**Reproductive traits – BCI (draft 4 December 2007)**

This document describes the rationale and methods used for BCI reproductive trait determinations.

**Rationale**

The CTFS plant traits working group selected three reproductive traits to be measured across CTFS sites (Appendix A). We add dispersal mode to this recommendation. Table 4 presents these four traits, their rationale, and sample sizes recommended by Cornelissen et al. (2003). Seed mass influences seed and early seedling survival and growth. Diaspore shape and mass influence seed dispersal. For BCI, we have also measured both fresh and dry masses of fruits, diaspores and seeds and the number of seeds and capsules per fruit. We use seeds and capsules per fruit to inform analyses of fruit trap data, which includes entire fruit as well as separated seeds and capsules. We define capsule broadly to include any reproductive part that vertebrates never consume and that can be identified to species.

Table 4. Reproductive traits. '+' marks denote well established associations with environmental gradients in climate or disturbance regime, competitive ability, and defense against herbivores and pathogens. Recommended sample sizes are numbers of individuals and numbers of fruits per individual from Cornelissen et al. (2003).

| Trait (units) | Literature association of trait with | | | | Sample Size | |
|---|---|---|---|---|---|---|
| | Response to | | Com-petitive ability | Defense | Indi-viduals | Items |
| | Climate | Distur-bance | | | | |
| Dispersal mode (categorical) | | + | | | | |
| Diaspore shape (unitless) | | + | | | 3-10 | 5 |
| Diaspore mass (mg) | | + | | | 3-10 | 5 |
| Seed mass (mg) | | + | + | + | 3-10 | 5 |

**Methods**

We first present methods for the four reproductive traits to be measured at all CTFS sites (Table 4). We then present methods for additional reproductive traits measured at BCI.

**Methods – Selection of individuals**

We have collected plant reproductive parts opportunistically. We attempt to collect five mature fruit from five individuals of each species. This is easily accomplished for abundant species whose fruit can be reached or fall to the ground entire. This can be much more difficult for rare species and for tall species whose fruit rarely fall to the ground entire, and we have collected single fruit and even single diaspores for these species.

**Methods – Collection and storage of fruits and diaspores**

We place fresh fruit or diaspores into sealed 'Ziploc' bags. The collector often lacks an ice chest because most collections are made opportunistically. Instead, the sealed bags are placed in a refrigerator or freezer within six hours of collection. Refrigerated samples are processed with 48 hrs. Frozen samples are processed within two months.

**Methods – Dispersal mode**

Cornelissen et al. (2003) distinguish eight relevant dispersal modes. These are unassisted dispersal (gravity dispersed), wind dispersal (anemochory), internal animal transport (endozoochory), external animal transport (exozoochory), dispersal by hoarding (dyszoochory), ant dispersal (myrmecochory), water dispersal (hydrochory), and dispersal by launching (ballistichory). A ninth dispersal mode (bristle contraction) is absent

from tropical forests. Species are assigned to dispersal mode on the basis of fruit traits. Cornelissen et al. (2003) provide brief descriptions of these fruit traits, which are well known to botanists.

**Methods – Diaspore shape**

Diaspore shape is the variance of diaspore length, width and depth (or thickness), where the variance is taken after dividing each measurement by length. This standardized measure of diaspore shape varies between 0 and 1. Fruit flesh, pappus and other loose parts are removed and dial calipers are used to measure length, width and depth (Cornelissen et al. 2003). Miles Silman (silmanmr@wfu.edu) provided diaspore length, width and depth determined from specimens in the BCI herbarium.

**Methods – Diaspore mass**

We record fresh diaspore mass because fresh mass is relevant at the time of dispersal. We also record standard dry mass after drying at 60C for at least 72 hrs (Cornelissen et al. 2003). We have found that the largest diaspores can require significantly longer to reach constant mass.

**Methods – Additional measurements to inform seed trap studies**

We begin with an entire fruit and proceed through the following steps:

1. weigh the fresh fruit
2. dissect the fruit
3. weigh four randomly chosen fresh diaspores
4. count the number of filled seeds, empty seeds and capsules (Capsules are defined below.)
5. weigh four randomly chosen fresh seeds where seed refers to embryo plus endosperm
6. place all parts in a drying oven at 60C until mass is constant
7. weigh the dry fruit, four diaspores and four seeds

Appendix G presents the full data form.

We use numbers of seeds and capsules per fruit to be able to convert the fruit, seeds and capsules captured in seed traps to common units (either number of fruit or number of seeds). We use capsules to quantify the numbers of fruits and seeds consumed by arboreal and volant animals. Our capsules are identifiable to species and are never consumed by animals. The capsule might be a pedicel, bract, valve or a part internal to the fruit. Photographs of capsules, fruits, diaspores and seeds of BCI species can be found at the following web site: http://striweb.si.edu/esp/tesp/plant_search_quick.htm. We measure masses of seeds, diaspores and fruit to be able to evaluate biomass allocation to the seed versus other parts of the diaspore and fruit. We determine fresh and dry masses to capture masses relevant to frugivores and to dispersal agents.

Appendix G. The data form used to record fruit, diaspore and seed traits on BCI. Each line represents one fruit. The data form extends to a second page for each fruit. The final five columns are only used when it proves to be impossible to dissect the botanical seed (embryo plus endosperm) away from surrounding tissues (testa or seed coat, endocarp or both). In this case, the column headed "tipo de semilla" identifies precisely what was weighed under the columns headed "peso de semillas frescas" and "peso de semillas secas" and the columns headed "peso de testa seca" are for the dry weights of the testa or seed coat, endocarp or both. A key to the possible values of "tipo de semilla" is presented beneath the second page of the data form. We have not used "4. plantula" (we had intended to germinate the smallest seeds and weigh the seedling immediately – this has not been successful).

| | | PESO DE | FRUTO | # SEMILLAS | | # | PESO DE DIASPORAS FRESCAS | | | | PESO DE DIASPORAS SECAS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDIV | FECHA | FRESCO | SECO | LLENAS | VACIAS | CAPS | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
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| | | PESO DE SEMILLAS FRESCAS | | | | PESO DE SEMILLAS SECAS | | | | TIPO DE | PESO DE TESTA SECA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDIV | FECHA | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | SEMILLA | 1 | 2 | 3 | 4 |
| | | | | | | | | | | | | | | |
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TIPO DE SEMILLA: 1=ENDOSPERMA+EMBRIA; 2=1+TESTA; 3=2+ENDOCARPA; 4=PLANTULA / CUENTA DE SEMILLAS PESADAS