

<sup>1</sup> *METADATA FOR:*<sup>2</sup> **Demography of the understory herb *Heliconia acuminata* (Heliconiaceae) in an**  
<sup>3</sup> **experimentally fragmented tropical landscape**<sup>4</sup> Emilio M. Bruna<sup>1,2,3</sup>, María Uriarte<sup>4</sup>, Maria Rosa Darrigo<sup>3</sup>, Paulo Rubim<sup>3</sup>, Cristiane F.  
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<sup>15</sup> Institution, PO Box 37012, Washington DC, USA<sup>16</sup> *Corresponding author:* Emilio M. Bruna (embruna@ufl.edu)<sup>17</sup> *Open Research Statement:* The complete data set is available as Supporting Information at:  
<sup>18</sup> [TBD]. Associated data is also available at the Dryad Digital Repository: [DOI].

19

## METADATA

### 20 I. CLASS I. Data Set Descriptors

21 **A. Data set identity:** Demographic data from populations of the understory herb  
22 *Heliconia acuminata* (Heliconiaceae) in an experimentally fragmented tropical landscape  
23 (1998-2009).

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

- 25 1. Data set File 1: HDP\_plots.csv  
26 2. Data set File 2: HDP\_1998\_2009.csv

27 **C. Data set description:**

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

32 **2. Abstract:** Habitat fragmentation is thought to be a leading cause of extinction, but  
33 the demography of species in fragmented landscapes remains poorly understood. This  
34 is particularly true of those in tropical ecosystems, where studies monitoring  
35 populations of species across all life-history stages in both fragments and continuous  
36 habitat are virtually nonexistent. Here we report 11 years (1998-2009) of annual  
37 censuses of 13 populations of the Amazonian understory herb *Heliconia acuminata* (LC  
38 Rich.). These surveys were conducted in plots established in the experimentally  
39 fragmented landscape of the Biological Dynamics of Forest Fragments Project, located  
40 north of Manaus, Brazil. The plots, each 50 × 100m, are located in forest fragments of  
41 different sizes (N = 4 plots in 1-ha fragments and N = 3 plots in 10-ha fragments) as  
42 well as 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 recorded the identity of flowering plants and the number of inflorescences each produced. The resulting data set 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, 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:** 1998-2009

**4. Objectives:** Habitat fragmentation remains 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 put forward as a threat to the integrity of ecosystems (Harris 1984, Wilcove et al. 1986). Decades of research have documented myriad biotic changes in fragmented landscapes, including the local extinction of species from fragments (Harrison and Bruna 1999, Laurance et al. 2011). The demographic mechanisms underlying these extinctions are rarely known (Bruna et al.

67 2009). However, many of them – especially in lowland tropical forests – are thought to  
68 be driven by one of two mechanisms: (1) reduced recruitment in fragments resulting  
69 from changes in the diversity or abundance of specialized pollinators and seed  
70 dispersers (Murcia 1996, Silva and Tabarelli 2000), or (2) increased rates of individual  
71 mortality in fragments (Laurance et al. 1998, Zartman et al. 2015) due to dramatically  
72 altered abiotic conditions, especially near fragment edges (reviewed in Broadbent et al.  
73 2008). Unfortunately, tests of these potential mechanisms remain limited due to the  
74 paucity of long-term demographic data collected in both forest fragments and  
75 continuous forest sites (Bruna et al. 2009).

76 Most studies investigating the effects of forest fragmentation on tropical plants  
77 focus on trees (Cordeiro et al. 2009, Jurinitz et al. 2013, Zambrano and  
78 Salguero-Gómez 2014), in part because they are major reservoirs of carbon (Slik  
79 et al. 2010, Lasky et al. 2014). However, herbaceous species can comprise up to  
80 30% of the plant species in lowland tropical forests (Gentry and Emmons 1987,  
81 Ribeiro et al. 2010, Iannone and Vargas 2022, Spicer et al. 2022), where they are  
82 habitat and food for myriad animal taxa as well as economically and culturally  
83 important non-timber forest products (Nakazono et al. 2004, Athayde et al.  
84 2006). Despite their biocultural importance, however, the way in which habitat  
85 fragmentation and other global change phenomena influences the population  
86 dynamics of tropical understory plants remains conspicuously understudied  
87 (Bruna et al. 2009).

88 The *Heliconia* Demography Project (HDP) was established to address the lack of  
89 data on the demography of understory plants in fragmented tropical landscapes.  
90 The core of the HDP is annual censuses of thirteen populations of *Heliconia*  
91 *acuminata* located in either continuous forest or experimentally isolated forest  
92 fragments at Brazil's Biological Dynamiocts 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 2006) with which to (1) compare the demography and population dynamics of *H. acuminata* populations in fragments and continuous forest, and (2) test the hypothesis that reductions in seedling establishment in forest fragments would lead to population declines.

**5. Abstract:** Here we report 12 years (1998-2009) of demographic data from populations of the Amazonian understory herb *H. acuminata* (LC Rich.) found at Brazil's Biological Dynamics of Forest Fragments Project. The resulting data set comprises >67000 plant×year records of N = 8586 plants, including N = 3464 seedlings that became established after the initial census. The thirteen populations were in permanent plots located in experimentally isolated fragments (one in each of four 1-ha fragments and one in each of three 10-ha fragments) as well as in six continuous forest sites. Each plot was 50 × 100m, with the distance between plots ranging from 500 m-60 km. The plants in each plot were censused annually, at which time we recorded, identified, marked, and measured new seedlings, identified any previously marked plants that died, and recorded the size of surviving individuals. Plots were also surveyed during the flowering season to identify reproductive plants and record the number of inflorescences each produced. These data have been used to investigate topics ranging from the way fragmentation-related reductions in germination influence population dynamics to statistical methods for analyzing reproductive rates. This breadth of prior use reflects the potential value of these data to future researchers - an invaluable resource for studies of plant responses to habitat fragmentation, but also also an exceptional one with to address fundamental questions in plant demography, the evolutionary ecology of tropical plants, and for developing and testing demographic models and tools.

119     6. **Sources of funding:** The initial establishment of plots and the 1998-2002 surveys  
120       were supported by grants to E. M. Bruna from the Smithsonian Institution (Graduate  
121       Student Research Award), the University of California, Davis (Center for Population  
122       Biology Graduate Research Grant, M. E. Mathias Graduate Research Grant), the  
123       Biological Dynamics of Forest Fragments Project (Graduate Student Logistics Grant),  
124       the National Science Foundation (Dissertation Improvement Grant INT 98-06351), and  
125       the Ford Foundation (Dissertation Year Fellowship). The 2001-2005 surveys were  
126       supported a grant from the National Science Foundation to E. M. Bruna (Research  
127       Starter Grant DEB-0309819). The 2006-2009 surveys were supported by grants from  
128       the National Science Foundation to E. M. Bruna (DEB-0614149) and María Uriarte  
129       (DEB-0614339). Subsequent analyses and the preparation of these data for archiving  
130       were supported by the National Science Foundation (DEB-1948607).

131     **B. Subproject description**

132     1. **Site description**

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

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

138       c. **Habitat:** The BDFFP is dominated by tropical evergreen lowland forest  
139       (i.e., ‘tropical moist forest’, *sensu* Holdridge (1967). The forest canopy at  
140       the sites is ~35–40 m tall, with emergent trees of up to ~45 m  
141       (Rankin-de-Mérona et al. 1992). The tree community at the BDFFP is  
142       highly diverse: ~1300 species total (Laurance 2001), with as many as 280  
143       tree species ha<sup>-1</sup> (Oliveira and Mori 1999). The understory is dominated by

144 stemless palms (Scariot 1999). All HDP plots are located in *terra-firme* (i.e.,  
145 non-flooded) forest and none are bisected by streams.

146 d. **Geology:** Soils in the sites are nutrient-poor xanthic ferralsols, known as  
147 yellow latosols in the Brazilian soil classification system. Despite their high  
148 clay content they have poor water-retention capacity (Fearnside and  
149 Leal-Filho 2001). The often rugged topography at the BDFFP ranges in  
150 elevation from 50-150 m elevation (Gascon and Bierregaard 2001).

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

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

168 g. **Climate:** Mean annual temperature at the site is 26°C (range 19-39°C).

169 Annual rainfall ranges from 1900-2300 mm (Scott et al. 2022), with a  
170 pronounced dry season from June-December in which there is <100 mm  
171 rain per month.

## 172 2. Sampling Design

173 **a. Design characteristics:** Annual demographic surveys of *Heliconia*  
174 *acuminata* populations were carried out in 13 permanent plots distributed  
175 across the BDFFP landscape (Bruna and Kress 2002). Six plots are located  
176 in continuous forest, four in 1-ha fragments, and three in 10-ha fragments  
177 (one plot per fragment; Fig. 1).

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

188 Each *Heliconia acuminata* has a basal rhizome from which emerge  
189 erect vegetative shoots with broad leaves. Reproductive plants have  
190 one or more flowering shoots, each of which has a single inflorescence.  
191 Plants grow slowly (Bruna and Ribeiro 2005, Gagnon et al. 2011) and  
192 the proportion of plants that flower is low (Bruna 2002, Bruna and  
193 Kress 2002). The primary herbivores of *Heliconia* species are Hispine

194 beetles, whose larvae and adults scrape the surface of unrolled  
195 immamture leaves (Strong 1977). The beetle species associated with *H.*  
196 *acuminata* is *Cephaloleia nigriceps* Baly (Staines and Garcia-Robledo  
197 2014); it actually does little damage to leaves but can cause extensive  
198 damage to bracts, flowers, and developing ovaries.

199 *Heliconia* can be propagated by segmenting the rhizome (Berry and  
200 Kress 1991, Bruna and Andrade 2011), and clonal spread is common in  
201 the *Heliconia* species found in open or disturbed habitats (Schleuning  
202 et al. 2008). However, recruitment in *H. acuminata* and other  
203 understory species is primarily via seeds (Bruna 1999, 2002). Plants  
204 that flower do so during the rainy season, with the propbability of  
205 flowering increasing with plant size (Bruna and Kress 2002). The  
206 overwhelming majority of plants in our data set that flowered (75%)  
207 produced a single inflorescence (range = 1-7). Inflorescences have an  
208 average  $22.28 \pm 1.17$  SE flowers (range 4-62); each flower remains open  
209 for one day before falling from the plant. Pollen transfer experiments  
210 indicate self-compatibility is extremely low (Bruna and Darrigo,  
211 *unpubl. data*); succesfully pollinated flowers can produce 1-3 seeds,  
212 with an average of 2 seeds per fruit (Bruna 2014).

213 *Heliconia acuminata* is pollinated by the ‘traplining’ hummingbirds  
214 *Phaeothornis superciliosus* and *P. bourcieri*. Visitation rates to flowers  
215 are extremely low (<1 visit hour<sup>-1</sup>, Bruna et al. 2004), as are rates of  
216 fruit production (Bruna and Kress 2002). The fleshy blue fruits are  
217 consumed by birds (Uriarte et al. 2011); in our study sites the primary  
218 dispersers are several species of manakin (*Pipra erythrocephala*, *P.*  
219 *pipra*, *Lepidothrix serena*, *Schiffornis turdinus*, *Corapipo gutturalis*)

and the White-necked Thrush (*Turdus albicollis*). The seeds germinate 6-7 months after dispersal, which coincides with the onset of the rainy season (Bruna 1999, 2002). Experiments indicate that post-dispersal seed predation is negligible and while rates of seed germination and seedling establishment were generally low, they were significantly higher in continuous forest than forest fragments (Bruna 1999, 2002). Although some seeds germinated >1 year after experimental dispersal, this was generally rare - especially in fragments. These results are consistent with the generalization that few plant species in lowland tropical forests have long-lived seed banks (Vázquez-Yanes and Orozco-Segovia 1993).

b. **Permanent Plots:** Each demographic plot is 50 × 100m and is subdivided into 50 contiguous subplots of 10 × 10m to facilitate the surveys. Plots in 1-ha fragments were established in a randomly selected half of the fragment (Fig. 2), plots in 10-ha fragments are located in the center of the fragment (Fig. 3), and plots in continuous forest are located 500-4000 m from any borders with cattle pastures or secondary forest (Fig. 4). The plots furthest apart are from each other are separated by ~70 km.

Plots in 1-ha fragments, 10-ha fragments, and three of the continuous forest sites were demarcated in January-April 1997. The remaining three plots in continuous forest were demarcated in January 1998, 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.

c. **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. Regular visits were made to all 13 plots throughout the rainy season to identify reproductive individuals and record the number of flowering shoots and inflorescences that they had produced.

### 3. Research Methods

a. **Demographic Surveys:** 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/HeliconiaSurveys>), and recorded if plants were under treefalls or damaged by fallen branches or palm fronds.

b. **Taxonomy and systematics:** *Heliconia* is the only genus in the family Heliconiaceae. This family is distinguished from the others in the order Zingiberales by having inverted flowers, a single staminode, and drupaceous

fruits (Kress 1990). It is estimated that there are 200-250 species of *Heliconia*, almost all of which are native to the Neotropics. *Heliconia acuminata* L. C. (Rich.) (Richard 1831) is one of the approximately 20 *Heliconia* species found in the Brazilian Amazon (Kress 1990). We deposited voucher specimens of *H. acuminata* collected in areas adjacent to demographic plots at the herbaria of the Instituto Nacional de Pesquisas da Amazônia (Accession Numbers INPA 189569-189573) and the University of California, Davis (Accession Numbers DAV 69391-69396).

**4. Project personnel:** In addition to the Originators, other key personnel include the Project Managers that were responsible for coordinating the annual censuses and other field activities, BDFFP Technicians (“*Mateiros*”) that assisted with data collection and provided logistical support in the field, and undergraduate and postgraduate field assistants hired to assist with the surveys.

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

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

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

### **295 CLASS III. DATA SET STATUS AND ACCESSIBILITY**

296 **A. Status**

297 **1. Latest update:** 2023-01-06

298 **2. Latest archive date:** [date of archiving at Dryad to be added upon acceptance]

299 **3. Metadata status:** Complete (last update: 2023-01-06)

300 **4. Data verification:** An extensive review of the data was also conducted in preparation  
301 for archiving. We began by generating a list of potential anomalies that could indicate  
302 errors (e.g. extremely large changes in size from one year to the next, plants marked as  
303 dead that had subsequent measurements), and then wrote code to search for these  
304 anomalies using the R statistical programming language (R Core Development Team  
305 2014). We also used the `pointblank` library (Iannone and Vargas 2022), which  
306 similarly identifies cases in a data set for review and validation. All records flagged  
307 were evaluated by E. M. Bruna by checking the values in the electronic records against  
308 the original data sheets. Corrections to the data set were also made using R scripts;  
309 the code documenting and implementing these changes is archived at Zenodo [*url to be*  
310 *added upon acceptance*]. Questions regarding the data set or code should be referred to  
311 E. M. Bruna, who will investigate and update the database or code as needed. Code  
312 for any post-publication updates is maintained at the HDP Github Repository.

313 **B. Accessibility**

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

316 **2. Contact person:** Emilio M. Bruna, Department of Wildlife Ecology and  
317 Conservation, Box 110430, Gainesville, FL 32611 USA. Phone: (352) 846-0634. Email:  
318 embruna@ufl.edu

319     3. **Copyright restrictions:** None

320     4. **Proprietary restrictions:** None.

321         a. **Conditions of Reuse:** Any publication using data collected at the BDFFP  
322             must include a BDFFP Technical Series Number in the Acknowledgments.

323             Authors can request this series number upon the acceptance of their article  
324             by contacting the BDFFP's Scientific Coordinator or E. M. Bruna.

325         b. **Citation:** Authors of any publications or products using these data should  
326             cite both this data paper and the Dryad data archive [*citation of Dryad*  
327             *archive to be added upon acceptance*]. We also request that they provide E.  
328             M. Bruna a copy of their article upon acceptance, which allows us to track  
329             the data set's usage, inform users of any corrections or updates, report  
330             articles using the data to the funding agencies that provided support, and  
331             document the different ways in which the scientific community uses the data.

332         c. **Disclaimers:** While the data are provided in good faith and are accurate  
333             to the best of our knowledge, they are provided "as is". We do not assume  
334             any legal liability or responsibility for their accuracy, completeness, or  
335             utility. The responsibility for use and analysis of these data lies completely  
336             with the user.

337     5. **Costs of acquiring data:** None.

338     **CLASS IV. DATA STRUCTURAL DESCRIPTORS**

339     A. **Data set File 1:** Descriptors of demographic plots

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

341         2. **Size:** 14 rows (including header), 404 Bytes

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

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

345     **5. Alphanumeric attributes:** Mixed

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

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

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

349     **9. Variable Information:** Each row is one plot, with the columns providing  
350         plot-specific values for each variable (Table 1).

351     **B. Data set File 2: *Heliconia* Demographic Data**

352     **1. Identity:** HDP\_data\_1998-2009.csv

353     **2. Size:** 66785 rows (including header), 3.61 MB

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

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

357     **5. Alphanumeric attributes:** Mixed.

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

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

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

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

367       The stakes and numbered tags used to mark plants were sometimes displaced,  
368       broken, or buried under leaf litter as a result of tree falls or other disturbances. If  
369       a plant’s tag couldn’t be found after an extensive search, it would be marked  
370       with a new tag. In some cases, it was straightforward to determine such a plant’s  
371       original number when entering the survey data (e.g., when all plants in a  
372       low-density subplot were found except one, which in the prior year was similar in  
373       size as the plant found without a tag). In those cases, the plant’s prior  
374       measurements were transferred to the new number and we logged the details of  
375       the change in tag number; the log is available at the HDP Github repository. In  
376       other cases, it was impossible to definitively determine a plant’s original number  
377       (e.g., when two similarly sized plants in a subplots were both missing their tags).  
378       In these cases the original number was maintained in the database with the  
379       plant’s status noted as ‘missing’ in subsequent surveys. The record for the new  
380       number indicates the plant with which it is associated is an established plant  
381       that was found without a tag (see Section IV, Table 2) and not a new seedling.

382       There were also cases in which established plants were found without tags in  
383       subplots where all previously tagged plants had already been located and  
384       measured, indicating previous survey teams had failed to find and mark them.  
385       These plants were marked, measured, and added to the database with a code  
386       indicating they were a established (i.e., post-seedling) but previously unmarked

387 plant (See Table 2). Of the N = 947 plants in the data set, 11% were found  
388 without tags after the plot had been established. Almost half of these (49%) were  
389 in the three plots where *H. acuminata* density was highest (CF-1, FF-7, CF-3).

390 Due to logistical or financial constraints, no surveys were conducted in plot CF-6  
391 in 2003, in plots CF-4, CF-5, and CF-6 in 2000, or plots FF-5,FF-6, and FF-7 in  
392 2008-2009.

- 393 **8. Variable information:** Each row in the data set is a demographic plot, with columns  
394 of data describing that plot (Table 2). Blanks do not denote missing information, but  
395 rather nothing relevant to report.

## 396 CLASS V. SUPPLEMENTAL DESCRIPTORS

### 397 A. Data acquisition:

- 398 **1. Data forms:** Examples of the forms used to collect survey data are available on the  
399 HDP Github repository.

- 400 **2. Location of original data forms, electronic files, and archived copies:** Original  
401 data sheets are stored at the University of Florida. Scanned copies of the data sheets  
402 (in .pdf format) and the electronic copies of the data in (in .csv format) are stored on a  
403 desktop computer at the University of Florida that is backed up daily to two portable  
404 hard drives and two cloud storage services. The integrity of digital files is verified  
405 semi-annually.

- 406 **3. Data entry verification procedures:** Following each survey, the measurements of  
407 plant height and stem number were compared with those from the previous year to  
408 identify potential errors in either plant measurement or entry (e.g., a plant with 1  
409 shoot in year t and 11 shoots in year t+1 is likely an error in data entry).

410 Discrepancies were investigated by referring to the original data sheets and, on

411 occasion, returning to the field to remeasure plants.

412 **B. Quality assurance/quality control procedures:** An extensive review of the data was  
413 conducted in preparation for archiving. We began by generating a list of potential anomalies  
414 that could indicate errors (e.g. extremely large changes in size from one year to the next,  
415 plants marked as dead that had subsequent measurements), and then wrote code to search  
416 for these anomalies using the R statistical programming language (R Core Development  
417 Team 2014). We also used the `pointblank` library (Iannone and Vargas 2022), which  
418 similarly identifies cases in a data set for review and validation. All records flagged were  
419 evaluated by E. M. Bruna by checking the values in the electronic records against the  
420 original data sheets. Corrections to the data set were also made using R scripts; the code  
421 documenting and implementing these changes is archived at Zenodo [*url to be added upon  
422 acceptance*]. Questions regarding the data set or code should be referred to E. M. Bruna,  
423 who will investigate and update the database or code as needed. Code for any  
424 post-publication updates is maintained at the HDP Github Repository.

425 **C. Related materials:** A diagram showing each demographic plots' location, orientation,  
426 and subdivision into subplots can be found in Appendix S1. Photographs, data summaries,  
427 updates, and other related materials can be found at the HDP Github Repository.

428 **D. Computer programs and data-processing algorithms:** The version of the R code  
429 used to prepare this data archive can be found at Zenodo [*url to be added*]. Any  
430 post-publication updates to the code or data can be found at the HDP Github Repository  
431 (<https://github.com/BrunaLab/HeliconiaSurveys>).

432 **F. Publications:**

433 1. **Publications including analyses of the data set.** An update list and  
434 downloadable *BibTeX* file can be found at the HDP Github repository.

- 435 1. Bruna, E. M. and W. J. Kress. 2002. Habitat fragmentation and the  
436 demographic structure of an Amazonian understory herb (*Heliconia*  
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492 fragmented ecosystems. *Ecological Modelling* 457: 109681.
- 493 2. **Related publications and data sets:** The following data archives and articles  
494 include information (e.g., seeds per fruit, seed germination rates, seedling survival  
495 rates, plant growth rates following damage) that can be used in concert with the  
496 census data to conduct demographic modeling and other analyses. An update list and  
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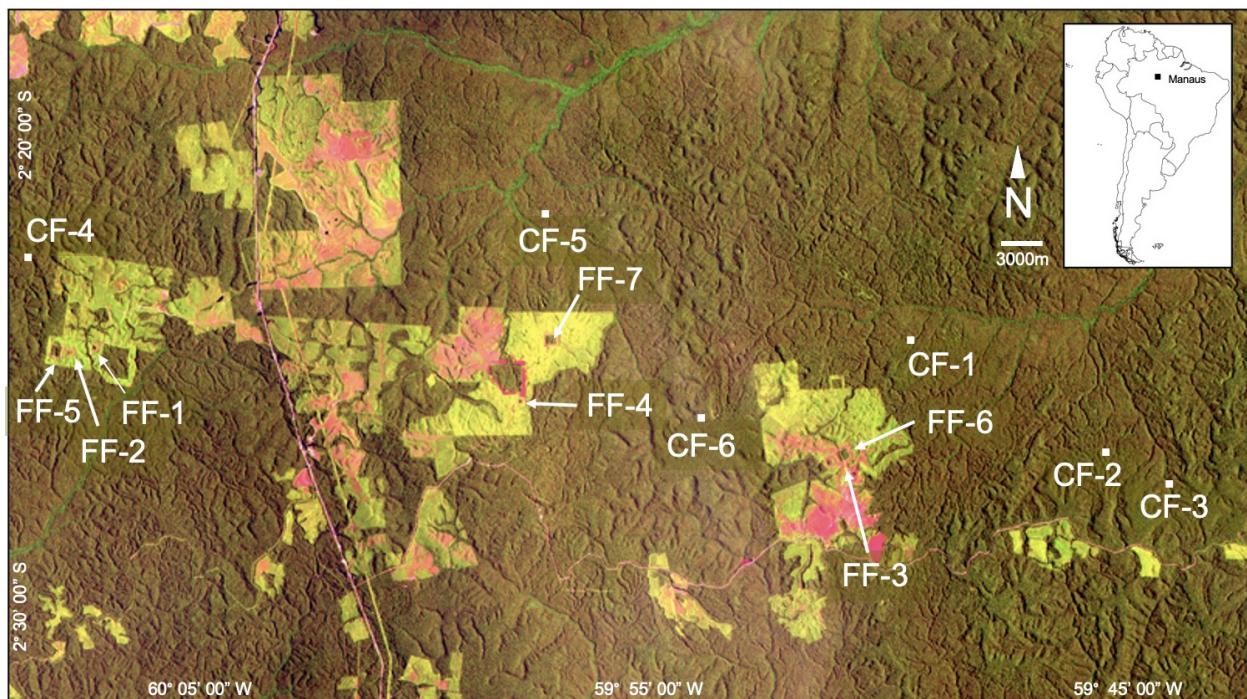


Figure 1. Satellite image of the Biological Dynamics of Forest Fragments Project (ca. 1995) showing the location of the *Heliconia* Demographic Plots. Plots are located in Continuous Forest (CF1-CF6) or Forest Fragments (FF1-FF7), both of which are dark green. Light green areas are regenerating forest, while red indicates pasture. The BDFFP is located 70 km north of Manaus, Brazil (inset map). For additional details on each plot see Table 1.

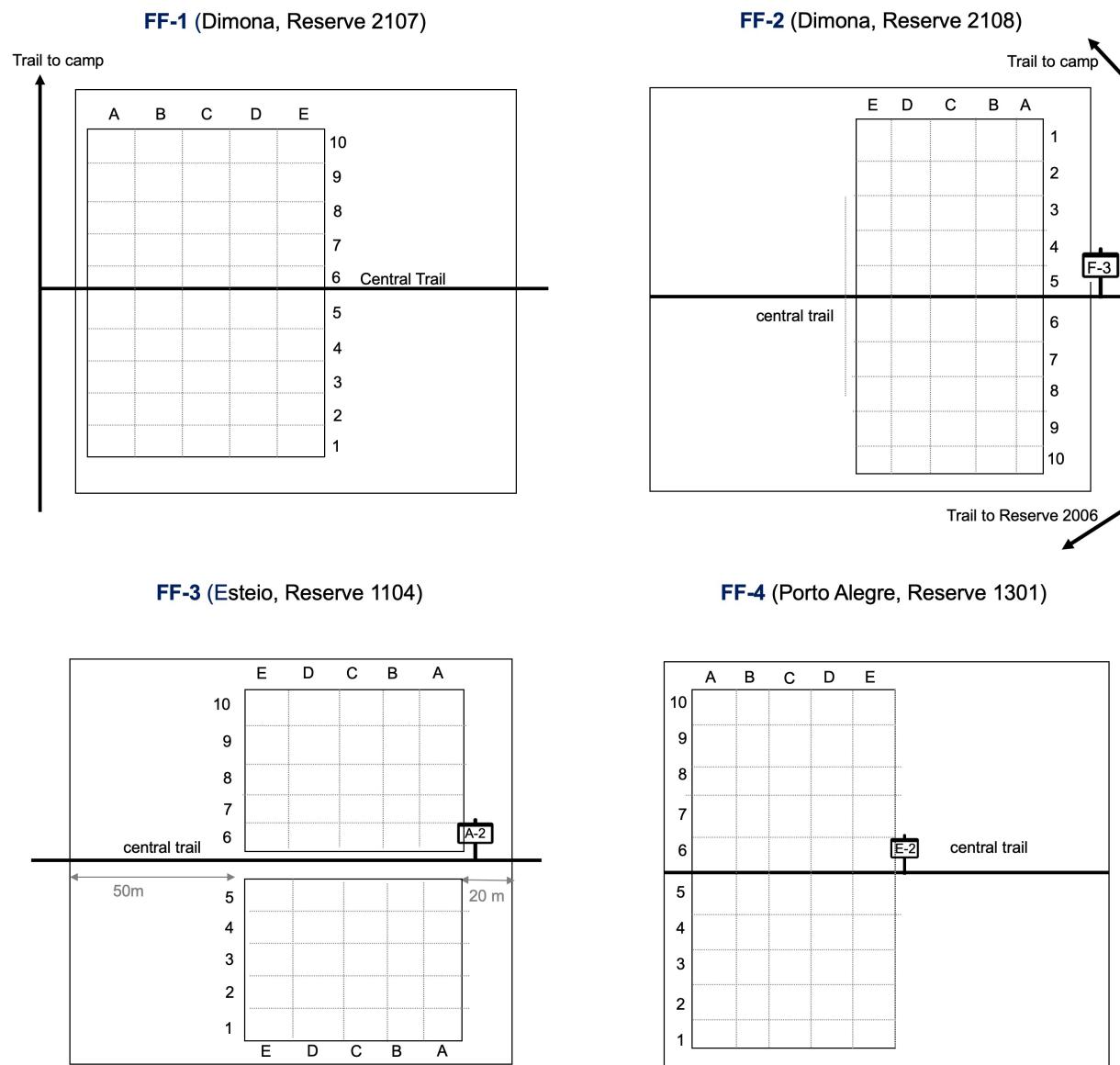


Figure 2. Schematic of the *Heliconia* Demographic Plots in the BDFFP 1-hectare forest fragment reserves. Note: not to scale.

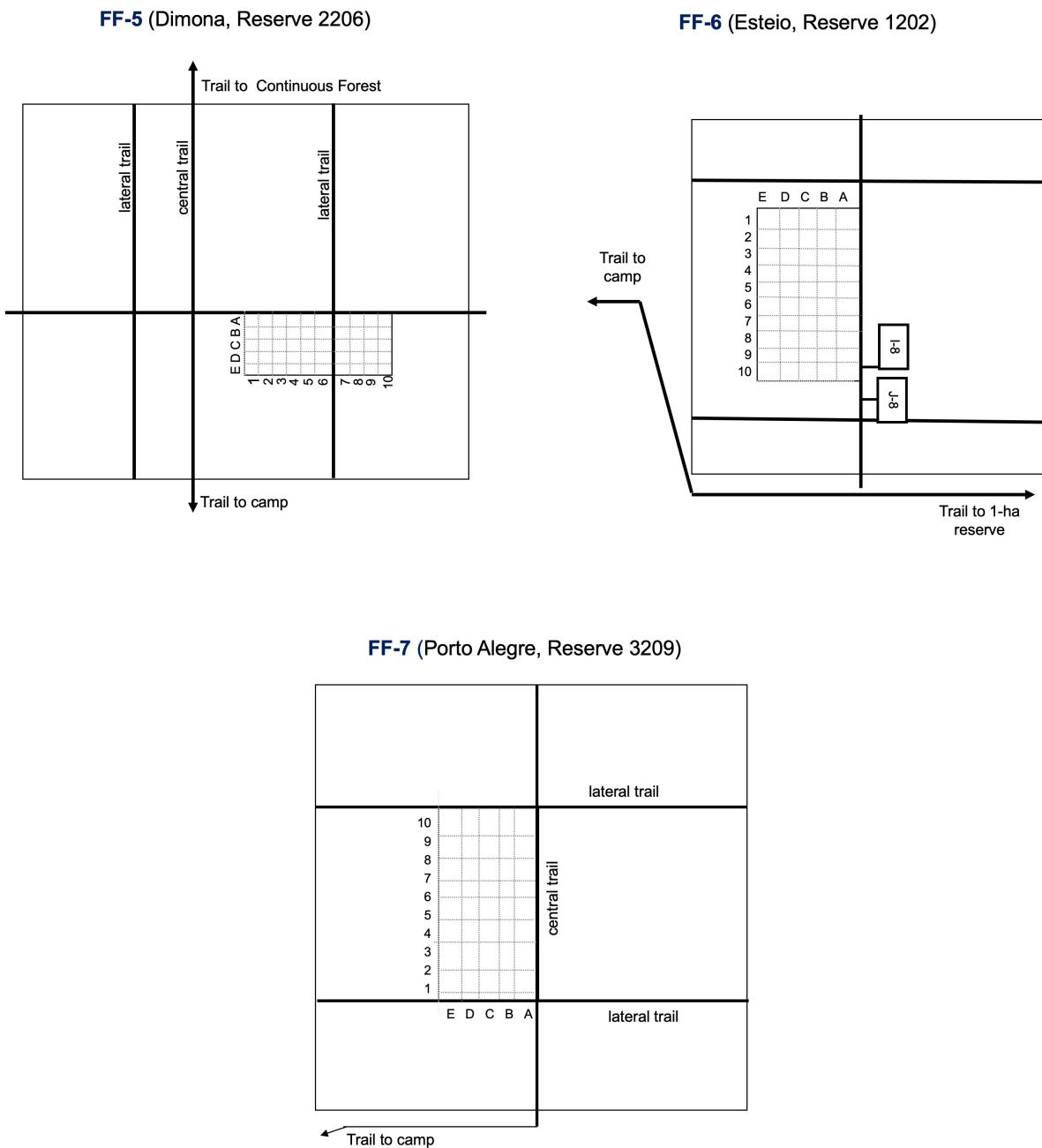


Figure 3. Schematic of the *Heliconia* Demographic Plots in the BDFFP 10-ha forest fragment reserves. Note: not to scale.

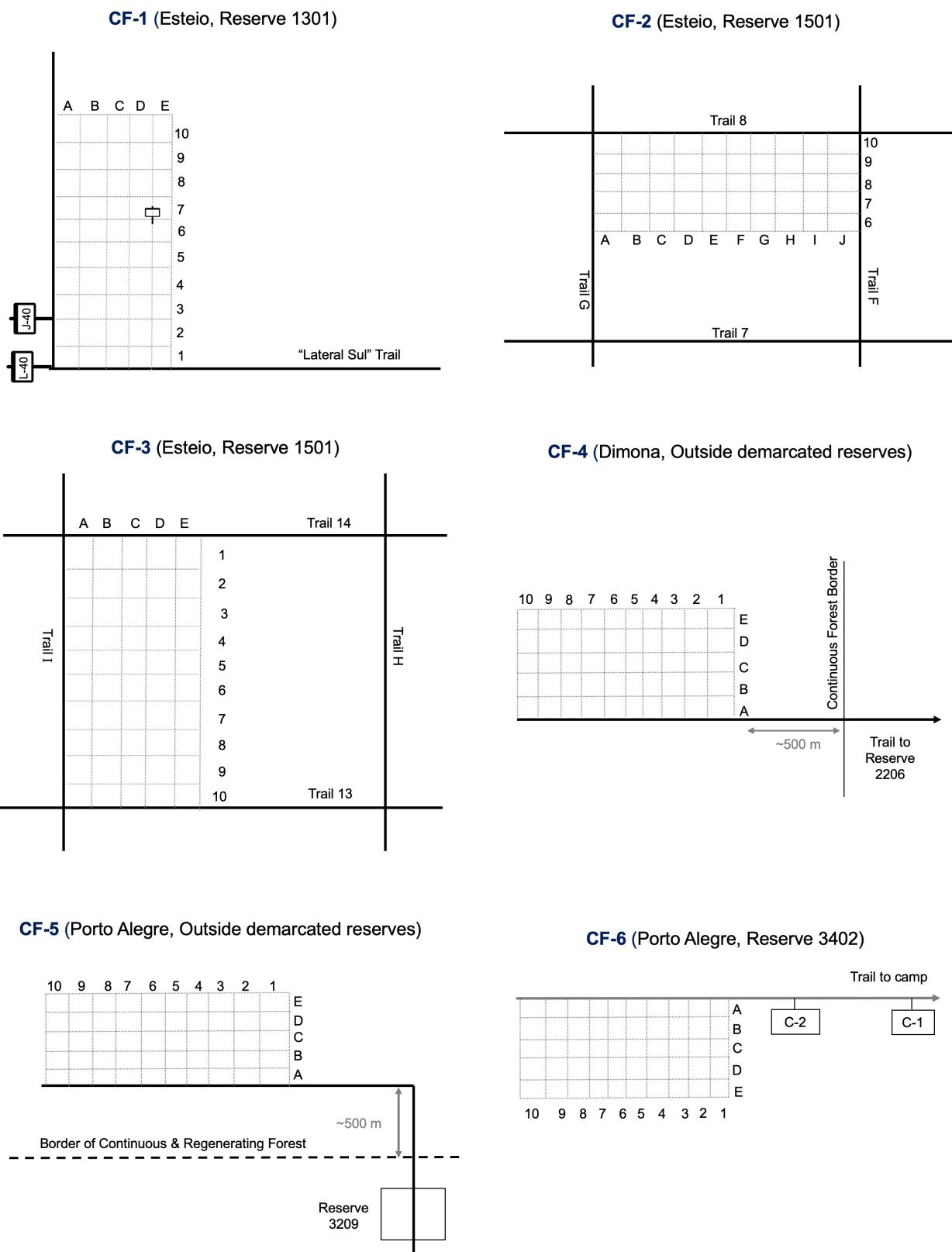


Figure 4. Schematic of each *Heliconia* Demographic Plot in the BDFFP Continuous Forest reserves. Note: not to scale.

**Table 1.** Variable Information for “Data set File 1: *Descriptors of demographic plots*”.

<b>Variable</b>	<b>Definition</b>	<b>Codes</b>	<b>Storage</b>
plot	Code used to identify a plot	FF1-FF7: plots in fragments CF1-CF6: plots in continuous forest	string
habitat	Habitat 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	BDFFPs Reserve ID Number <sup>1</sup>	1104, 1202, 1301, 1501, 2107, 2108, 2206, 3209, 3402, NA	string
yr_isolated	For fragments, the year initially isolated	1980, 1983, 1984	integer

<sup>1</sup> See Gascon and Bierregaard (2001) for details of the reserve numbering scheme. ‘NA’ indicates the plot is not inside a formally demarcated BDFFP reserve.

**Table 2.** Variable Information for “Data set File 2: *Heliconia Demographic Data*”.

Variable	Definition	Codes or Range of Values	Storage
plot	Plot in which plant is located	FF1-FF7, CF1-CF6	string
subplot	Subplot in which plant is located	A1-E10 except in CF3, where F6-J10 <sup>1</sup>	string
plant_id	Unique ID no. assigned to plant	range = 1-8660 (units: number, precision: 1)	integer
year	Calendar year of survey	range = 1998-2009 (units: year, precision: 1)	integer
shts	No. of shoots when surveyed	range = 0-24 (units: shoots, precision: 1)	integer
ht	Plant height when surveyed	range = 0-226 (units: cm, precision: 1)	integer
infl	No. of inflorescences (if flowering)	range = 1-7 (units: shoots, precision: 1)	integer
recorded_sdlg	New seedling	TRUE, FALSE	logical
found_without_tag	Established (i.e., post-seedling) individual without tag	TRUE, FALSE	logical
treefall_status	Plant under fallen tree crowns, branches, or leaf litter	branch: under fallen tree limbs tree: under tree crown or fallen trees litter: under accumulated leaf-litter	string
census_status	Plant status in a census	measured: alive, measured dead: died prior to census missing: not found during census	string

<sup>1</sup> For the arrangement of the subplots see Figures 2-4