The Importance of Leaf Demographic Data to Accurate Calculations of Annual Production by Sawgrass (*Cladium jamaicense*) in Freshwater Everglades Wetlands

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Abstract

Net annual primary productivity (NAPP) is an important measure of ecosystem energetics, and its near-universality allows cross-comparison among a tremendous variety of ecosystems. As part of the FCE LTER Program, we are currently quantifying NAPP of sawgrass (*Cladium jamaicense*)—the dominant macrophyte in freshwater Everglades wetlands. A reliable estimation of mortality is critical to these measures of NAPP. We have been quantifying leaf turnover data to best estimate this mortality term by following the demographics of individual sawgrass leaves on select plants (since August/99) in the Taylor Slough/C-111 Panhandle region (Southern Everglades). All leaves were individually tagged as they emerged from the culm with small colored bands and counted bimonthly, allowing for each leaf to be tracked throughout its lifetime. From these data, we calculated new leaf production, leaf mortality (the key term for our NAPP models), and sloughing rates. These rates were not significantly different across a variety of Southern Everglades sites. An average of one leaf was produced bimonthly, lived approximately 4.5 months, and remained on the plant for an additional 7 months until sloughing off. Leaf mortality rates were used in a multiple regression analysis in order to obtain an equation in which a mortality term can be calculated from turnover data at sites throughout the Southern Everglades. A temporal effect has also been detected in productivity, longevity, and loss rates. For example, leaf productivity is twice as high in July (0.50 leaves/month) than in December (0.25 leaves/month). Further work is being conducted in Shark River Slough.

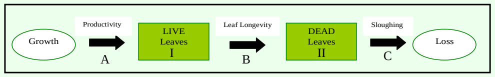

Figure 1. Box Model of Leaf Demographics of *Cladium jamaicense*.

Introduction:

Sawgrass (*Cladium jamaicense* Crantz) is the common and characteristic plant of the Everglades freshwater marsh ecosystem (Davis and Ogden 1994), covering 65-70% of the marsh in dense monospecific stands (Loveless 1959). This perennial sedge grows centripetally with a phyllotaxy of I/3 and as new leaves emerge, older leaves move to the outside. New leaves are continuously being thrust up into the center of the cone while older leaves' attachment to the stock becomes pushed farther and farther away from the growing point. As leaves grow older they separate from the cone and may remain green but eventually the tips of the leaves brown and withering proceeds to the base until all of the chlorophyll is destroyed. When completely brown, the aerial portion of the leaf breaks or erodes until a dead base is left on the plant (Conway 1936). Leaf production, growth, and mortality continue throughout most of the plant's life span as its biomass increases and/or decreases (Davis 1989).). However, little or no research has focused on the rates of leaf turnover on a small scale. This study intends to quantify leaf productivity, longevity, and sloughing rates (Figure 1: A, B, and C), which will provide an estimate of mortality, which is needed, along with biomass and turnover (Figure 1: I and II) data, in order to calculate net annual primary productivity (NAPP). An estimate of NAPP is important because the sawgrass community is among the most productive systems in the United States with an NAPP of 2991± 891 g DWm-2y-1 (Daoust and Childers 1998) and 802-3035 g DW m-2y-1 (Davis 1989) that is attributed to *C. jamaicense* alone (Daoust and Childers 1999).

Methods:

We calculated the mortality term of our NAPP model by following the demographics of individual leaves on select sawgrass plants (from August 1999 to January 2002). Three tagged turnover plants in each 1m^2 plot at select sites were haphazardly selected (1 each small, medium, and large) and leaves were individually tagged with colored bird bands in a color series (Figure 2). Leaf age was determined by relative location on the culm. Each leaf was tagged according to its relative age, using this color series, allowing us to track each leaf throughout its lifetime. A leaf was determined to be "live" if there was any green color, and we measured the length of all live leaves plus the culm diameter at the base of the tagged plants. Leaf longevity was the time a leaf remained "live" after separating from the main stem, and sloughing rate was calculated from time a "dead" leaf remained on the plant (determined if a tagged leaf could not be located). We identified and tagged new leaves when they separated from the stem.

Figure 2. Colored bird bands were used to track individual sawgrass leaves throughout their lifetime.

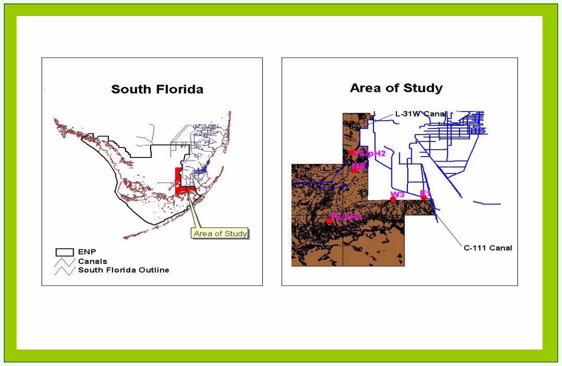

Figure 3. Study Area in the Florida Southern Everglades Taylor Slough/C-111 Panhandle Region.

Study Area:

This study was conducted in the southeastern Taylor Slough/C-111 Panhandle drainage basin of Everglades National Park (Figure 3), an area covered predominantly by sawgrass marshes, tree islands, wet prairies, and slough communities (Loveless 1959). Water levels are typically provided by direct rainfall, rising and falling with the accompanying June-November rainy seasons and December-May dry seasons (Davis 1989). All sample sites were used in conjunction with ongoing monitoring efforts by Childers. Two sample sites, in an East-West direction (E1 and W3), were located parallel to the C1-11 canal in the southeast Panhandle region (C1-11 Basin). The remaining three sample sites, in Taylor Slough Basin, were placed in a North-South direction (TS/pH2, ME, and TS/pH3). Each sampling site contained established triplicate square meter plots of sawgrass; each containing ten individually tagged turnover plants.

Results and Discussion:

New leaf production (Figure 1: A), mortality (Figure 1: B), sloughing rates (Figure 1: C) were calculated for all five sites (Figure 4). No significant differences were found between any of the sites. New leaf production rates were calculated by averaging the number of new leaves produced per month. New sawgrass leaves are produced every 0.45 months in the southern Everglades (Figure 5). Leaf productivity is twice as high in July (0.50 leaves/month) than in December (0.25 leaves/month). Leaf mortality or death was calculated for each month (Figure 6) and Sloughing rates were also calculated (Fig. 7). All three rates were similar across the three years of the study.

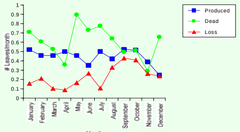

Figure 4. Leaf Demographics. Average number of leaves produced, died, and were lost per month.

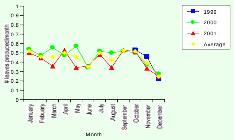

Figure 5. Leaf Productivity. Average number of new leaves produced per month

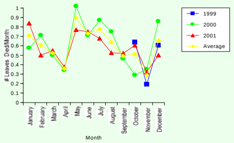

Figure 6. Leaf Mortality. Average number of leaves that died per month.

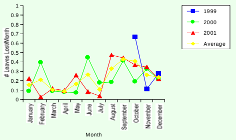

Figure 7. Leaf Loss. Average number of leaves lost per month.

The percentage of leaves that died from the previous sampling was used in a multiple regression analysis in addition with change of live and dead leaves (turnover data) in order obtain an equation in which a mortality term can be calculated from turnover data (Figure 1: I and II) at sites throughout the southern everglades :

% Mortality = (Δ in Dead)(0.059) - (Δ in Live)(0.039)   n = 472; P-value < 0.0001; R2 = 0.233

This % mortality term can then be multiplied with standing biomass to get a mortality term, which in turn can be used to calculate NAPP for the past five years.

In addition, green leaf and dead leaf longevity rates were calculated from average leaf longevity of leaves (live or dead), or how long a leaf was alive or remained on the culm respectively. On average, leaves died 4.41 months after separating from the culm (Figure 8). Dead Leaf longevity was determined from the length of time a leaf stayed attached to the culm after it had died, on average sawgrass leaves remained on the culm 6.90 months before sloughing off (Figure 9). Although, there are leaves at present on plants that have still not sloughed off and have lasted on the plant for over 20 months. Further work is being done in Shark River Slough (since November 2000).

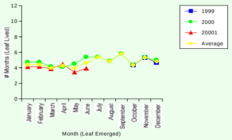

Figure 8. Green Leaf Longevity. The month a leaf separated from the culm determined its longevity.

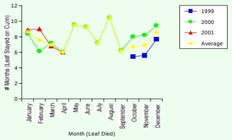

Figure 9. Dead Leaf Longevity. The month a leaf died determined how long the dead leaf remained attached to the culm.

Literature Cited:

Conway, V. M. 1936. Studies in the autecology of *Cladium mariscus*. The New Phytologist 35:177-205.

Daoust, R. J., Childers, D. L. 1998. Quantifying aboveground biomass and estimating net aboveground primary production for wetland macrophytes using a non-destructive phenometric technique. Aquatic Botany 62:115-133.

Daoust, R. J., Childers, D. L. 1999. Controls on emergent macrophyte composition, abundance, and productivity in freshwater Everglades wetland communities. Wetlands 19:262-275.

Davis, S. M. 1989. Sawgrass and Cattail production in relation to nutrient supply in the Everglades. p. 325-341. In: Freshwater Wetlands and Wildlife: Proceedings of a symposium held at Charleston, South Carolina, march 24-27, 1986. Sharitz, R. R. and Gibbons, J. W. (eds.). U. S. Department of Energy, Virginia.

Davis, S. M., Ogden, J. C. (eds.) 1994. Everglades: The ecosystem and its restoration. St. Lucie Press, Delray Beach, FL. USA.

Loveless, C. M. 1959. A study of the vegetation in the Florida Everglades. Ecology 40:1-9.

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