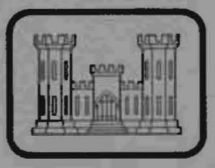

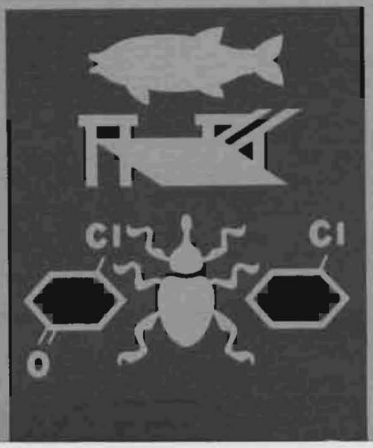

MISCELLANEOUS PAPER A-80-4

BIOLOGICAL CONTROL AGENTS ON WATERHYACINTH AT NINETEEN LOCATIONS IN LOUISIANA

By James A. Foret, J. Robert Barry, Edwin A. Theriot

University of Southwestern Louisiana
Lafayette, La. 70501

October 1980

Final Report

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under Contract No. DACW39-74-C-0074

Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Miscellaneous Paper A-80-4	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* BIOLOGICAL CONTROL AGENTS ON WATERHYACINTH AT NINETEEN LOCATIONS IN LOUISIANA		5. TYPE OF REPORT & PERIOD COVERED Final report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* James A. Foret, J. Robert Barry, Edwin A. Theriot		8. CONTRACT OR GRANT NUMBER*(s)* DACW39-74-C-0074
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Southwestern Louisiana Lafayette, La. 70501		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Aquatic Plant Control Research Program
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers, U. S. Army Washington, D. C. 20314		12. REPORT DATE October 1980 13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS*(If different from Controlling Office)* U. S. Army Engineer Waterways Experiment Station Environmental Laboratory P. O. Box 631, Vicksburg, Miss. 39180		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Aquatic plant control
Biological control
Louisiana
Waterhyacinths

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

When plans were being formulated for a large-scale study of the effects of insects and plant pathogens on waterhyacinths in Louisiana, it became apparent that baseline conditions of the sites on which the organisms were to be placed were not known.

The purpose of the work reported herein was to accumulate data on what organisms were already present at the sites to be used. These data were collected and the baseline conditions are described herein.

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Preface

The work reported herein was conducted by the University of Southwestern Louisiana, Lafayette, La., under Contract No. DACW39-74-C-0074 to the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss. The investigators for the work and authors of the report were Drs. J. A. Foret and J. R. Barry and Mr. Edwin A. Theriot.

The work was conducted under the general supervision of Dr. John Harrison, Chief, Environmental Laboratory, WES, and the direct supervision of Mr. J. Lewis Decell, Manager, Aquatic Plant Control Research Program, WES.

Commanders and Directors of WES during the conduct of this study and preparation of the report were COL John L. Cannon, CE, and COL Nelson P. Conover, CE. Technical Director was Mr. F. R. Brown.

Contents

BIOLOGICAL CONTROL AGENTS ON WATERHYACINTH AT NINETEEN LOCATIONS IN LOUISIANA

Background

1. Waterhyacinth was introduced into this country nearly a century ago and is regarded today as the most troublesome of all aquatic weeds within the Southern United States. Organized control efforts for this aquatic plant pest have centered upon the use of mechanical and chemical control measures. These methods have provided control ranging from completely inadequate to highly satisfactory. The effectiveness of mechanical and chemical control methods is largely dictated by factors such as access to the waterhyacinth growth, effectiveness of the mechanical equipment or the herbicide treatment employed, skill of the control personnel, timing of the control effort, and the environmental impact on both chemical and mechanical control methods.

2. The need for supplemental and/or alternative methods of control is obvious. An alternate approach currently under study is the use of biological control agents such as plant pathogens and arthropods which feed upon the waterhyacinth. Several biological agents have been discovered to be effective for waterhyacinth control or to exert growth inhibiting pressures upon the species. Some of these agents have been introduced into this country while several are native. To establish the level of effectiveness and the most appropriate use procedures for biological control agents, extensive testing is necessary. As part of this research effort, a large-scale study of biological agents for control of waterhyacinth has been proposed for Louisiana during 1979 and subsequent years.

Purpose

3. The purpose of this study was to provide background data that would aid in implementing the Large-Scale Operations Management Test (LSOMT) on insect and plant pathogens in Louisiana. Information

gathered in this study will also contribute to the interpretation of data subsequently obtained in the large-scale project.

4. The objectives of this preliminary survey project were as follows:

a. To establish, as part of the baseline data effort for the LSOMT on insect and plant pathogens in Louisiana, a comprehensive list of insects and diseases associated with waterhyacinth.

b. To evaluate visually the potential effectiveness of the biological agents observed at each site surveyed.

c. To collect data on waterhyacinth vigor, stage of maturity, and abundance at each site.

d. To collect data on water movement, depth, pH, temperature (surface and bottom), and dissolved solids.

Approach

Site selection

5. Survey sites were selected both in the southern and northern areas of the state of Louisiana. The following features served as a basis for the sites chosen:

a. Presence of waterhyacinth in relatively large quantity.

b. Geographical locations both in south and north Louisiana.

c. Physical features of the site which would enable containment of waterhyacinth plants within a given area.

d. Locations that were unlikely to be sprayed.

e. Locations that were readily accessible.

6. Assistance in locating sites that possessed the general features outlined above was provided by the Aquatic Weed Control Branch of the Louisiana Wildlife and Fisheries Commission. Fifteen sites south of Highway 190 and a similar number of sites on the northern side of this highway were originally selected. However, several sites in the northern sector could not be used due to lack of waterhyacinth growth or because they had been previously sprayed with 2,4-D. A total of 19 sites were finally included in this survey (Figure 1). Fifteen of these sites were located along Highway 190 or south thereof, while only four

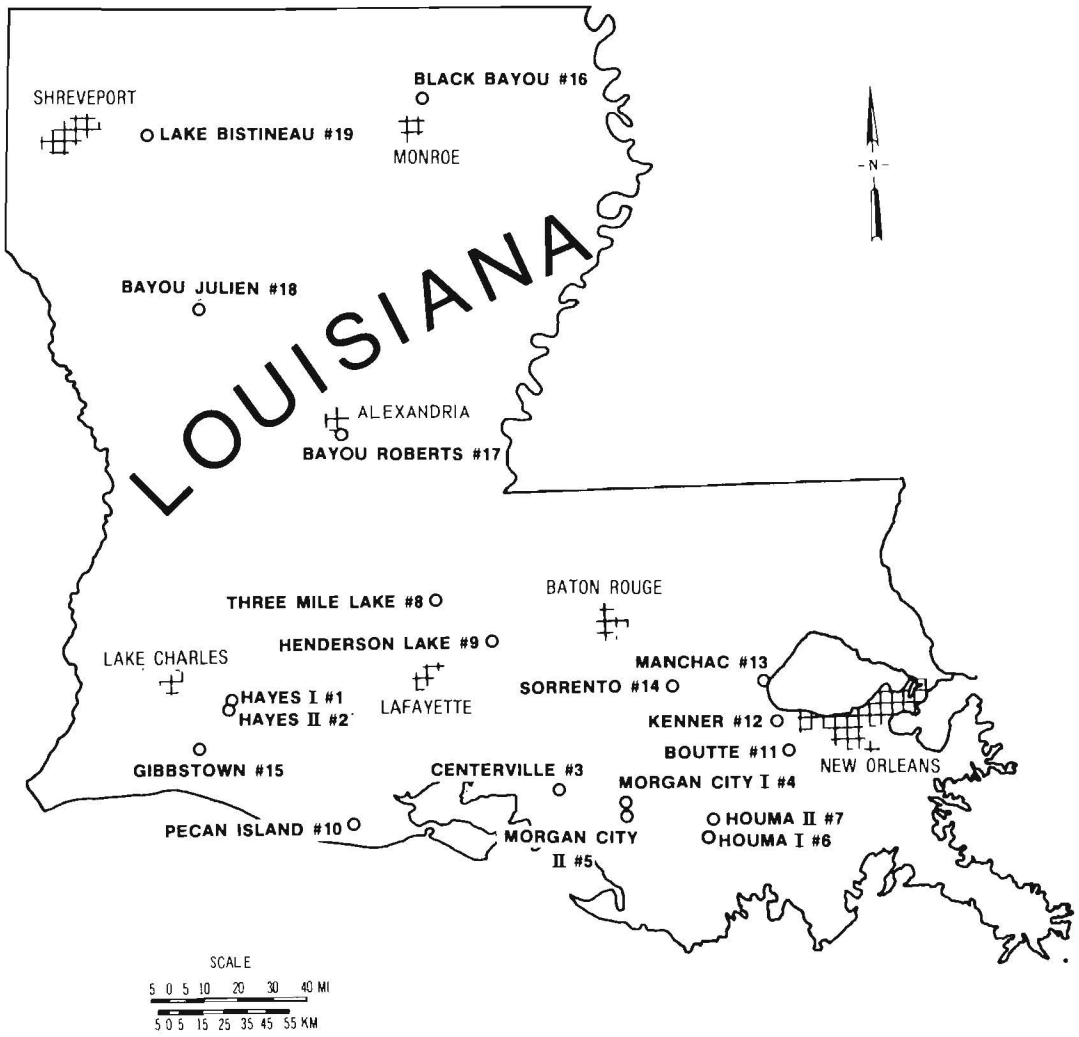

Figure 1. Survey sites

sites in the northern part of the state contained waterhyacinth populations suitable for inclusion in this study.

Data collected

7. Each site was surveyed twice during the 1978 growing season. The first investigation was conducted during the period of May 23 through May 31, and the last inspection was conducted during the period of August 17 through August 23. The following information was collected during the site surveys:

a. Kinds of arthropods found on waterhyacinth and extent of feeding observed.

b. Plant diseases present on waterhyacinth and extent of infection.

c. Growth stage and vigor of waterhyacinth.

d. Water pH, dissolved solids, surface and bottom water temperature, and direction and relative rate of flow.

e. Other aquatic macrophytes present.

8. Waterhyacinth plants at each site were examined for the physical presence or the feeding signs of Neochetina sp., Arzama densa, Orthogalumna terebrantis, common grasshoppers, and other arthropods. Feeding was classified as to heavy, medium, or light where such injury was found on waterhyacinth plants.

9. Symptoms judged to be caused by plant pathogens were photographed (for color slides), and specimens were taken for a gross laboratory identification of the causal agents involved. Standard procedures for identification of plant pathogens were employed by workers utilizing the facilities of the Department of Microbiology at the University of Southwestern Louisiana.

10. Growth stage of the waterhyacinth at each site was classified using the procedures of Addor.* This system groups waterhyacinth plants according to three stages of growth based upon the vegetative characteristics expressed. Stage I includes young plants, either seedlings or daughter plants, having a rosette form with bulbous petioles and reniform leaf blade. Stage II represents an intermediate stage which includes plants with slightly bulbous enlongated petioles and reniform leaf blades. Stage III includes older plants which are generally taller, have no bulbing of the petiole, and have ovate leaf blades. Plants were further characterized as to whether they were vegetative or flowering and as to state of vigor. The state of vigor was evaluated visually by employing a numerical scale ranging from 1 to 5 in which 1 represented nonvigorous plants and 5 represented plants of maximum vigor (Table 1).

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* E. E. Addor, Botanist, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

11. The pH, dissolved solids, and water temperatures at the surface and bottom were recorded at each site (Table 2). In addition, notes were taken on direction of water flow, relative speed of water movement, and depth. Locations for each site surveyed are indicated in Appendix A.

Results

12. Results of the survey of the 19 sites for plant pathogens are presented in Tables 3 and 4.

Arthropods

13. Arthropod feeding was found to be heavier and more widespread among the various sites on the mid-August survey. The greatest incidence of arthropod activity occurred at the southern locations, while practically no signs of insects or mites were observed at locations near Alexandria or north of this city. This geographical difference can be accounted for by the cold winter and spring experienced during the 1977-78 season. The low temperatures affected the arthropod population directly, and also through the destruction of much of the waterhyacinth growth from the 1977 crop. Many sites originally proposed for north Louisiana could not be used in this study due to absence of waterhyacinth when surveyed.

14. Neochetina or its feeding signs were found at 12 locations during the May survey and at 13 locations during the August survey. Feeding injury to the host ranged from slight to heavy; however, the impact upon growth of waterhyacinth was minimal. Arzama was observed at 3 locations in both the May and August surveys. Feeding by this insect ranged from light to heavy, but the overall impact upon waterhyacinth growth was slight. Orthogalumna was present at only 2 sites during the first survey but was observed at 10 sites during the August survey. Injury produced was rated as light to moderate with little effect upon the growth of waterhyacinth. Grasshoppers were found at several locations and minor feeding was attributed to this insect. The overall impact of the arthropods present upon waterhyacinth biomass was found to be minimal at

the times and locations surveyed. Table 5 summarizes the insect activity.

Plant pathogens

15. Disease symptoms and the microorganisms isolated from affected waterhyacinth tissue are described in Tables 3 and 4. Isolates from diseased waterhyacinth tissue included fungi, bacteria, and a yeast. Fungi representing six different genera were identified. Although fungal pathogens were not identified as to species, Cercospora rodmanii was suspected as the causal agent producing the leaf spotting and foliar dieback observed at the Pecan Island and Hayes I sites. This fungus had been released at both sites in 1977, and it is logical to assume that it caused the symptoms noted in 1978. The control exerted by this pathogen was significant in localized areas and showed promise of further spread during the fall.

16. Acremoniun zonatum was observed at Centerville, La., but this pathogen was limited in its effect upon the waterhyacinths present. The other fungi and bacteria caused an assortment of foliar and/or stem spotting and decay of tissue, but had little impact upon the waterhyacinth biomass.

Conclusions

17. Based on the data presented, the following conclusions can be made:

a. The overall impact of arthropod damage to the waterhyacinth populations in the test sites was minimal.

b. Neochetina sp. occurred in abundance on most sites and was the most common arthropod impacting waterhyacinth.

c. Plant pathogens produced only minor adverse effects upon waterhyacinth in the test sites.

d. Cercospora rodmanii was present at two sites and was effective in causing destruction of the plants in localized areas.

e. South Louisiana offers the greatest potential for experimentation with biological control agents due to the abundance of areas containing large populations of waterhyacinth.

Table 1

Condition of Waterhyacinth Plants in May and August 1978

Site No.	Growth Stage		Flowering		Rating of Vigor	
	5/78	8/78	5/78	8/78	5/78	8/78
1	I	II	X		4	3
2	I	III	X		3	5
3	III	III	X		1	5
4	II	III	X		3	5
5	I	II	X		4	3
6	I	II	X		2	3
7	III	III	X		1	5
8	No plants	No plants	No plants	No plants	No plants	No plants
9	II, III	II		X	1	4
10	III	III	X		1	3
11	I	III	X	X	4	3
12	II	III			3	5
13	III	III	X		2	5
14	I	II	X		5	4
15	I	III		X	1	5
16	I	I			4	3
17	I	I			3	3
18	I	III			3	3
19	No plants	II			No plants	4

Table 2

Water Quality

Site	Depth, m		pH		Salinity, ppt		Temperature, °C			
							Bottom 10 m		Surface 10 m	
	5/78	8/78	5/78	8/78	5/78	8/78	5/78	8/78	5/78	8/78
1	0.72	0.69	7.3	6.5	210	198	24	--	24	--
2	0.82	1.06	7.1	6.4	220	205	24	--	25	--
3	1.90	1.84	7.2	6.5	150	77	27	27	28	27
4	0.31	1.28	6.8	7.2	100	147	23	26	24	27
5	0.31	0.18	7.0	6.2	180	77	26	32	26	32
6	0.31	0.28	6.8	7.0	900	1536	24	28	24	28
7	0.77	0.56	7.2	6.7	210	128	25	27	27	27
8	2.46	No data	6.7	No data	160	No data	29	No data	31	No data
9	1.54	0.15	7.4	7.2	180	173	28	33	31	33
10	0.38	0.72	7.0	6.9	900	832	23	26	24	26
11	0.46	0.44	6.4	6.7	160	70	24	25	25	26
12	0.67	≈0	6.8	6.7	400	195	27	25	30	27
13	0.72	0.51	7.1	6.4	500	403	28	27	28	27
14	1.15	0.82	7.2	6.3	180	70	24	25	25	25
15	1.13	1.15	7.6	6.5	220	384	27	No data	28	No data
16	1.54	1.18	7.0	7.2	<64	64	26	31	28	33
17	0.36	0.15	7.8	6.8	211.1	179	29	35	32	35
18	0.61	0.16	7.3	7.17	108.8	518	25	35	26	35

Table 3

Fungal Isolates and Associated Symptoms Found in Waterhyacinth

Site No.	Location	Date	Symptoms	Organism Identified
1	Hayes I	8/17/78	Leaf spotting	*Fusarium* sp. and *Helminthosporium* sp.
1	Hayes I	8/17/78	Foliar chlorosis	*Nigrospora* sp.
1	Hayes I	8/17/78	Leaf necrosis	*Cercospora* sp.
3	Centerville	8/18/78	Zonate leaf spot	*Acremonium zonatum*
5	Morgan City II	8/18/78	Leaf necrosis	*Alternaria* sp.
6	Houma I	8/18/78	Chlorotic streaking	*Fusarium* sp.
10	Pecan Island	8/17/78	Leaf spot and foliage dieback	*Cercospora* sp.
11	Boutte	8/18/78	Leaf spotting	*Helminthosporium* sp.
12	Kenner	5/24/78	Leaf spotting	*Alternaria* sp.
14	Sorrento	5/25/78	Leaf streaking	*Alternaria* sp.
14	Sorrento	8/18/78	Wet decay of foliage	*Helminthosporium* sp.
15	Gibbstown	8/17/78	Leaf spotting	*Fusarium* sp.

Table 4

Bacterial Isolates and Associated Symptoms Found in Waterhyacinth*

Site No.	Location	Date	Symptoms	Organism Identified
1	Hayes I	5/23/78	Foliar chlorosis	Family Pseudomonodaceae
1	Hayes I	8/17/78	Foliar necrosis	Erwinia sp.
1	Hayes I	8/17/78	Foliar necrosis	Pseudomonas sp.
1	Hayes I	8/17/78	Foliar spot	Achromobacter sp.
2	Hayes II	5/23/78	Foliar spot	Family Pseudomonodaceae
2	Hayes II	8/17/78	Foliar and stem spotting	Pseudomonas sp.
3	Centerville	5/23/78	Foliar spot	Achromobacter sp.
3	Centerville	8/18/78	Foliar spot	Family Pseudomonodaceae

(Continued)

* Distribution of identified genera in nature:

1. Pseudomonas - Many species are found in soil and water, including seawater or even heavy brines. Many are plant pathogens; very few are animal pathogens.
2. Xanthomonas - Widely distributed, mostly plant pathogens causing necrosis.
3. Achromobacter - Occur in salt to fresh water and in soil. Most likely opportunist or secondary invader.
4. Proteus - Primarily occur on putrefying materials.
5. Erwinia - Widely distributed and invade tissues of living plants producing dry necrosis, galls, wilts, and soft rot.
6. Aerobacter - Widely distributed in nature.

Table 4 (Concluded)

Site No.	Location	Date	Symptoms	Organism Identified
6	Houma I	8/18/78	Foliar and stem spotting	*Aerobacter* sp.
7	Houma II	8/18/78	Foliar and stem spotting	*Erwinia* sp.
9	Henderson	8/17/78	Foliar spot	*Achromobacter* sp.
10	Pecan Island	8/17/78	Foliar spot	*Proteus* sp.
11	Boutte	8/18/78	Rusty spotting	*Pseudomonas* sp.
12	Kenner	8/18/78	Foliar spotting	Family *Pseudomonodaceae*
13	Manchac	5/24/78	Foliar chlorosis	*Achromobacter* sp.
13	Manchac	5/24/78	Foliar chlorosis	*Achromobacter* sp.
13	Manchac	5/24/78	Foliar chlorosis	*Proteus* sp.
13	Manchac	5/18/78	Foliar and stem spot	Yeast
14	Sorrento	8/18/78	Soft decay	Family *Pseudomonodaceae*
14	Sorrento	8/18/78	Foliar chlorosis	*Erwinia* sp.
15	Gibbstown	5/23/78	Foliar spot	Family *Pseudomonodaceae*

Table 5

Insect Activity

Species	Date	Site* 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Neochetina	5/78	L	H	L		M			H	L	L		L	H	H	L		L		
	8/78	M	H	M	L	L	L	L		H	H		H	H	H			L		
Arzama	5/78			L					H			H								
	8/78			L	L						M									
Orthogalumna	5/78										L				M					
	8/78	H	L	L		L	L	L				M	L	M	H					
Grasshoppers	5/78	L		L	L	L				L	L			L		L	L			
	8/78		L	L			M	L			L			L	L	L				
Others	5/78											M	H							
	8/78		L					L				L								

* L = light feeding; H = heavy feeding; M = moderate feeding; Blank = organism absent.

Appendix A: Site Descriptions

Site 1. Hayes I. Located 1 km north of Hayes on Highway 101 in a heavily wooded swamp east and west of the bridge. The site is rather inaccessible.

Site 2. Hayes II. Located west of Hayes on Highway 14 in a heavily wooded swamp lying north and south of the bridge. The site is rather inaccessible.

Site 3. Centerville. Located next to the levee bordering the Atchafalaya Basin north of Centerville in a large borrow pit. It is easily accessible.

Site 4. Morgan City I. Located 50 m past the railroad tracks north of Morgan City on Highway 662. The site included a small canal with large overhanging trees.

Site 5. Morgan City II. This site is a borrow pit on the west side of Highway 398 northeast of Morgan City. The site was inaccessible and very shallow.

Site 6. Houma I. Located along Highway 315 approximately 1.7 km south of Intracoastal bridge in a borrow pit west of the road.

Site 7. Houma II. Located north of Houma on the east side of Highway 90 at wooden bridge over a borrow pit. The site was readily accessible.

Site 8. Three Mile Lake. Located near Port Barre at the east end of the lake. This is a privately developed lake. There is good access.

Site 9. Henderson Lake. Located in Opelousas Bay approximately 3.5 km north of the boat ramp under I-10. The site is inaccessible during low water periods.

Site 10. Pecan Island. Located about 8 km down the shell road that branches off Highway 82 in an open borrow pit. The site is readily accessible.

Site 11. Boutte. Located in a borrow pit on the south side of Highway 90 about 6 km east of Highway 52 junction.

Site 12. Kenner. Located approximately 8.5 km west of Kenner and just west of the Highway 50 junction in a borrow pit on the north side of the highway.

Site 13. Manchac. Located in a canal off Highway 51 south of Manchac. Heavy mats of waterhyacinth and other species were present.

Site 14. Sorrento. Located at the pipeline in a borrow pit off Highway 61 south of Sorrento (approximately 5 km).

Site 15. Gibbstown. Located 1 km north of Gibbstown bridge on Highway 27. The site is an open borrow pit on the west side of the highway and is readily accessible.

Site 16. Black Bayou. Located at the north end of the lake. Very few waterhyacinth plants were present. This site is probably not suitable for a test location.

Site 17. Bayou Roberts. Located in the bayou west of the Highway 71-167 bridge. Few plants were found at this location.

Site 18. Bayou Julien. Located at the bridge about 4 km north of Holiday Inn on the Highway 1 bypass. Very few plants were present at this location.

Site 19. Lake Bistineau. Located along Crane Lake Slough in a cove north of Crane Lake. Few scattered plants were present at this location.

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Foret, James A
Biological control agents on waterhyacinth at nineteen locations in Louisiana / by James A. Foret, J. Robert Barry, Edwin A. Theriot, University of Southwestern Louisiana, Lafayette, La. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1980.
8, [6], 2 p. : ill. ; 27 cm. (Miscellaneous paper - U. S. Army Engineer Waterways Experiment Station ; A-80-4)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW39-74-C-0074.

1. Aquatic plant control. 2. Biological control. 3. Louisiana. 4. Water hyacinths. I. Barry, J. Robert, joint author. II. Theriot, Edwin A., joint author. III. Louisiana. University of Southwestern Louisiana, Lafayette. IV. United States. Army. Corps of Engineers. III. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Miscellaneous paper ; A-80-4.
TA7.W34m no.A-80-4