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Title of Project: Final Report to The Nature Conservancy on the Restoration of Cypress Swamps along the Cache River, Southern Illinois;

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PROJECT SUMMARY

As part of the North American Waterfowl Management Plan, much of the Cache River region will be restored to bottomland hardwood forest and is currently being purchased by public and private agencies (U.S. Fish and Wildlife Service 1990). While sedimentation and water quality problems threaten the natural character of the remaining swamps in the Lower Cache River (Demisse 1992), currently less than 35% of the entire Cache River region is used for agriculture. Since most of this area will eventually be under public ownership, it is possible that the hydrological character of parts of the Cache River region can be restored. Natural restoration of the vegetation is doomed, however, without a thorough understanding of the relationship of hydrology and seed dispersal.

Currently, habitat islands of cypress (*Taxodium distichum* L.) swamp exist along a riverine corridor supplying a potential seed source for restoration of these areas. However, this project has shown that the seeds from these swamps are not reaching the farmed areas because their seed banks are devoid of cypress swamp species. Seed dispersal studies in this project have shown that seeds of swamp species travel in the river however, indicating that restoration of the seed bank and vegetation could follow hydrologic restoration. This study will provide an understanding of the relationship of flooding in cypress swamp hydrology with seed dispersal in order develop a less expensive and more effective way to restore cypress swamps than hand planting of a limited number of species. Funding from the Nature Conservancy for this project has provided funds for undergraduates to participate in this project.

PROJECT DESCRIPTION

Study Rationale

Restoration of cypress swamps is as much a question of hydrology as biologic processes in southern bottomland forests. Seeds move in the river from cypress swamps during peak flooding, which is usually in the winter (Schneider and Sharitz 1988). In portions of the Cache River where hydrology will be restored, the natural restoration of farmland to cypress swamp can be achieved simultaneously, if the river water is laden with swamp seeds.

Study Area

The Cache River area in southern Illinois (Fig. 1) was once an extensive region of cypress and mixed hardwood swamp of approximately 250,000 hectares in the northernmost region of the Gulf Coastal Plain (Ugent *et al.* 1981) before its extensive alteration for agriculture. Agricultural development by clearing and drainage began in the Cache River area in the late 1800's though most of the area was drained in the 1930's. The Post Creek Cutoff, built in about 1916, was only partially successful in draining the area, but it did alter the flow pattern of the Lower Cache River (Demissie *et al.* 1990). Altogether, 50% of the area has been farmed in the past, but even before the governmental land acquisition began, 15% of the farmland had been abandoned (U.S. Fish and Wildlife Service 1990).

Objectives

The specific objectives of my ongoing work have been to:

1. assess which species of cypress swamps are present in the soil after farming,

2. observe the timing of the movement of seeds in the river, and

3. document hydrologic alteration in the region by documenting drainage activities from 1940-1990 by analyzing images from aerial photographs processed with a Map Image Processing System (M.I.P.S.).

Specific Findings

In the first year of this project, I examined the nature of the seed bank in these areas. I have found that only the seeds of a few herbaceous species remain in the soil of farmed lands. Wetlands in the prairie pothole region which have been drained for more than 20 years have only 60% of the species of undrained wetlands (Wienhold and van der Valk 1989). My studies suggest that cypress swamps suffer an even greater toll, in that, all of the dominant woody species of the swamps, including cypress, tupelo, and overcup oak disappear in less than 5 years after farming begins. All characteristic herbaceous species also disappear from the seed bank during farming including featherfoil (*Hottonia inflata* Ell.) and frog's bit (*Limnobium spongia* (Bosc.) Steud.; Table 1). Only a select group of wetland species maintain themselves in the seed bank during farming including rice cut grass (*Leersia oryzoides* L.) and sedge (*Eleocharis obtusa* L.).

The seed bank is lost within the first year of farming as shown in the second seed bank study. Most of the species of cypress swamps have seeds which are extremely short-lived, especially the trees and shrubs (Figs. 1 & 2). In addition, I have watched farmers prepare swamps for farming and have observed that they scrape the surface 6-12 inches of soil with a bulldozer. This removes the viable seed bank. Both of these factors contribute to the near absence of cypress swamp species in the seed bank of farmed swamps targetted for restoration.

Because cypress swamps lie along riverine corridors, it would seem likely that seeds of the species of cypress swamps could spread during peak hydrologic flow during the winter to replenish the seed bank. Cypress seeds are shed then, and are spread distances of up to 1800 m through the floodplain (Schneider and Sharitz 1988). While viable seeds of at least 30 species of trees, shrubs (Figs. 1 & 2) and many herbaceous species are spread via the river, only a few the herbaceous species and none of the tree and shrub species find their way to farmed areas. This would indicate that the main problem in natural restoration of farmed areas is hydrologic alteration. The analysis of aerial photos from 1940-1990 show the extensive hydrologic alteration of the region.

Future Research

In order to determine the relationship of flooding and seed dispersal, the seed content of flood water from the Cache will be sampled with nets in 20 transects running perpendicular to the river channel at 5 m intervals starting at the edge of the flood sheet to the channel of the Cache (Figure 3). It is likely that flood water carries seeds to the edge of the flood sheet and then drops them at the point farthest from the channel. The seeds collected will be tested for viability using

tetrazolium. Means of seed density for each species will be estimated for various distances from the river channel.

This information will be used to create a model of a seed dispersal for each species overlain against various flood events for 1 year. The extent of the flood sheet will be estimated by relating gage height to topographic relief. Topographic maps will be scanned using a Map Image Processing System (M.I.P.S.) and overlain with mean seed density estimated at distances from the channel for various flooding episodes. Similarly, the spread of the historical flood sheet will be estimated by using maximum gage heights in the Cache River near Forman, Illinois (Table 2), related to U.S.G.S. topographic maps for areas near the gage and mapped using a scanned image of the U.S.G.S. map.

If substantial portions of farm fields historically have not received overflow from the river, then it is possible that overflow is not able to bring seeds to these farmed sites given current hydrologic conditions.

2.6 Tables and Figures

Table 1. Species in the seed banks of cypress swamps and farming as based on the ongoing study in the Cache River Region, southern Illinois. Group 1 are species characteristic of cypress swamp never found in farmed fields and Group 2 species are found in all swamps whether farmed or not.

Species	Not Farmed	Farmed ≤10 yrs	Farmed >10 yrs
Group 1			
Alisma plantago-aquatica	x		
Cephalanthus occidentalis	x		
Hottonia inflata	x		
Limnobium spongia	x		
Sium suave	x		
Group 2			
Cyperus erythrorhizos	x	x	x
Leersia oryzoides	x	x	x
Eleocharis obtusa	x	x	x
Ludwigia glandulosa	x	x	x
Riccia macrocarpa	x	x	x
Veronica peregrina	x	x	x
Group 3			
Ammannia auriculata		x	x
Ammannia coccinea		x	x
Callitriche heterophylla		x	x
Group 4			
Agrostis perennis			x
Alopecurus carolinianus			x
Echinochloa crus-galli			x
Eclipta prostrata			x
Euphorbia marginatus			x
Galium tinctorum			x
Gratiola virginica			x
Hypericum mutilum			x
Juncus bufonus			x
Ranunculus scleratus			x

Table 2. Maximum gage height and discharge rate for the Cache River near Forman, Illinois from 1982-1991. All data are from the U.S.G.S. Water Data Reports (Stahl *et al.* 1982-1988; Maurer *et al.* 1989-91).

Date	gage height	discharge rate
February 2, 1982	26.3 ft	7280 ft^3 sec^{-1}
December 27, 1983	25.8 ft	7020 ft^3 sec^{-1}
November 28, 1984	14.7 ft	2040 ft^3 sec^{-1}
April 2, 1985	23.3 ft	5540 ft^3 sec^{-1}
May 18, 1986	21.7 ft	4740 ft^3 sec^{-1}
February 28, 1987	13.0 ft	1650 ft^3 sec^{-1}
December 26, 1988	14.9 ft	2450 ft^3 sec^{-1}
February 16, 1989	22.2 ft	5080 ft^3 sec^{-1}
May 19, 1990	16.4 ft	2920 ft^3 sec^{-1}
December 31, 1991	17.4 ft	3000 ft^3 sec^{-1}

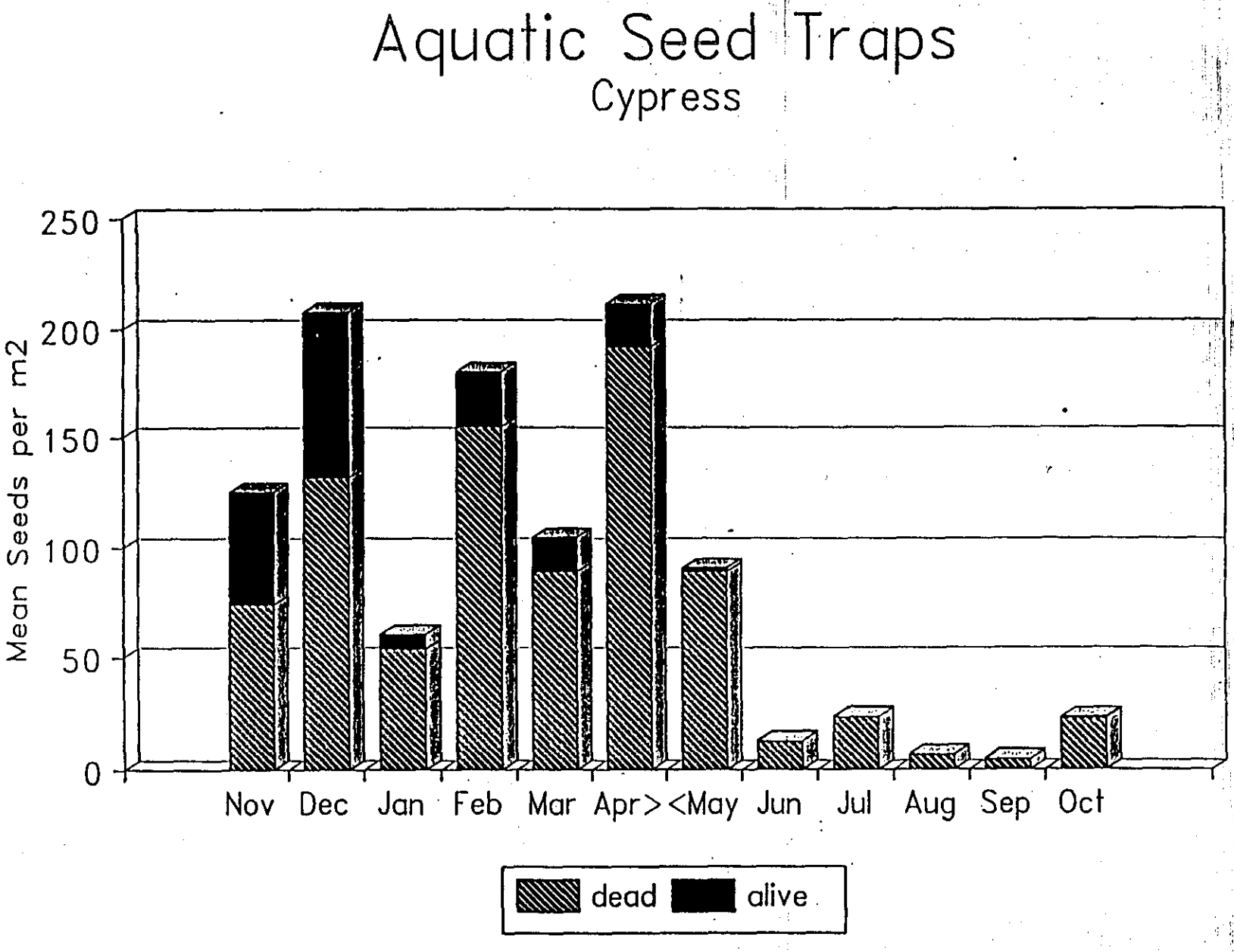

Figure 1. Seasonal seed dispersal for cypress from November, 1991 through October 1992 in the Lower Cache River, Perks, Illinois.

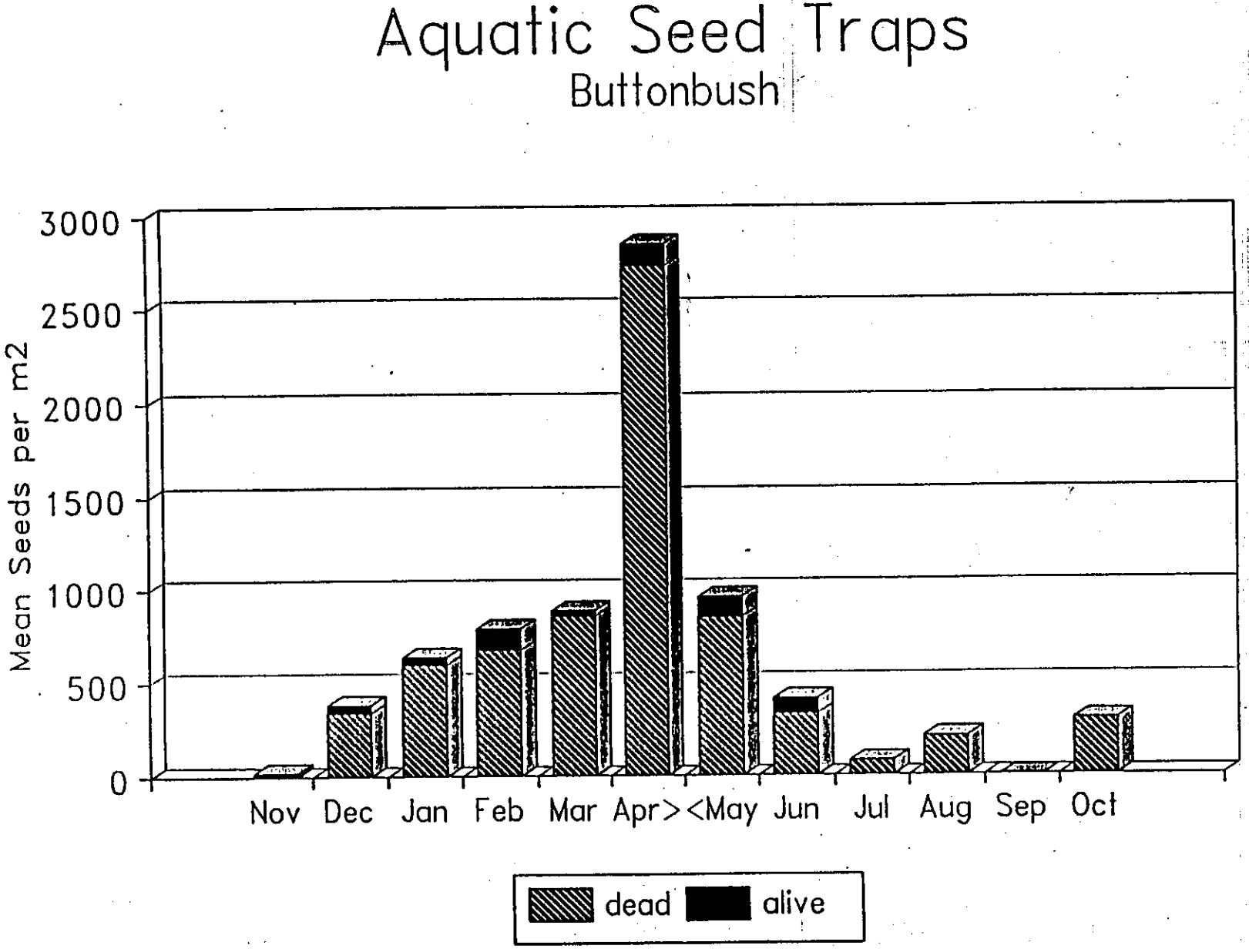

Figure 2. Seasonal seed dispersal for buttonbush from November, 1991 through October, 1992 in the Lower Cache River, Perks, Illinois.

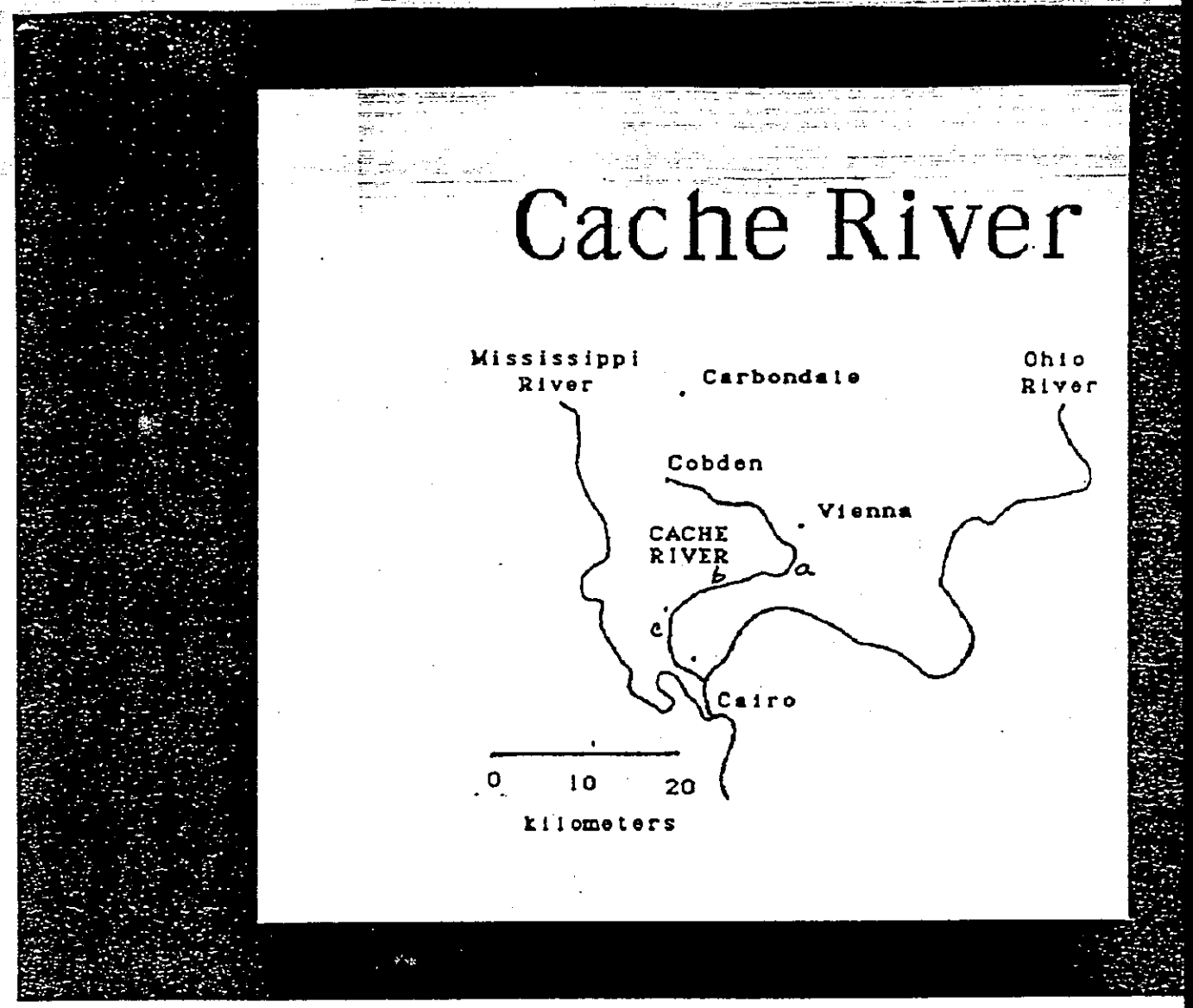

Figure 3. Map of the Cache River region. Study sites will be at Forman (a) and Tamms (c), Illinois.