants focus on trees (Cordeiro et al. 2009, Jurinitz et al. 2013, Zambrano and Salguero-Gómez 2014), in part because they are major reservoirs of carbon (Slik et al. 2010, Lasky et al. 2014). However, herbaceous species can comprise up to 30% of the plant species in lowland tropical forests (Gentry and Emmons 1987, Ribeiro et al. 2010, Iannone and Vargas 2022, Spicer et al. 2022), where they are habitat and food for myriad animal taxa and economically and culturally vital non-timber forest products (Nakazono et al. 2004, Athayde et al. 2006). Despite their biocultural importance, however, the way in which habitat fragmentation and other global change phenomena influences the population dynamics of tropical understory plants remains conspicuously understudied (Bruna et al. 2009).

The *Heliconia* Demography Project (HDP) was established to address the lack of data on the demography of understory plants in fragmented tropical landscapes. The core of the HDP is annual censuses of thirteen populations of *Heliconia acuminata* located in either continuous forest or experimentally isolated forest fragments at Brazil's Biological Dynamics of Forest Fragments Project (Laurance et al. 2011) The primary purpose behind their initial collection was to parameterize size-structured demographic models (Caswell 2000, Ellner and Rees

106 2006) with which to (1) compare the demography and population dynamics of *H.*  
107 *acuminata* populations in fragments and continuous forest, and (2) test the  
108 hypothesis that reductions in seedling establishment in forest fragments would  
109 lead to population declines.

110 **5. Abstract:** Here we report 12 years (1997-2009) of annual censuses of 13 populations  
111 of the Amazonian understory herb *Heliconia acuminata* (LC Rich.). These surveys  
112 were conducted in plots established in the experimentally fragmented landscape of the  
113 Biological Dynamics of Forest Fragments Project, located north of Manaus, Brazil.  
114 The plots, each 50 × 100m, are located in forest fragments of different sizes (N = 4  
115 plots in 1-ha fragments and N = 3 plots in 10-ha fragments) as well as continuous  
116 forest (N = 6 plots). The population in each plot was censused annually, at which time  
117 we recorded identified, marked, and measured new seedlings, identified any previously  
118 marked plants that had died, and recorded the size of individuals that survived.  
119 During the flowering season we conducted regular surveys to recorded the identity of  
120 flowering plants and the number of inflorescences each produced. The resulting dataset  
121 comprises >67000 plant×year records of N = 8586 plants, including N = 3464  
122 seedlings that became established after the initial census. These data have been used  
123 in publications on topics ranging from how fragmentation-related reductions in  
124 germination influence population growth rates to tests of statistical methods for  
125 analyzing reproductive rates.

126 **6. Sources of funding:** The initial establishment of plots and the 1997-2002 surveys  
127 were supported by grants to E. M. Bruna from the Smithsonian Institution (Graduate  
128 Student Research Award), the University of California, Davis (Center for Population  
129 Biology Graduate Research Grant, M. E. Mathias Graduate Research Grant), the  
130 Biological Dynamics of Forest Fragments Project (Graduate Student Logistics Grant),  
131 the National Science Foundation (Dissertation Improvement Grant INT 98-06351), and

the Ford Foundation (Dissertation Year Fellowship). The 2001-2005 surveys were supported a grant from the National Science Foundation to E. M. Bruna (Research Starter Grant DEB-0309819). The 2006-2009 surveys were supported by grants from the National Science Foundation to E. M. Bruna (DEB-0614149) and María Uriarte (DEB-0614339). Subsequent analyses and the preparation of these data for archiving were supported by the National Science Foundation (DEB-1948607).

## 138 B. Subproject description

### 139 1. Site description

140 a. **Site type:** Lowland tropical forest

141 b. **Geography:** The data were collected at the Biological Dynamics of Forest  
142 Fragments Project (BDFFP, 2°30'S, 60°W), a 1000-km mosaic of lowland  
143 forest, forest fragments, secondary forests, and pastures located  
144 approximately 70 km north of Manaus, Amazonas, Brazil (Fig. 1).

145 c. **Habitat:** The BDFFP is dominated by tropical evergreen lowland forest  
146 (i.e., ‘tropical moist forest’, *sensu* Holdridge (1967). The forest canopy at  
147 the sites is ~35–40 m tall, with emergent trees of up to ~45 m  
148 (Rankin-de-Mérona et al. 1992). The tree community at the BDFFP is  
149 highly diverse: ~1300 species total (Laurance 2001), with as many as 280  
150 tree species ha<sup>-1</sup> (Oliveira and Mori 1999). The understory is dominated by  
151 stemless palms (Scariot 1999). All HDP plots are located in *terra-firme* (i.e.,  
152 non-flooded) forest and none are bisected by streams.

153 d. **Geology:** Soils in the sites are nutrient-poor xanthic ferralsols, known as  
154 yellow latosols in the Brazilian soil classification system. Despite their high  
155 clay content they have poor water-retention capacity (Fearnside and

156 Leal-Filho 2001). The often rugged topography at the BDFFP ranges in  
157 elevation from 50-150 m elevation (Gascon and Bierregaard 2001).

158 e. **Watersheds:** The BDFFP landscape includes catchments of the Urubu,  
159 Cuieiras, and Preto da Eva rivers (Nessimian et al. 2008).

160 f. **Site history:** A complete history of the BDFFP can be found in Gascon  
161 and Bierregaard (2001) and Bierregaard et al. (2002). Briefly, the BDFFP  
162 reserves were established on three cattle ranches. Fragments were isolated  
163 between 1980-1984 by felling the trees surrounding the patch of forest to be  
164 isolated (Lovejoy et al. 1986). Fragment reserves were fenced to prevent the  
165 incursion of cattle from the surrounding pastures. To ensure fragments  
166 remain isolated, a 100m strip around each fragment is regularly cleared of  
167 the secondary growth (Gascon and Bierregaard 2001). The structure and  
168 species composition of the secondary growth that surrounds a fragment,  
169 which is strongly dependent on whether fire was used to clear land prior to  
170 planting pasture grasses (Mesquita et al. 2001), can have large effects on  
171 the species composition, ecological processes, and abiotic conditions in  
172 fragments (reviewed in Laurance et al. 2002, 2011). The BDFFP is  
173 currently administered collaboratively by the Smithsonian Tropical Research  
174 Institute and Brazil's Instituto Nacional de Pesquisas da Amazônia (INPA).

175 g. **Climate:** Mean annual temperature at the site is 26°C (range 19-39°C).  
176 Annual rainfall ranges from 1900-2300 mm (Scott et al. 2022), with a  
177 pronounced dry season from June-December in which there is <100 mm  
178 rain per month.

179 2. Sampling Design & Research Methods

180 a. **Focal species:** *Heliconia acuminata* (Heliconiaceae) is a perennial,

self-incompatible monocot native to Amazonia (Kress 1990) and widely distributed throughout the Amazon basin (Kress 1990). Although many species of *Heliconia* grow in large aggregations on roadsides, gaps, and in other disturbed habitats, others, including *H. acuminata*, grow primarily in the shaded forest understory (Kress 1983). *Heliconia acuminata* is the most abundant understory herb throughout much of the BDFFP (Ribeiro et al. 2010); the other two *Heliconia* species found in the BDFFP reserves are either very rare (*H. latispatha*) and restricted saturated soils adjacent to streams (*H. tarumaensis*).

Each *Heliconia acuminata* has a basal rhizome from which emerge erect vegetative shoots with broad leaves. Reproductive plants have one or more flowering shoots, each of which has a single inflorescence. Plants grow slowly (Bruna and Ribeiro 2005, Gagnon et al. 2011) and the proportion of plants that flower is low (Bruna 2002, Bruna and Kress 2002). The primary herbivores of *Heliconia* species are Hispine beetles, whose larvae and adults scrape the surface of unrolled immamture leaves (Strong 1977). The beetle species associated with *H. acuminata* is *Cephaloleia nigriceps* Baly (Staines and Garcia-Robledo 2014); it actually does little damage to leaves but can cause extensive damage to bracts, flowers, and developing ovaries.

*Heliconia* can be propagated by segmenting the rhizome (Berry and Kress 1991, Bruna and Andrade 2011), and clonal spread is common in the *Heliconia* species found in open or disturbed habitats (Schleuning et al. 2008). However, recruitment in *H. acuminata* and other understory species is primarily via seeds (Bruna 1999, 2002). Plants that flower do so during the rainy season, with the propbability of

207 flowering increasing with plant size (Bruna and Kress 2002). The  
208 overwhelming majority of plants in our dataset that flowered (75%)  
209 produced a single inflorescence (range = 1-7). Inflorescences have an  
210 average  $22.28 \pm 1.17$  SE flowers (range 4-62); each flower remains open  
211 for one day before falling from the plant. Pollen transfer experiments  
212 indicate self-compatibility is extremely low (Bruna and Darrigo,  
213 *unpubl. data*); successfully pollinated flowers can produce 1-3 seeds,  
214 with an average of 2 seeds per fruit (Bruna 2014).

215 *Heliconia acuminata* is pollinated by the ‘traplining’ hummingbirds  
216 *Phaeothornis superciliosus* and *P. bourcieri*. Visitation rates to flowers  
217 are extremely low (<1 visit hour<sup>-1</sup>, Bruna et al. 2004), as are rates of  
218 fruit production (Bruna and Kress 2002). The fleshy blue fruits are  
219 consumed by birds (Uriarte et al. 2011); in our study sites the primary  
220 dispersers are the White-necked Thrush (*Turdus albicollis*), the  
221 Thrush-like-Manakin (*Schiffornis turdinus*), and several species of  
222 manakin (*Pipra erythrocephala*, *P. pipra*, *Lepidothrix serena*, and  
223 *Corapipo gutturalis*). The seeds germinate 6-7 months after dispersal,  
224 which coincides with the onset of the rainy season (Bruna 1999, 2002).  
225 Experiments indicate that post-dispersal seed predation is negligible  
226 and while rates of seed germination and seedling establishment were  
227 generally low, they were significantly higher in continuous forest than  
228 forest fragments (Bruna 1999, 2002). Although some seeds germinated  
229 >1 year after experimental dispersal, this was generally rare -  
230 especially in fragments. These results are consistent with the  
231 generalization that few plant species in lowland tropical forests have  
232 long-lived seed banks (Vázquez-Yanes and Orozco-Segovia 1993).

233        b. **Taxonomy, systematics, and voucher specimens:** *Heliconia* is the only  
234        genus in the family Heliconiaceae. This family is distinguished from the  
235        others in the order Zingiberales by having inverted flowers, a single  
236        staminode, and drupaceous fruits (Kress 1990). It is estimated that there  
237        are 200-250 species of *Heliconia*, almost all of which are native to the  
238        Neotropics. *Heliconia acuminata* L. C. (Rich.) (Richard 1831) is one of the  
239        approximately 20 *Heliconia* species found in the Brazilian Amazon (Kress  
240        1990). We deposited voucher specimens of *H. acuminata* collected in areas  
241        adjacent to demographic plots at the herbaria of the Instituto Nacional de  
242        Pesquisas da Amazônia (Accession Numbers INPA 189569-189573) and the  
243        University of California, Davis (Accession Numbers DAV 69391-69396).

244        c. **Permanent Plots:** Surveys of *Heliconia acuminata* demography were  
245        carried out in 13 permanent demographic plots distributed across the  
246        BDFFP landscape (Bruna and Kress 2002). Six plots are in continuous  
247        forest, four are in 1-ha fragments, and three are in 10-ha fragments (Fig. 1).  
248        Each demographic plot is 50 × 100m and is subdivided into 50 contiguous  
249        subplots of 10 × 10m to facilitate the surveys. Plots in 1-ha fragments were  
250        established in a randomly selected half of the fragment, plots in 10-ha  
251        fragments are located in the center of the fragment, and plots in continuous  
252        forest are located 500-4000 m from any borders with cattle pastures or  
253        secondary forest (Fig. 2). The plots furthest apart are from each other are  
254        separated by ~70 km.

255        Plots in 1-ha fragments, 10-ha fragments, and three of the continuous  
256        forest sites were demarcated in January-April 1997. The remaining  
257        three plots in continuous forest were demarcated in January 1998,  
258        which was also when the first complete census in all plots was

conducted. To mark the plants, a team of 2-3 people slowly walked through each subplot and located all *Heliconia acuminata* and marked them with a wooden stake to which was attached an individually numbered aluminum tag. The size of each plant was measured in two ways: (1) by counting its number of vegetative shoots and (2) by measuring the height of the plant from the ground to the top of its highest leaf (rounded to the nearest cm). Three additional plots were established in continuous forest sites in 1998 (CF 4-6); all plants in these plots were tagged and measuring in the same way as in other plots.

d. **Frequency of Data Collection** Plots were censused annually at the onset of the rainy season to coincide with seedling establishment (generally late January to February). The exception to this was the three continuous forest plots established in August 1998, which were censused in August 1999.

During each census team members recorded which plants died, the size (i.e., height and number of shoots) of all surviving plants, and the size of all new seedlings, which were also marked with a numbered tag. Survey team members also noted any new canopy gaps created by fallen trees or limbs, estimated the proportion of any subplot that was affected by a treefall (available at the HDP Github repository: <https://github.com/BrunaLab/HeliconiaDataPaper>), and recorded if plants were damaged by fallen branches or palm fronds (reported here).

Regular visits were made to all 13 plots throughout the rainy season to identify reproductive individuals and record the number of flowering shoots (i.e., inflorescences) that they had produced.

3. **Project personnel:** In addition to the Originators, other key personnel include the

285 Project Managers that were responsible for coordinating the annual censuses and other  
286 field activities, BDFFP Technicians (“*Mateiros*”) that assisted with data collection and  
287 provided logistical support in the field, and undergraduate and postgraduate field  
288 assistants hired to assist with the surveys.

289 a. **Project Managers:** Paulo Rubim (2007-2012), Maria Beatriz Nogueira  
290 (2002), Maria Rosa Darrigo (2002-2003), Cris Follman Jurinitz (2003),  
291 Simone Benedet (2004).

292 b. **BDFFP Technicians:** Osmaildo Ferreira da Silva, Francisco Marques,  
293 Alaercio Marajó dos Reis, João de Deus Fragata, Romeu Cardoso.

294 c. **Undergraduate & Postgraduate Field Assistants:** Olavo Nardy  
295 (2000), Obed Garcia (2001), Sylvia Heredia (2001-2002), Maria Beatriz  
296 Nogueira (2002), Cris Follman Jurinitz (2003), David M. Lapola (2003),  
297 Denise Cruz (2003), Cristina Escate (2004), Bruno Turbiani (2005),  
298 Elisabete Marques da Costa (2006), Wesley Dátilo da Cruz (2007),  
299 Jefferson José Valsko da Silva (2007).

300 **CLASS III. DATA SET STATUS AND ACCESSIBILITY**

301 **A. Status**

302 1. **Latest update:** 2022-08-17

303 2. **Latest archive date:** 2022-08-17 (*to replace with date of archiving at Dryad*)

304 3. **Metadata status:** Complete (last update: 2022-08-17)

305 4. **Data verification & quality control procedures:** Following each survey, the  
306 measurements of plant height and stem number were compared with those from the  
307 previous year to identify potential errors in either plant measurement or entry (e.g., a

308 plant with 1 shoot in year t and 11 shoots in year t+1 is likely an error in data entry).  
309 Discrepancies were investigated by referring to the original data sheets and, on  
310 occasion, returning to the field to remeasure plants.

311 An extensive review of the data was also conducted in preparation for archiving.  
312 We began by generating a list of potential anomalies that could indicate errors  
313 (e.g. extremely large changes in size from one year to the next, plants marked as  
314 dead that had subsequent measurements), and then wrote code to search for  
315 these anomalies using the R statistical programming language (Team 2014). We  
316 also used the `pointblank` library (Iannone and Vargas 2022), which similarly  
317 identifies cases in a dataset for review and validation. All records flagged were  
318 evaluated by E. M. Bruna by checking the values in the electronic records against  
319 the original data sheets. Corrections to the dataset were also made using R  
320 scripts; the code documenting and implementing these changes is archived at  
321 Zenodo [*url to be added upon acceptance*]. Questions regarding the dataset or  
322 code should be referred to E. M. Bruna, who will investigate and update the  
323 database or code as needed. Code for any post-publication updates is maintained  
324 at the HDP Github Repository.

## 325 B. Accessibility

326 1. **Storage location and medium:** Ecological Society of America Data Archives [url to  
327 be added] and the Dryad Digital Repository [url to be added].

328 2. **Location of original data forms, electronic files, and archived copies:** Original  
329 data sheets are stored at the University of Florida. Scanned copies of the data sheets  
330 (in .pdf format) and the electronic copies of the data (in .csv format) are stored on a  
331 desktop computer at the University of Florida that is backed up daily to two portable  
332 hard drives and two cloud storage services. The integrity of digital files is verified

333 semi-annually.

334 **3. Contact person(s):** Emilio M. Bruna, Department of Wildlife Ecology and  
335 Conservation, Box 110430, Gainesville, FL 32611 USA. Phone: (352) 846-0634. Email:  
336 embruna@ufl.edu

337 **4. Copyright restrictions:** None

338 **5. Proprietary Restrictions:**

339 a. **Proprietary restrictions:** None.

340 b. **Conditions of Reuse:** Any publication using data collected at the BDFFP  
341 must include a BDFFP Technical Series Number in the Acknowledgments.  
342 Authors can request this series number upon the acceptance of their article  
343 by contacting the BDFFP's Scientific Coordinator or E. M. Bruna.

344 c. **Citation:** Authors of any publications or products using these data should  
345 cite both this data paper and the Dryad data archive [*citation of Dryad*  
346 *archive to be added upon acceptance*]. We also request that they provide E.  
347 M. Bruna a copy of their article upon acceptance, which allows us to track  
348 the dataset's usage, inform users of any corrections or updates, report  
349 articles using the data to the funding agencies that provided support, and  
350 document the different ways in which the scientific community uses the data.

351 d. **Disclaimers:** While the data are provided in good faith and are accurate  
352 to the best of our knowledge, they are provided "as is". We do not assume  
353 any legal liability or responsibility for their accuracy, completeness, or  
354 utility. The responsibility for use and analysis of these data lies completely  
355 with the user.

**356 CLASS IV. DATA STRUCTURAL DESCRIPTORS**

**357 A. Dataset File 1:** Descriptors of demographic plots

**358 1. Identity:** HDP\_plot\_descriptors.csv

**359 2. Size:** 14 rows (including header), 408 bytes.

**360 3. Format and storage mode:** ASCII text, comma delimited. No compression scheme  
**361 used.**

**362 4. Header information:** The first row of the file contains the variable names.

**363 5. Alphanumeric attributes:** Mixed

**364 6. Special Characters:** Missing values are represented with NA.

**365 7. Authentication Procedures:** checksum (MD5:2d3ec96006667abab1ecc14e72055850)

**366 8. Start & End Columns:** Start: plot, End: yr\_isolated

**367 9. Variable Information:** Each row is one plot, with the columns providing  
**368 plot-specific values for each variable.**

**369 [INSERT TABLE 1 HERE]**

**370 B. Dataset File 2:** *Heliconia* Demographic Data

**371 1. Identity:** HDP\_data\_1997-2009.csv

**372 2. Size:** 66785 rows (including header), 3.79 kilobytes.

**373 3. Format and storage mode:** ASCII text, comma delimited. No compression scheme  
**374 used.**

375     **4. Header information:** The first row of the file contains the variable names.

376     **5. Alphanumeric attributes:** Mixed.

377     **6. Special Characters:** Missing values are represented with NA.

378     **7. Authentication Procedures:** Checksum (MD5:15bbb4869fe192649e93d3474d3145d1)

379     **8. Start & End Columns:** Start: plot, End: tag\_number

380     **9. Data anomalies:** Plants that could not be found during a survey were recorded as  
381       ‘missing’ but maintained on the survey list to be searched for in subsequent years. The  
382       same is true of plants under branches or the crowns of fallen trees, which might not be  
383       found for several years when the crown’s leaves dried and fell or the area under the  
384       crown could be safely searched. The codes used to denote such cases are defined in  
385       Table 2.

386       The stakes and numbered tags used to mark plants were sometimes displaced,  
387       broken, or buried under leaf litter as a result of tree falls or other disturbances. If  
388       a plant’s tag couldn’t be found after an extensive search, it would be marked  
389       with a new tag. In some cases, it was straightforward to determine such a plant’s  
390       original number when entering the survey data (e.g., when all plants in a  
391       low-density subplot were found except one, which in the prior year was similar in  
392       size as the plant found without a tag). In those cases, the plant’s prior  
393       measurements were transferred to the new number and we logged the details of  
394       the change in tag number; the log is available at the HDP Github repository. In  
395       other cases, it was impossible to definitively determine a plant’s original number  
396       (e.g., when two similarly sized plants in a subplots were both missing their tags).  
397       In these cases the original number was maintained in the database with the  
398       plant’s status noted as ‘missing’ in subsequent surveys. The record for the new

399 number indicates the plant with which it is associated is an established plant  
400 that was found without a tag (see Section IV, Table 2) and not a new seedling.

401 There were also cases in which established plants were found without tags in  
402 subplots where all previously tagged plants had already been located and  
403 measured, indicating previous survey teams had failed to find and mark them.  
404 These plants were marked, measured, and added to the database with a code  
405 indicating they were a established (i.e., post-seedling) but previously unmarked  
406 plant (See Table 2). Of the N = 947 plants in the dataset, 11% were found  
407 without tags after the plot had been established. Almost half of these (49%) were  
408 in the three plots where *H. acuminata* density was highest (CF-1, FF-7, CF-3).

409 Due to logistical or financial constraints, no surveys were conducted in plot CF-6  
410 in 2003, in plots CF-4, CF-5, and CF-6 in 2000, or plots FF-5,FF-6, and FF-7 in  
411 2008-2009.

- 412 8. **Variable information:** Each row in the data set is a demographic plot, with columns  
413 of data describing that plot. Blanks do not denote missing information, but rather  
414 nothing relevant to report.

415 [INSERT TABLE 2 HERE]

416 **CLASS V. SUPPLEMENTAL DESCRIPTORS**

417 A. **Computer programs and data-processing algorithms:** The version of the R code  
418 used to prepare the data for archiving can be found at Zenodo [*url to be added*].  
419 Post-publication updates to the code or data can be found at the HDP Github Repository  
420 (<https://github.com/BrunaLab/HeliconiaDataPaper>).

421 B. **Publications and results:** The following articles have included analyses of part or all of  
422 the dataset. An update list can be found at the HDP Github repository

423 (<https://github.com/BrunaLab/HeliconiaDataPaper>).

- 424 1. Bruna, E. M. and W. J. Kress. 2002. Habitat fragmentation and the demographic  
425 structure of an Amazonian understory herb (*Heliconia acuminata*). *Conservation  
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450 10. Gagnon, P. R., E. M. Bruna, P. Rubim, M. R. Darrigo, R. C. Littlel, M. Uriarte, and  
451 W. J. Kress. 2011. The growth of an understory herb is chronically reduced in  
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453 11. Uriarte, M. Anciães, M. T.B. da Silva, P. Rubim, E. Johnson, and E. M. Bruna. 2011.  
454 Disentangling the drivers of reduced long-distance seed dispersal by birds in an  
455 experimentally fragmented landscape. *Ecology* 92(4): 924-93.

456 12. Côrtes, M., M. Uriarte, M. Lemes, R. Gribel, W. J. Kress, P. Smouse, E. M. Bruna.  
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459 13. Brooks, M. E., K. Kristensen, M. R. Darrigo, P. Rubim, M. Uriarte, E. M. Bruna, and  
460 B. M Bolker. 2019. Statistical modeling of patterns in annual reproductive rates.  
461 *Ecology* 100(7): e02706.

462 14. Scott, E. R., M. Uriarte, and E. M. Bruna. 2022. Delayed effects of climate on vital  
463 rates lead to demographic divergence in Amazonian forest fragments. *Global Change  
464 Biology*. 28(2):463-479.

465 **C. Other relevant publications and datasets:** The following data archives and articles  
466 include information (e.g., seeds per fruit, seed germination rates, seedling survival rates,  
467 plant growth rates following damage) that can be used in concert with the census data to  
468 conduct demographic modeling and other analyses. An updated list can be found in the  
469 HDP's Github repository (<https://github.com/BrunaLab/HeliconiaDataPaper>).

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493 population structure of *Heliconia acuminata* in Amazonian secondary forests with  
494 contrasting land-use histories. *Journal of Tropical Ecology* 21(1):127–131.

495 **ACKNOWLEDGMENTS**

496 This work would not have been possible without the technicians and field assistants  
497 participating in the annual surveys, the logistical support provided by the BDFFP staff, and  
498 the organizations providing financial support. Sharon Y. Strauss, Susan P. Harrison, and  
499 Patricia Delamônica Sampaio provided invaluable feedback during the project's  
500 establishment. Charles L. Staines identified the Hispine beetle. Financial support for the  
501 preparation of this manuscript was provided by the U.S. National Science Foundation (award  
502 DEB-1948607). This paper is publication number -- in the BDFFP Technical Series.

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Variable	Definition	Codes	Storage
plot	Code used to identify a plot	FF1-FF7: plots in fragments CF1-CF6: plots in continuous forest	string
habitat	Habitat type in which a plot is located	one: 1-ha fragment ten: 10-ha fragment forest: continuous forest	string
ranch	Ranch in which a plot is located	Porto Alegre, Esteio, Dimona	string
bdffp_no	The BDFFP Reserve Number for the reserve in which plot is located	2017, 2018, 1104, 1301, 2206, 1202, 3209, 1501, or 'none' (for plots outside BDFFP reserve boundaries)	string
yr_isolated	Year in which a fragment was initially isolated	1980, 1983, 1984	integer

Variable	Definition	Codes	Range	Storage
plot	Plot in which plant is located	FF1-FF7, CF1-CF6	-	string
subplot	Subplot in which plant is located	A1-A10, B1-B10, C1-C10, D1-D10, E1-E10, (CF3 only: F6-F10, G6-G10, H1-H10, J1-J10)	-	string
plant_id	Unique ID number assigned to plant	-	1-8660	integer
year	Calendar year of survey	-	1998-2009	integer
shts	No. of shoots when surveyed (Units: shoots; Precision: 1)	-	0-24	integer
ht	Plant height when surveyed (Units: cm; Precision: 1)	-	0-226	integer
infl	No. of inflorescences (if flowering) (Units: Inflorescences; Precision: 1)	-	1-7	integer
recorded_sdlg	Plant was new seedling	TRUE = seedling FALSE = not a seedling)	-	logical
found_without_tag	Plant was found without a tag	TRUE = established plant with no tag FALSE = seedling or previously marked plant	-	logical
treefall_status	Plant was under fallen branch/tree	under branchfall, under treefall, under litter, NA	-	string
census_status	Status in a census	measured = plant alive, measured dead = plant died between this and prior census missing = plant not found in census	-	string

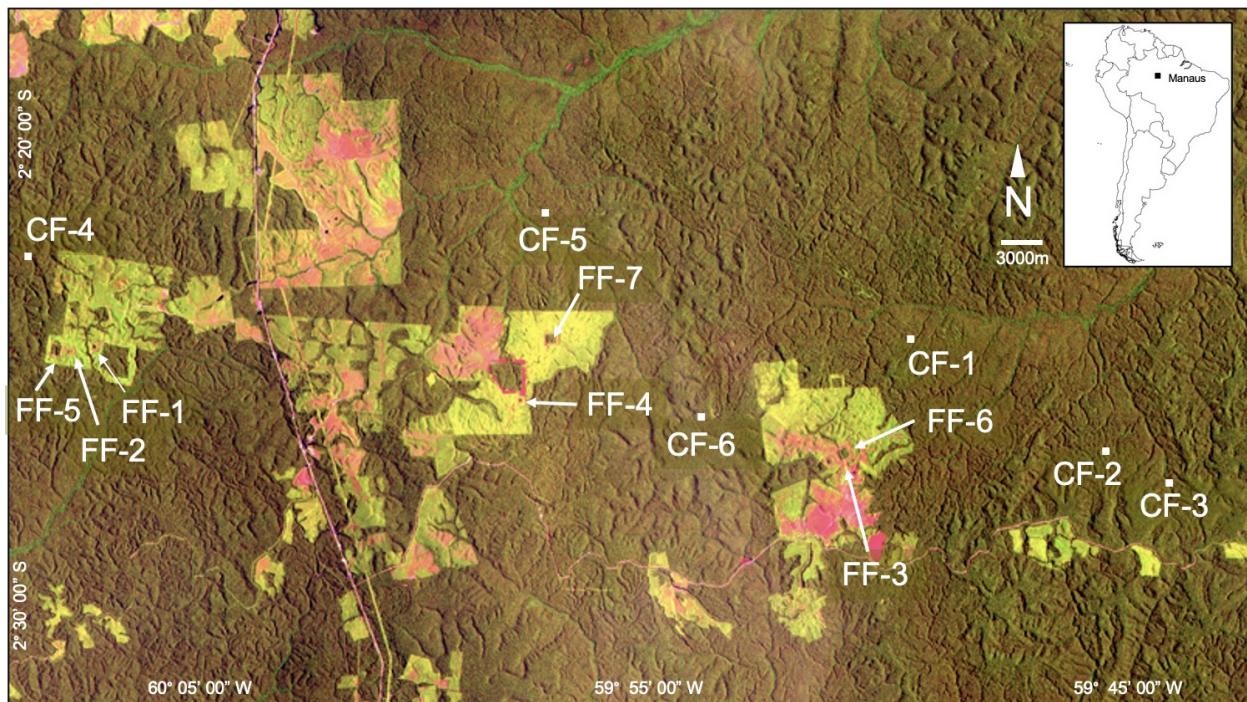
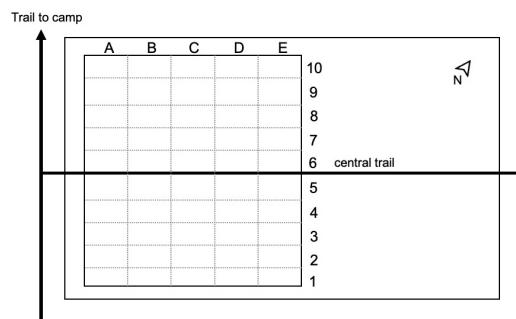


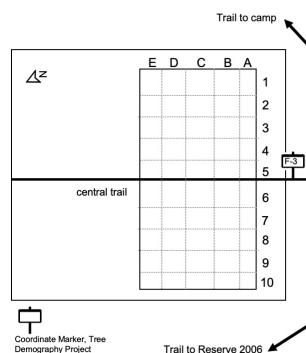
Figure 1. Satellite image of the Biological Dynamics of Forest Fragments Project showing the location of the *Heliconia* Demographic Plots and landscape cover at the time plots were established. Plots are located in Continuous Forest (CF1-CF6) or Forest Fragments (FF1-FF7). Dark green is primary forest, light green is regenerating forest, and red indicates pasture and recently cleared areas. The BDFFP is located 70 km north of Manaus, Brazil (inset map); for additional details on each plot see Table 1.

**FF-1**

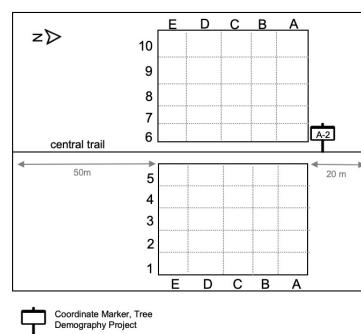
Ranch: Dimona Size: 1-ha Reserve: 2107

**FF-2**

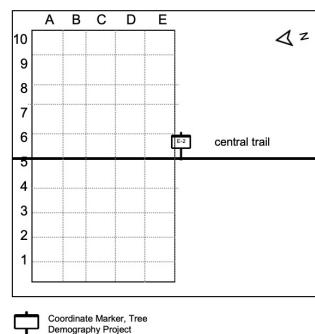
Ranch: Dimona Size: 1-ha Reserve: 2108

**FF-3**

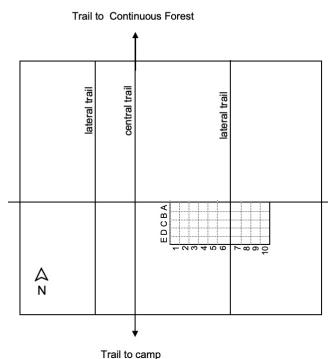
Ranch: Esteio Size: 1-ha Reserve: 1104 (Colosso)

**FF-4**

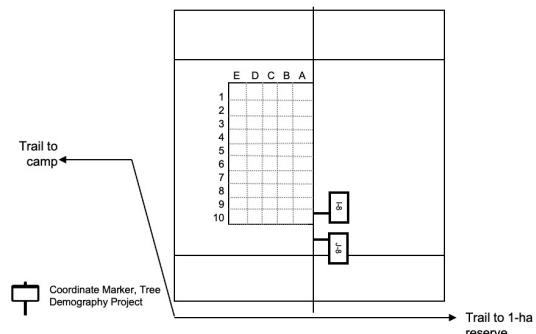
Ranch: Porto Alegre Size: 1-ha Reserve: 1301

**FF-5**

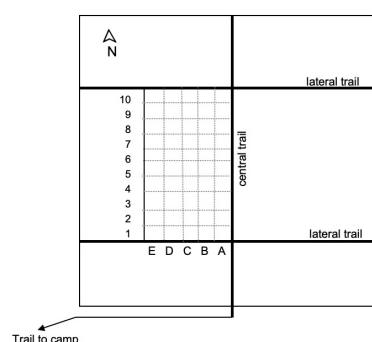
Ranch: Dimona Size: 10-ha Reserve: 2206

**FF-6**

Ranch: Esteio Size: 10-ha Reserve: 1202 (Colosso)

**FF-7**

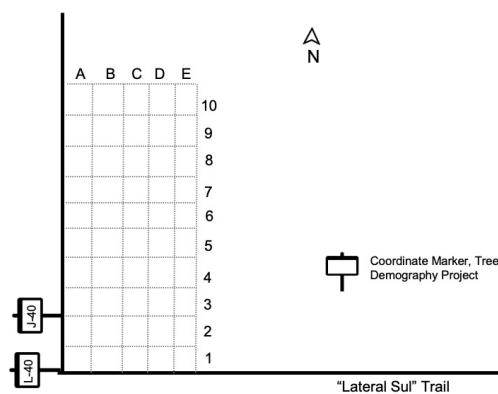
Ranch: Porto Alegre Size: 10-ha Reserve: 3209



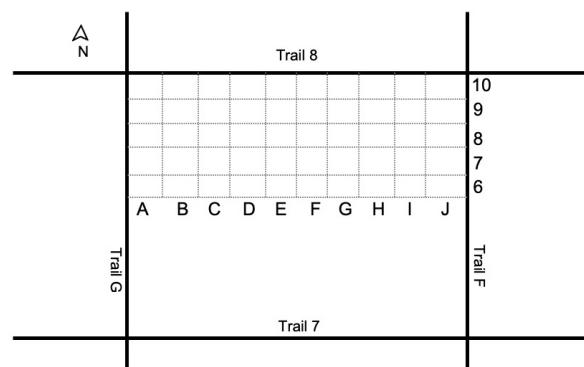
*Figure 2.* Schematic of the orientation and layout of each *Heliconia* Demographic Plots in Forest Fragments.

**CF-1**

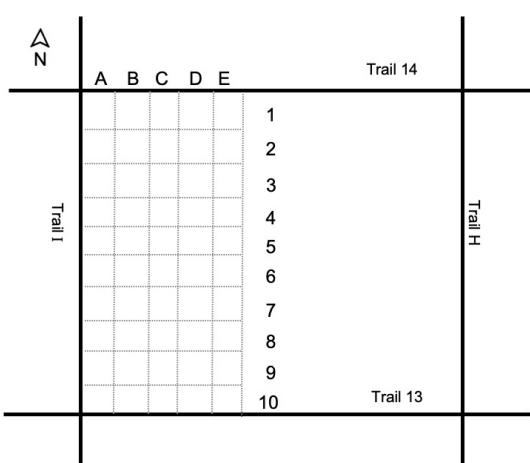
**Ranch:** Esteio **Size:** Continuous Forest **Reserve:** 1301 (Florestal)

**CF-2**

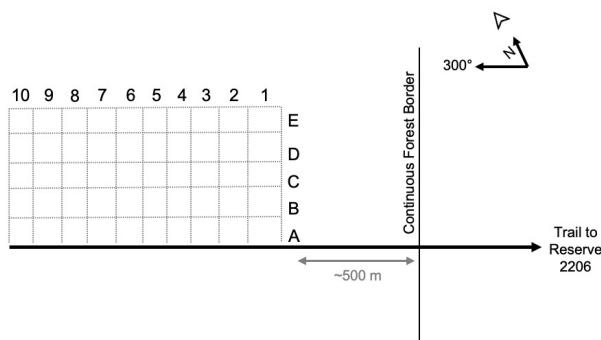
**Ranch:** Esteio **Size:** Continuous Forest **Reserve:** 1501 (Km 41)

**CF-3**

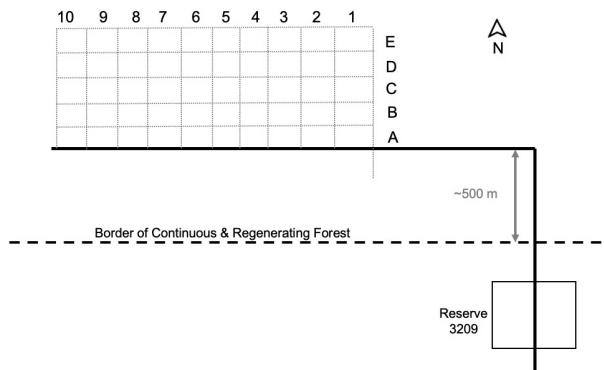
**Ranch:** Esteio **Size:** Continuous Forest **Reserve:** 1501 (Km 41)

**CF-4**

**Ranch:** Dimona **Size:** Continuous Forest **Reserve:** NA

**CF-5**

**Ranch:** Porto Alegre **Size:** Continuous Forest **Reserve:** NA

**CF-6**

**Ranch:** Porto Alegre **Size:** Continuous Forest **Reserve:** 3402 (Cabo Frio)

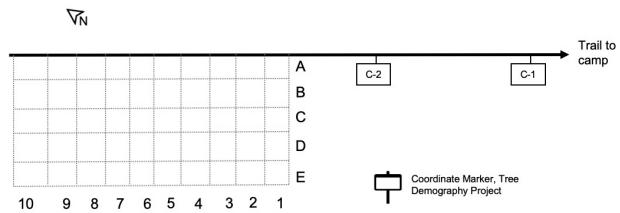


Figure 3. Schematic of the orientation and layout of each *Heliconia* Demographic Plot in Continuous Forest.