SEED BANK COMPOSITION ALONG A PHOSPHORUS GRADIENT IN THE NORTHERN FLORIDA EVERGLADES

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Abstract: Seed-bank samples were collected in the northern Everglades along a phosphorus gradient with three vegetation zones (cattail with the highest phosphorus levels, mixed cattail-sawgrass (transition), and sawgrass with the lowest phosphorus levels). The size and composition of the seed banks were estimated using both a direct seed separation (seed assay) and a seedling emergence technique (seedling assay). In the seedling assay, seed-bank samples were kept under two moisture regimes, saturated soil and shallowly flooded. In the seed assay, whole seed of 21 species were found, with a mean of about 8 species per sample in the cattail zone and about 5 in the transition and sawgrass zones. On the basis of their appearance, seeds of 18 species were judged to be intact, that is, probably viable. There were about 7 species per sample with intact seed in the cattail zone, and 3 and 4 in the transition and sawgrass zones, respectively. In the seedling assay, seedlings of only 11 species were found. All 11 were found in the saturated soil treatment, and 7 were also found in the shallowly flooded treatment. In the seed assay, the mean total number of whole and intact seeds in the cattail zone was estimated to be 78,400 and 44,400 seeds m\(^{-2}\), respectively. The mean total number of whole and intact seeds in the transition zone was much lower, 14,200 and 10,500 seeds m\(^{-2}\), respectively, and in the sawgrass zone, it was slightly higher at 20,900 and 14,700 seeds m\(^{-2}\), respectively. In the seedling assay, seed densities were much lower and were estimated to be only 3,700, 800, and 1,300 seeds m\(^{-2}\), respectively, in the cattail, transition, and sawgrass zones. The seedling assay results suggest that only about 1.3% of the intact seed had germinated. Overall, the composition of the seed banks of the transition and sawgrass zones were not significantly different from one another, but they were significantly different from that of the cattail zone. Seeds of several species were restricted primarily or exclusively to cattail-dominated areas, including seeds of Typha sp.

Key Words: dispersal, establishment, Everglades, Florida, plant invasion, seed bank, seed germination, wetlands

INTRODUCTION

Seed banks play a central role in vegetation dynamics of many wetlands. As environmental conditions change and established species are eliminated, species adapted to the new conditions often are recruited quickly from the seed bank (van der Valk and Davis 1978, van der Valk 1981, Pederson and van der Valk 1984). Consequently, seed bank data, because they can be used to predict seedling recruitment patterns, are an important component in many models of wetland vegetation dynamics (van der Valk 1981, Poiani and Johnson 1993, Stockey and Hunt 1994, Ellison and Bedford 1995).

Over the last 25 years, changes in the vegetation of the northern Everglades, especially the replacement of Cladium jamaicensis Crantz, sawgrass, by Typha domingensis Pers., cattail, have been hypothesized to be due to an increase in phosphorus inputs into the Everglades (Koch and Reddy 1992, Urban et al. 1993, Davis 1994, DeBusk et al. 1994, Jensen et al. 1995). This study was designed to examine the composition of the seed banks along the phosphorus gradient in Water Conservation Area 2A (WCA-2A) in the northern Everglades. Prior to this study, there was nothing known about the species composition and size (seeds m\(^{-2}\)) of the seed banks of different plant communities in the Everglades. The only previous studies had been of the seed germination characteristics of individual species, e.g., those of Cladium jamaicensis by Ponzio et al. (1995).
The primary objective of this study was to determine the species composition and size of seed banks at 13 sampling sites along three permanent transects (E, F, and U) in WCA-2A (Figure 1). These transects were established by the South Florida Water Management District to examine the effects of phosphorus enrichment in areas where canals carrying water from the Everglades Agricultural Area enter the northern Everglades. [For a description of the hydrology and recent changes in the vegetation of WCA-2A, primarily the spread of *Typha domingensis*, attributed to increased phosphorus inputs, see Urban et al. (1993) and Jensen et al. (1995)]. Two of these transects (E and F) begin in cattail-dominated areas with high phosphorus and end in sawgrass-dominated areas with low phosphorus levels. The effects of cattail invasion on the composition and size of the seed banks of the northern Everglades were the primary foci of this study. We specifically wanted to determine if seeds of *Typha* are found in the seed banks of areas currently not dominated by this species.

Two methods were used to estimate the composition and size of the seed banks: a direct seed separation technique, which is referred to as the seed assay, and a seedling emergence technique, which is referred to as the seedling assay. Previous studies with wetland and terrestrial seed banks that used both of these techniques indicate that they give similar, but not identical, results. The seed assay generally gives higher estimates of seed density, while the seedling assay tends to detect more species (e.g., Poiani and Johnson 1988).

By using both methods, it is also possible to estimate the germinability of the seeds of different species in the seed bank, which provides a crude measure of the relative ability of species to become established.

**METHODS**

**Seed Bank Collection**

Seed-bank samples were collected in WCA-2A along transects E, F, and U between November 6 and 8, 1995. A clear plastic tube, 5 cm in diameter, was pushed into the substrate by hand to collect core samples. A number of small samples were collected and composited as recommended by Bigwood and Inouye (1988). Specifically, at each sampling site at a randomly chosen spot, five cores to a depth of 10 cm were collected more-or-less equally around the periphery of an air boat, and five more were collected in the same pattern 15 to 20 m from the first five. The ten cores collected at a site were composited as they were being collected, and the composite sample stored in a cooler on ice.

Test corings indicated that, because of the thickness of the flocculant layer in cattail-dominated areas, cores needed to be 10 cm deep to contain at least 2 cm of consolidated substrate, which was necessary for them to be collectable. All core samples in areas not dominated by cattail also were taken to a depth of 10 cm. Periphyton mats, although collected while coring in areas dominated by sawgrass, were not considered as part of seed-bank sample because they are seasonal in occurrence and vary in their position in the water column. In other words, these cores were taken to a depth of 10 cm in the substrate irrespective of the thickness of the periphyton layer.

Seed-bank samples were collected at 13 sites, 5 along transects E and F and 3 along transect U. This resulted in four samples in the cattail zone, four in the transition zone, and 5 in the sawgrass zone (Figure 1). At site F5, a second sample was collected in a nearby slough, i.e., an area free of emergent vegetation. Data from the slough site have not been included in the analysis of the composition of the seed banks in the three vegetation zones. They have been included in analyses of the overall characteristics of the seed banks of WCA-2A.

Seed-bank samples were kept in coolers on ice to prevent overheating and shipped in these coolers to Ames, Iowa by air. In Ames, the samples were stored in the dark in a cold room until processed. Seed-bank samples were first passed through a coarse sieve to remove rhizomes, roots, and other debris, and the sieved samples stored in plastic pails in the cold room. Water that accumulated above the surface of the sam-