ATTACHMENT 2

PONDBERRY PROFILE

FINAL REPORT

PONDBERRY PROFILE

ENDANGERED SPECIES STUDY

CONTRACT NO. DACW38-90-D-0003

DELIVERY ORDER NO. 12

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS

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APRIL, 1991

TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF PHOTOGRAPHS

LIST OF FIGURES

LIST OF TABLES

PONDBERRY PROFILE

I. INTRODUCTION

This report discusses the methods and findings of the Pondberry Profile Endangered Species Study undertaken by Geo-Marine, Inc. (GMI). This report was prepared for the U.S. Army Corps of Engineers, Vicksburg District, under Contract No. DACW38-90-D-0003, Delivery Order No. 012.

Descriptions of the general project background as well as the purpose of this study are given in this section of the report. Methods adopted and utilized during the investigation are discussed in Section II. Results of the Pondberry Profile Study are addressed in Section III while Section IV presents the study's conclusions and recommendations.

PROJECT BACKGROUND AND PURPOSE

The U.S. Army Corps of Engineers, Vicksburg District, is currently undertaking a comprehensive reformulation study of the Upper Yazoo and Steele Bayou flood control projects. These projects involve various structural measures such as levee construction and channel modifications. The purpose of these measures is to reduce the area inundated by flooding. As part of the reformulation process, the Vicksburg District is analyzing all potential environmental effects, both adverse and beneficial, that are expected with each of the alternative flood control measures.

One of the potential effects is associated with the endangered plant species, pondberry (Lindera melissifolia). The U.S. Fish and Wildlife Service (USFWS) listed the pondberry as endangered on 31 July 1986. Since there are known pondberry locations within the Mississippi Delta Region (ie. Delta National Forest), a potential

exists for proposed flood control measures to affect (adversely or beneficially) extant pondberry communities.

Therefore, the Vicksburg District, in an effort to allow an accurate assessment of potential effects, has engaged in this pondberry profile study. The overall goal of this project was to develop a profile of the pondberry's life requisites within Mississippi. The profile was to be developed through field data collected and analyzed from known pondberry colonies and from pertinent secondary sources. The profile could then be used to develop a stratified sampling scheme which could be applied to the Upper Yazoo and Steele Bayou basins.

II. METHODOLOGY

The procedures implemented in developing the pondberry profile can be grouped into three categories: 1) literature search and review, 2) expert consultation, and 3) field data collection and analysis. This section discusses the methods and procedures utilized in each category.

LITERATURE SEARCH AND REVIEW

GMI's literature search included a review of both published and unpublished documents which evaluate and describe pertinent data and known facts about pondberry. GMI's sources of published and unpublished literature included botanical and biological abstracts, university herbariums and their literature collections, the Mississippi Natural Heritage Program, the USFWS, personal consultation with university professors and the U.S. Army Corps of Engineers, Vicksburg District.

In order to obtain a broad understanding of pondberry, a wide array of information was sought such as known colony sites, associated vegetation, morphological characteristics, reproductive characteristics, associated habitats and other apparent life requisites.

An annotated bibliography of the documents reviewed is included in this report as Appendix A.

EXPERT CONSULTATION

In order to verify/refute information obtained from the literature review and to obtain additional unpublished information, persons expected to have extensive experience or interest in pondberry were consulted. Initial contact and subsequent consultation were made by telephone conversation. A list of names,

telephone numbers, and addresses of those persons found to have a keen interest and/or knowledge of pondberry was then developed.

These people were consulted prior to initiating field work for help in developing the field data sheet. In addition, the experts were invited to a workshop, conducted at the Vicksburg District, to provide a critical review of the profile developed by GMI and to form a consensus concerning potential impacts and sampling schemes for subsequent surveys. The workshop is discussed in further detail in Section IV.

FIELD DATA COLLECTION AND ANALYSIS

GMI, along with the Vicksburg District, determined that in addition to literature review and expert consultation, prudent and worthwhile methods of developing a profile of pondberry should involve an analysis of extant pondberry colonies within the Delta region of West-Central Mississippi. Numerous known colonies are found on the Delta Natural Forest (DNF) and on private lands in Bolivar and Sunflower counties, Mississippi north of the DNF.

Before attempting any fieldwork, GMI developed a list of various biological and ecological factors relevant to pondberry that could be evaluated either objectively or subjectively in the field. This list of parameters was developed through the aid of the Vicksburg District, information gleaned from the literature review, and from advice and suggestions obtained through expert consultation. After compiling an appropriate list of relevant biological and ecological factors, a field data form was developed to better facilitate data collection (Exhibit A).

As previously mentioned, data were collected from existing pondberry colonies within the DNF and on private lands in Bolivar and Sunflower counties, Mississippi. A team of three people

GEO-MARINE, INC.
PONDBERRY PROFILE FIELD DATA

Recorder:_____ Sampler(s):_____ Date:_____
Location:_____ Colony ID : _____ Plot Number: _____
_____

Plot radius = 37 ft. (0.1 acre)

GENERAL QUESTIONS

What is the distance (ft.) to the nearest body of water? . _____
(Measure in field or determine from map)

What is the relative elevation of plot center? . . . . . _____

What is the maximum water depth on the plot? . . . . . _____

What general soil type is present? . . . . . _____

What is the soil pH? . . . . . _____

Stand Maturity, most trees are (circle one). 6" DBH 6-18" DBH >18" DBH Mixed Sizes

Is there any evidence of past disturbance near the site? . . . Yes
(e.g. stumps from harvesting operations, beaver damage, etc.) No

ASSOCIATED VEGETATION

Percent Canopy Coverage (Using densiometer)
North reading_____East reading_____South reading_____West reading_____
Avg. Percent Canopy Cover _____

Overstory Species

Understory Species

Shrubs and Herbaceous Species

PONDBERRY COLONY DATA

Number of clumps . . . . . _____
Avg. number of stems within each clump . . . . . _____
Approximate total number of stems . . . . . _____
Number of female stems . . . . . _____
Average height of clumps (ft) . . . . . _____
Average groundline diameter of stems . . . . . _____
Apparent health of colony . . . . . excellent good fair poor

including an ecologist, forester, and biologist performed the data collection. Compartment maps supplied by the Forest Service and topographic maps supplied by the Mississippi Chapter of The Nature Conservancy delineating known pondberry colonies were used to facilitate colony location in the field. Because many of the colonies are in remote areas, the field team was required to conduct transects in the general vicinity in order to locate the colonies. Each colony located was thoroughly sampled by completing the field data form, given a colony ID number, and then properly mapped, if not done so, on the reference maps.

Soil samples were collected at each site (Photograph 1) and submitted to the Louisiana State University Soils Testing Laboratory (Baton Rouge) for analysis. Each soil sample was analyzed for pH, phosphorus, sodium, potassium, magnesium, calcium, percent organic matter and characterized for physical attributes (ie. silt, loam, clay, etc.)

Elevations and distance were measured using a combination of pacing, topographic map interpretation, and visual estimations. Where the latter was utilized, consensus among the field team members was required.

Canopy cover was measured with a densiometer near the center of each pondberry colony. Associate species were recorded within a 0.1 acre plot surrounding the colony center at each vegetational layer (i.e., overstory, understory, shrubs and ground cover).

With the exception of a few very large colonies, individual stems of each clump of pondberry were counted and recorded. Stems were considered an individual plant if there was no apparent connection to other stems at or near the ground surface. For this study, clumps were defined as groups of stems that were located at least 15 feet from each other.

Photograph 1. Soil sampling at pondberry colonies.

For large colonies, such as the one in the Dowling Bayou Greentree Reservoir, a 25 percent sample of the colony was counted, measured and recorded. The numbers were then extrapolated for the entire colony. However, each female stem was counted and recorded, regardless of the size of the colony. Female stems were identified by maturing fruit (Photograph 2) and/or fruit pedicels from 1990 and 1989.

The general health of the colony was a subjective value based upon the ratio of dying stems to live stems, physical appearance of the leaves and stems, the density of the colony and the magnitude of insect damage (Photograph 3).

Pertinent quantitive field data were compiled from the field data sheets and statistically analyzed using the PARADOX$_{TM}$ computer software program. The analyses performed included means and standard deviation values of each parameter as well as pair-wise correlations for all variables.

Because herbaceous species are seasonal and are not possible to accurately identify in bottomland hardwood communities using remote sensing techniques, they would lack relative importance to developing a stratified sampling scheme. Consequently, herbaceous species were not included in the statistical analysis. Similarly, most of the woody vines, such as poison ivy (Rhus radicans), trumpet creeper (Campsis radicans), and grape (Vitus spp.) were not included in the statistical analysis because of their cosmopolitan habitat requirements.

Photograph 2. Pondberry fruit.

Photograph 3. Spicebush swallowtail caterpillar (Pterourus troilus) on pondberry.

III. RESULTS OF PONDBERRY PROFILE

This section details the findings of the Pondberry Profile Endangered Species Study. The results are presented in three subsections:

1) General
2) Physical Data
3) Biological Data

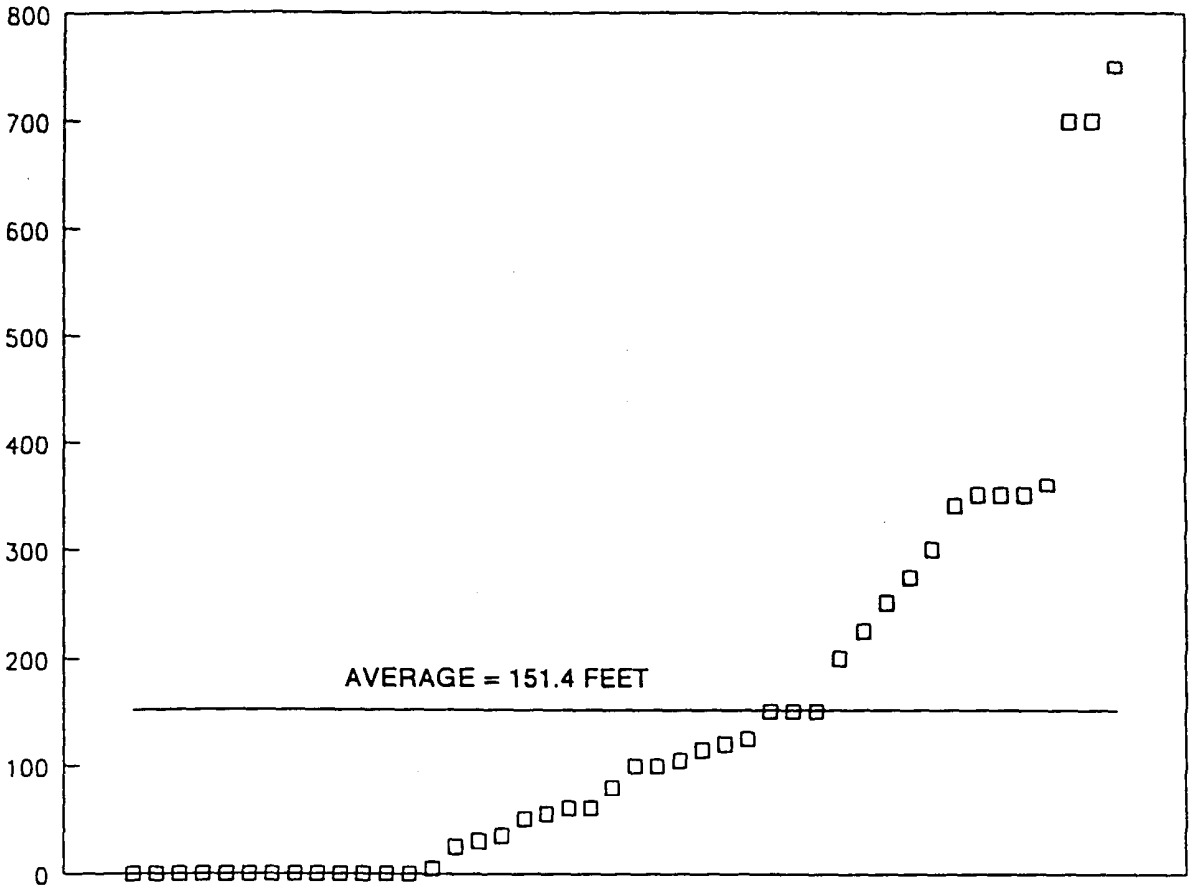
GENERAL

A total of 44 pondberry colonies were visited, only three of which were not located in the DNF. These three colonies were on private lands that supported small (less than five acres) remnant bottomland hardwood communities surrounded by croplands, primarily cotton and soybeans. The DNF is comprised of bottomland hardwoods with isolated and limited stands of cypress/tupelogum swamps.

PHYSICAL DATA

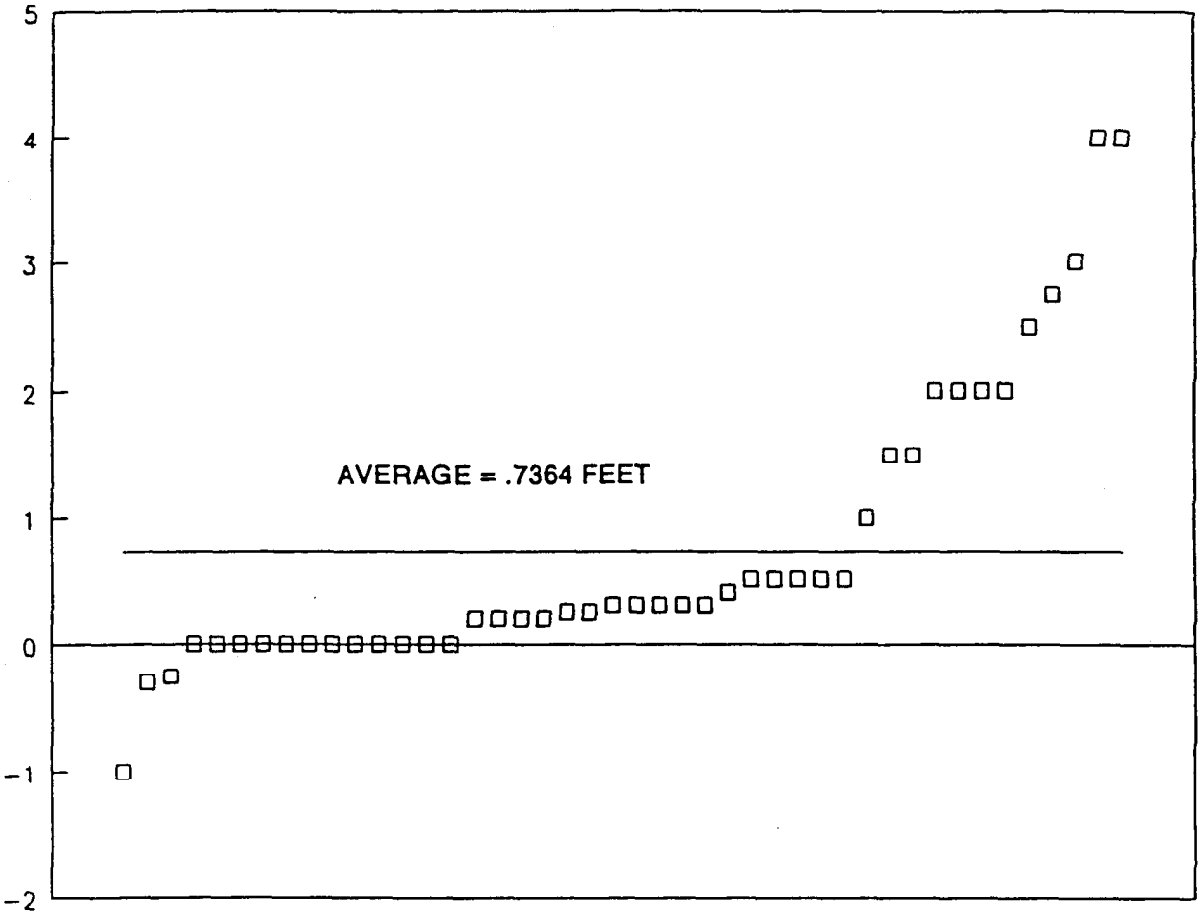
The average distance of a colony from a "permanent" or standing body of water was 151.4 feet. This distance is skewed due to three colonies which were in excess of 700 feet from a waterbody. Without these three colonies, the average distance would be 110 feet. Of the 44 colonies, 14 (32 percent) were within five feet of a waterbody. Figure 1 illustrates the distribution of each colony relative to its proximity to waterbodies.

The average elevation of the colonies, relative to the surrounding land, was 0.7 feet higher (Figure 2). Twelve colonies (27 percent) were in areas with no immediate topographic relief. Three colonies were in a slight depression area ranging from three to 12 inches lower than the surrounding land. Contrarily, nine colonies were on knolls/ridges that were two to four feet higher than the surrounding lands.



Source: GMI

Figure 1. Distance between pondberry colony and waterbody (in feet).



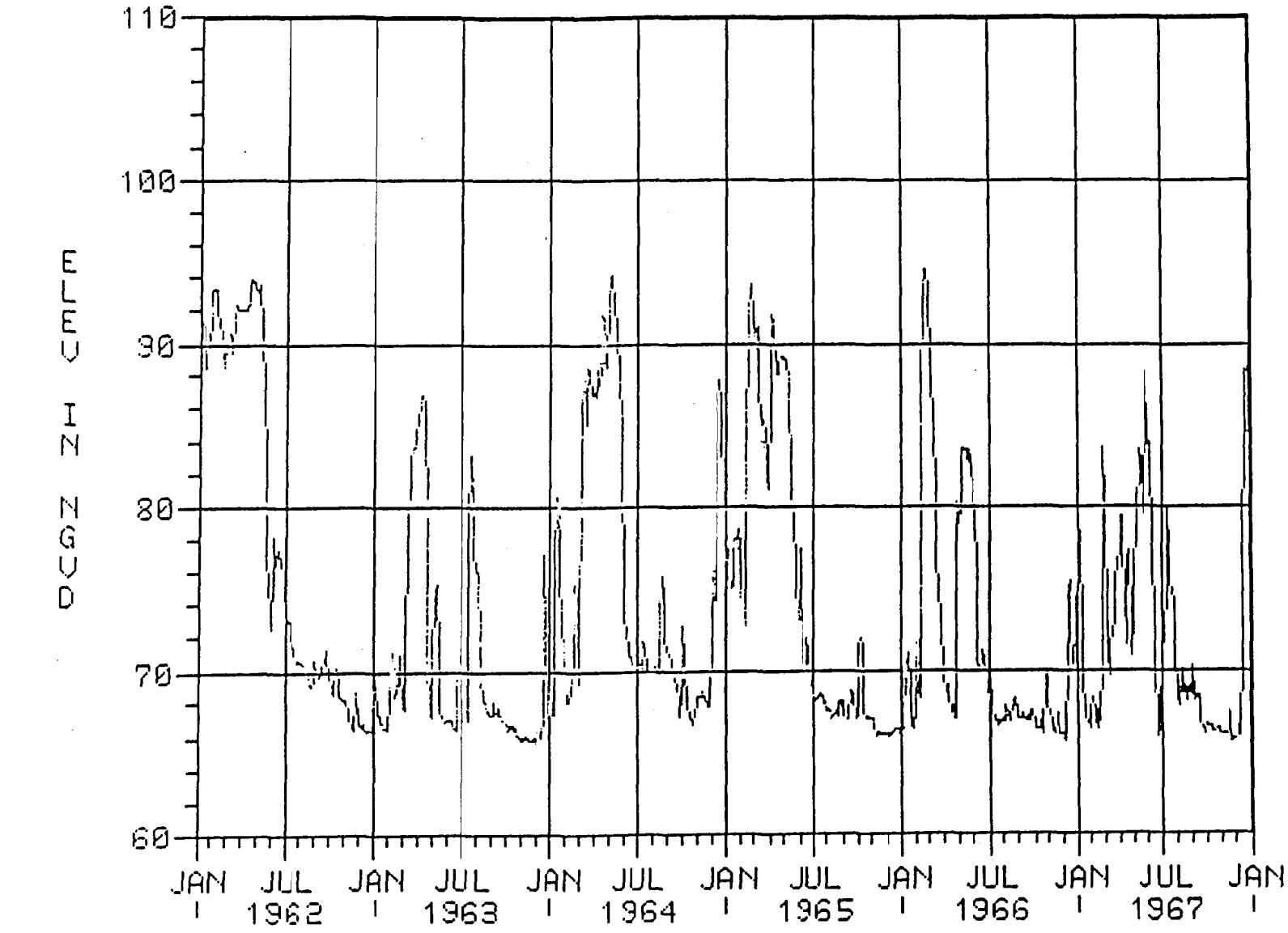
Source: GMI

Figure 2. Relative elevation of plot center for surrounding lands (in feet).

The approximate elevations of the 44 colonies sampled ranged from 91 to 145 feet National Geodetic Vertical Datum (NGVD). The elevation of the 39 colonies sampled on DNF ranged from 91 to 98 feet NGVD, with the average elevation of these colonies at 95.2 feet NGVD. Of the 39 colonies on DNF, 34 colonies (87 percent) were at elevations at or greater than 94 feet NGVD. This average elevation indicates that these colonies are above the 15-20 year floodplain of the Big Sunflower River, the main drainage system of the DNF. Water elevations on the Big Sunflower River for the period 1962-1990 are presented on Figure 3. As can be seen from this figure, river stages greater than 94 feet occurred only five times during the past 30 years and for very short durations during each occurrence.

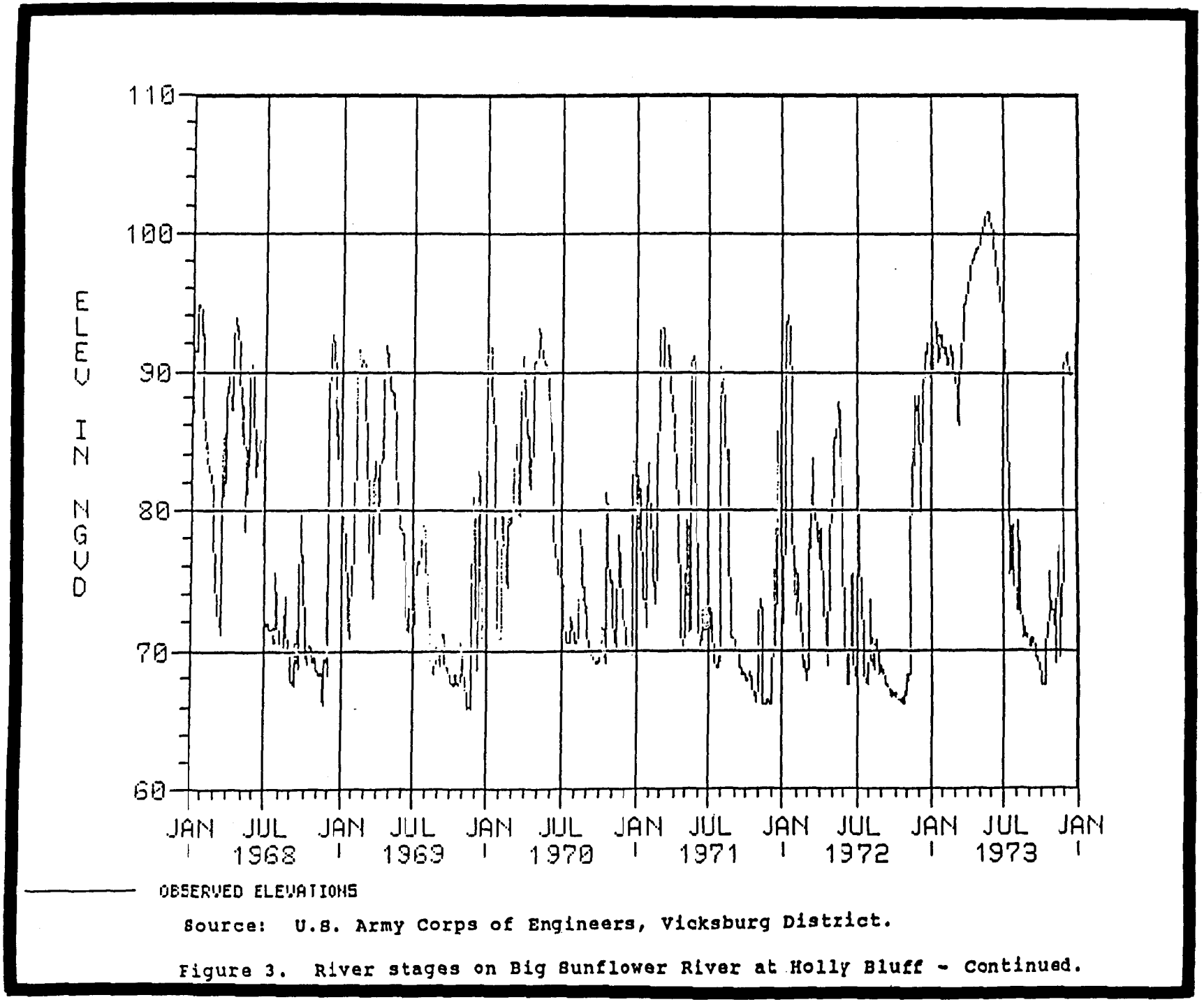
Although the majority of the colonies were in proximity to standing water and in relatively flat areas, 32 of the 44 colonies (73 percent) had no indication of standing water within the colony. The remaining 12 colonies had evidence of standing water ranging in depth from 1.5 to six inches (Figure 4).

Silt comprised a major portion of the soils at all the colony sites. Approximately 41 percent of the colonies were located in soils classified as silty clay and about 32 percent were situated in silty clay loam soils. The remaining 27 percent of the colonies were located in silt loam soils. A summary of the results of the soil chemical analyses of the 44 soil samples collected is presented in (Table 1).



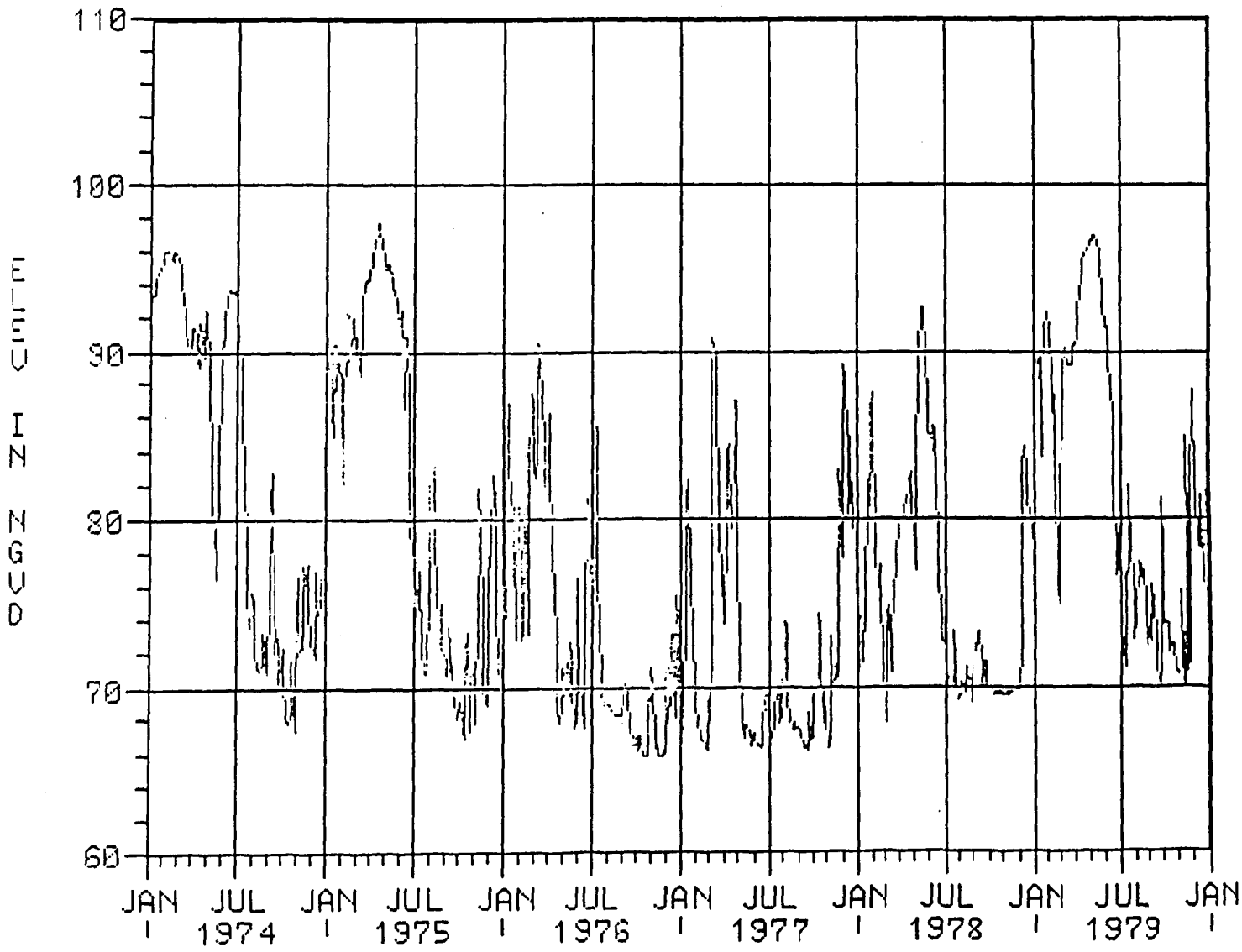
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff



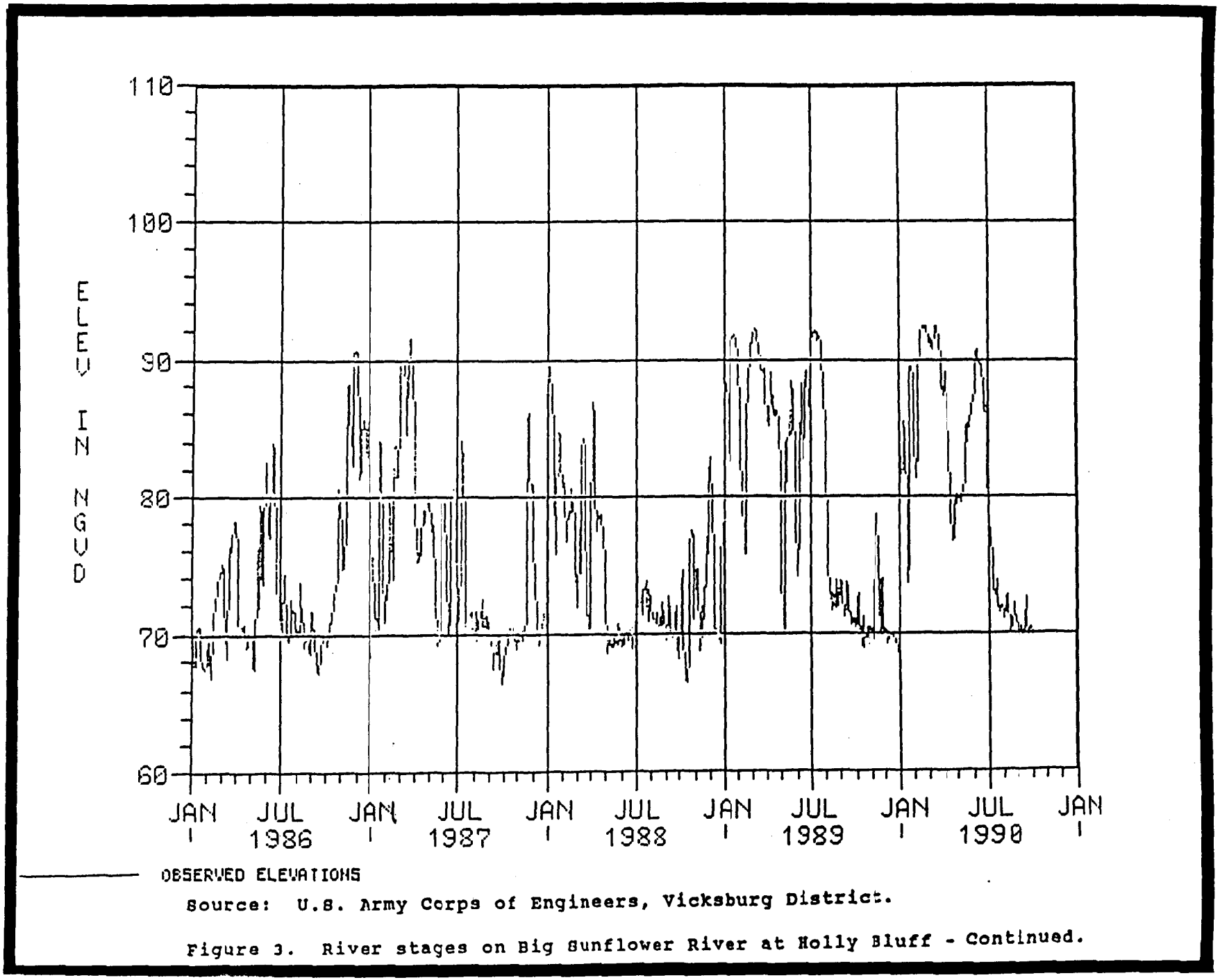
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



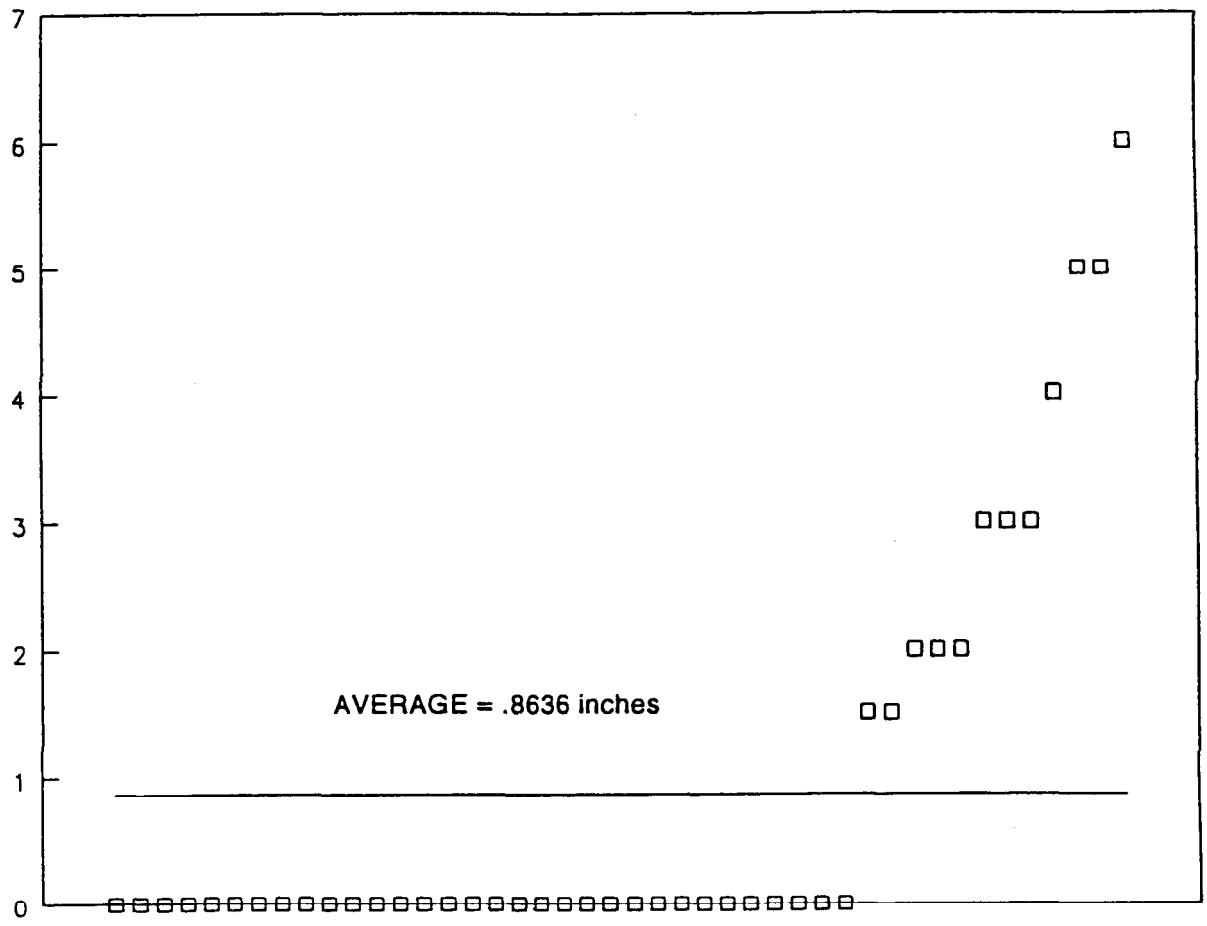
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff -Continued.



Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



Source: GMI

Figure 4. Maximum depth water on plots (in inches).

TABLE 1

Analytical Results of Soil Samples Collected at
44 Pondberry Colonies, Mississippi

	Minimum Value	Maximum Value	Average
pH	4.7	5.7	5.1
Phosphorous	38.0	359.0	129.2
Sodium	13.0	58.0	30.2
Potassium	98.0	600.0	278.4
Magnesium	334.0	1493.0	698.6
Calcium	1319.0	5228.0	2879.7
Organic matter (%)	0.6	4.5	1.8

Note: Unless otherwise specified, all units are in parts per million (ppm); pH has no units.

Source: GMI

BIOLOGICAL DATA

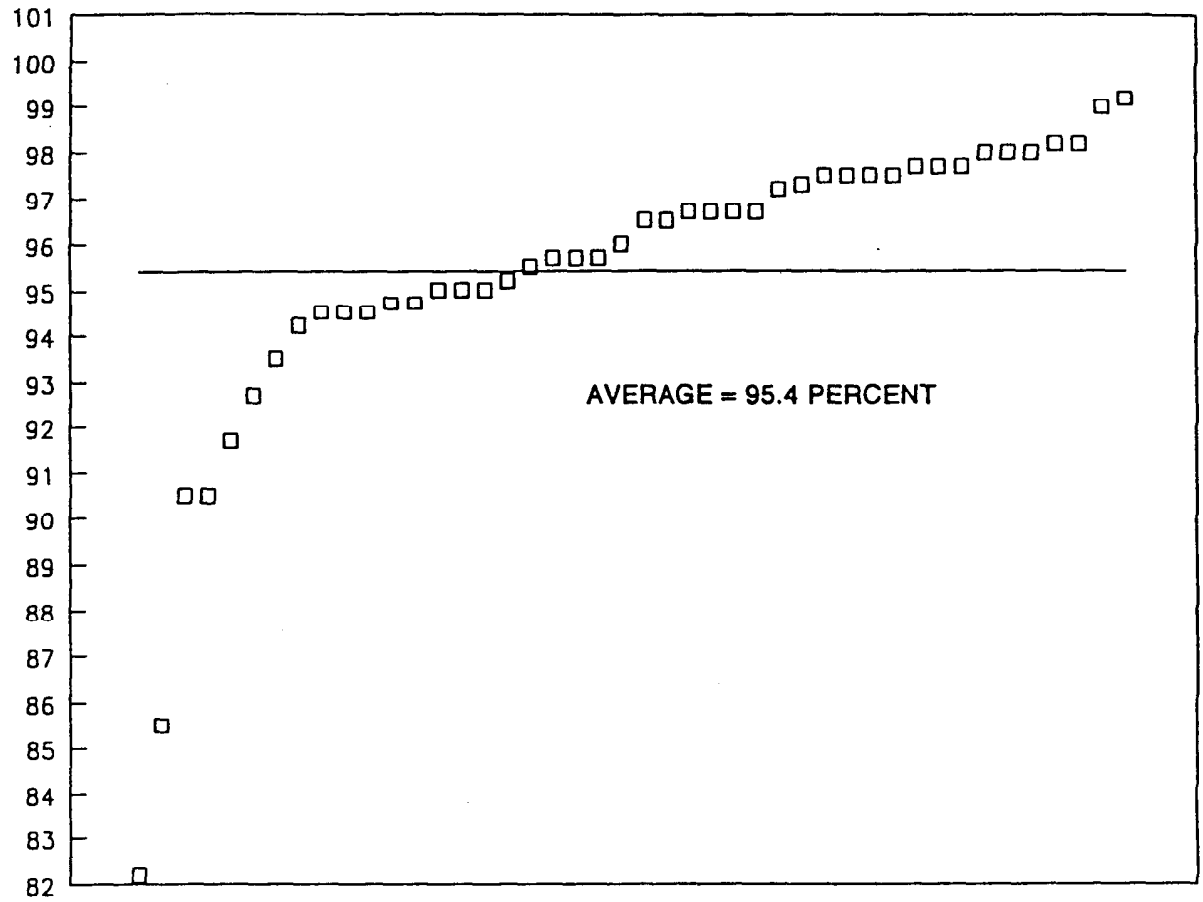
The average percent canopy closure was 95.4, which is generally indicative of a mature forest stand with a multi-layered canopy (Photograph 4). The lowest canopy closure recorded was 82 percent, which occurred at one of the sites located on private lands that was completely surrounded by croplands. Only seven colonies were located in stands with canopy closures of less than 94 percent (Figure 5).

Oaks, primarily Quercus lyrata, Q. phellos, and Q. nuttallii, were the most frequently recorded overstory species occurring at 82 percent of the colony sites. Sweetgum (Liquidambar styraciflua) and elms (Ulmus americana, U. alata, and U. crassifolia) were recorded in the overstory of about 60 percent and 50 percent of the sites, respectively.

Sweetgum and sugarberry (Celtis laevigata) were the most common understory species, occurring in 70 and 57 percent of the sites, respectively. The most common shrub species were American snowbell (Styrax americana) and deciduous holly (Ilex decidua), both of which occurred in over 82 percent of the sites. Other common shrub species, in descending order of frequency, include: sugarberry, red maple (Acer rubrum), green ash (Fraxinus pennsylvanica), elms, swamp dogwood (Cornus drummondii), oaks, palmetto (Sabal minor), elderberry (Sambucus canadensis), persimmon (Diospyros virginiana), red mulberry (Morus rubra), and sweetgum.

Oaks were recorded within either the overstory, understory, or shrub layer in all of the sites. The other species that were most frequently recorded in at least one of the vegetation layers included elm (98 percent), sugarberry (86 percent), green ash (84 percent), and sweetgum (82 percent). The strongest correlation between any two of the species occurring at a given site was with sweetgum and palmetto.

Photograph 4. Pondberry colony under dense BLH canopy.



Source: GMI

Figure 5. Average percent canopy cover.

IV. CONCLUSIONS AND RECOMMENDATIONS

This section discusses the conclusions, based upon the results of GMI's field investigations, of a typical pondberry colony in Mississippi. This profile was presented to and reviewed by several known pondberry experts during a workshop conducted at the Vicksburg District, as will also be discussed later in this section. Recommendations for subsequent investigations and potential mitigation measures are presented in the last part of this section.

PROFILE OF A TYPICAL PONDBERRY COLONY IN MISSISSIPPI

Based upon physical and biological data, it appears that the typical pondberry colony within Mississippi should occur on slight ridges in a ridge and swale community which is either frequently or periodically flooded (Photograph 5), or is in proximity (less than 100 feet) to a permanent waterbody, with soils that are comprised of silty clays, silty loams, or a combination of the two. The pondberry populations in Mississippi are shade tolerant and probably shade dependent. Common associate tree species are oaks, sweetgum, and elms, while common associate shrub species are American snowbell, deciduous holly and palmetto.

However, it should be noted that because the majority of the colonies are located on the Delta National Forest and the Forest Service manages for oaks, the apparent importance of oaks as associate species may be exaggerated. It should also be noted that, although cypress (Taxodium distichum and/or T. ascendens) has been reported from various locales as a common associate, the closest cypress tree to any of the pondberry sites visited was 50 feet and the majority of the sites (86 percent) were beyond 200 feet from the nearest cypress tree. Further, the cypress trees recorded within 200 feet of the pondberry colonies were usually individual or sporadically located trees that did not comprise a cypress community.

Photograph 5. Typical pondberry colony on relatively flat terrain with slight ridge and swales.

(Note the absence of ground cover in the foreground indicating long periods of standing water.)

Pondberry colonies in Mississippi are located at elevations above the 15-20 year floodplain of the Big Sunflower River. River stages of the Big Sunflower River at Holly Bluff, Mississippi, and the average elevation of pondberry colonies on the DNF (ie. 95 feet NGVD) indicate that the colonies in Mississippi are likely located above the 15-20 year floodplain of larger rivers.

PONDBERRY PROFILE WORKSHOP

On 19 December 1990, GMI, in conjunction with U.S. Army Corps of Engineers, Vicksburg District, conducted a workshop at the District's Office. The workshop's attendees consisted of U.S. Army Corps of Engineers personnel, GMI personnel, U.S. Forest Service representatives, USFWS representatives and various pondberry experts from universities, The Nature Conservancy, and state Natural Heritage programs. The basic objectives of the meeting were to critically review the pondberry profile developed by GMI, to identify potential impacts of proposed flood control projects on pondberry colonies that may occur within project area and to determine the feasibility of developing a stratified sampling scheme for future surveys and possible surveying approaches.

The workshop participants provided two main conclusions. First, local precipitation and hydrology have more of an influence on the pondberry colonies than overbank flooding, since the colonies on the Delta National Forest are located above the 15-20 year floodplain. The group also concluded that subsequent surveys should be limited to mature bottomland hardwood communities with a mixture of heavy clays and silty loam soils and that cypress/tupelo swamps, scrub/shrub communities, and natural levees and point bars could be eliminated from future surveys.

A copy of the workshop's minutes is presented in Appendix B. Also included in Appendix B is a copy of a letter submitted by the Vicksburg District to each attendee asking for their thorough review

and comments of the minutes. No comments were received from any of the participants concerning the minutes.

RECOMMENDATIONS

Based upon the data gleaned from existing pondberry colonies and the workshop discussions, GMI suggests that subsequent surveys for pondberry can be limited to those areas which will be directly affected by construction, provided that the proposed project will not significantly alter local hydrology in areas where pondberry may occur. A buffer zone of at least 200 feet around construction areas should also be surveyed. If pondberry colonies are found within construction rights-of-way, mitigative measures such as realignment or transplanting would be necessary. In addition, pondberry colonies found within the 5-year floodplain of major streams may indicate a need to reevaluate habitat requirements and subsequent survey approaches.

Future field investigations, such as Habitat Evaluation Procedures (HEP) studies should, whenever practical, incorporate surveys for pondberry in order to locate unknown colonies that may aid in confirming/refuting current theories about the habitat requirements of pondberry.

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South: Vol. 1 Isoetaceae through Euphorbiaceae. USDA Forest Service. Tech. Publ. R8-TP2, pp 459-462.

Brief report that gives technical description of pondberry. Also relates distribution and flowering season, special identification features, habitats, associated species, etc.

Klomps, V. L. 1980. Status Report on Lindera melissifolium (Walt.) Blume. Missouri Department of Conservation.

Sixteen page status report that discusses species information such as classification and nomenclature, present legal status at the time of the report, geographical distribution, environment and habitat, etc. This report gives assessments, recommendations, and information sources pertinent to pondberry.

Klomps, V. L. 1980. The Status of Lindera melissifolium (Walt.) Blume, Pondberry, in Missouri. Trans. Missouri Acad. Sci. 14:61-66.

This publication discusses the historical and current status of pondberry, its morphological characteristics, habitat and associated species in Missouri, and indicates unknowns such as habitat requirements, reproduction, pollination, disease, and predation.

Mansburg, Laura. 1983. Letter (with attachments) to Gary Tucker, Arkansas Tech University, dated 27 October 1983. North Carolina Department of Natural Resources and Community Development. Raleigh, North Carolina.

This letter and attachments summarize locations of pondberry in North Carolina and some ecological characteristics eg., associate species. Included as attachments were field notes by Ms. Julie Moore.

Morris, N.W. 1987. Lindera melissifolia in Mississippi. Castanea 51:226.

This article gives a brief description of known colonies in Mississippi and reveals a new location 6 miles northeast of Cleveland, MS, in Sunflower County. The habitat associated with the location is given along with relevant colony size, health, and associated species.

Radford, A.E. 1976. Vegetation - Habitats - Floras, Natural Areas in the Southeastern United States: Field Data and Information. University of North Carolina Student Stores, University of North Carolina, Chapel Hill.

Field notes from bog-sink forest in Berkeley County, South Carolina approximately 2 miles northeast of Honey Hill. Gives information on slope, canopy height, topsoil depth, soil pH, depth of water table, and delineates trees, shrubs, herbs, and forbs found on the site associated with pondberry.

Steyermark, J.A. 1949. Lindera melissaefolia. Rhodora 51:153-162.

This article reveals history of Lindera melissaefolia and relates confusion/obscurity associated with Lindera benzoin var. pubescens. The author discusses records and history of both pondberry and spice bush and describes morphological, physiological and other differences.

Tucker, G.E. 1974. The Vascular Plant Family Lauraceae in Arkansas. Ark. Acad Sci. Proc. 28:74-75.

This publication discusses four species in Arkansas that represent the family Lauraceae. These four are of the genera Lindera, Persea, and Sassafras. Pondberry is reported in Arkansas for the first time with keys, distribution maps, and other relevant information given.

Tucker, G.E. 1984. Status Report on Lindera melissifolia (Walt.) Blume. Provided under contract to the U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia.

This lengthy report gives an overall review of biology, ecology, description, distribution, and other relevant facts known about pondberry at the time of publication. The status report gives assessments of vigor, trends, critical habitat and gives recommendations for conservation/recovery. Sources of information/literature previously published as well as new information is also presented.

U.S. Fish and Wildlife Service. 1986. Endangered and threatened wildlife and plants: determination of endangered status for Lindera melissifolia. Federal Register. 51:27495-27499.

Final ruling which justifies determination of pondberry as an endangered species. Gives background information on population status, critical habitat, available conservation measures and summaries of comments, recommendations, and factors affecting the species.

U.S. Fish and Wildlife Service. 1990. Pondberry Technical Draft Recovery Plan. Atlanta, Georgia 52pp.

This draft report first gives a general species description and detailed technical description of pondberry. The current range and status along with the life history, reproductive for decline. Most importantly, a draft recovery plan is presented detailing objectives and methods to utilize in achieving those objectives. The recovery plan is based upon apparent habitat requirements and current status of Missouri populations of pondberry.

Wofford, B.E. 1983. A New Lindera (Lauraceae) from North America. J. Arnold Arbor. 64:325-331.

This publication mainly describes a potential new species, Lindera subcoriacea. In addition, this article also relates typical habitats, morphological and physiological characteristics, associated species, and other facts relative to pondberry.