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AQUATIC PLANT CONTROL RESEARCH PROGRAM

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ALLIGATORWEED AND ITS BIOCONTROL AGENTS

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Alligatorweed (Figure 1), *Alternanthera philoxeroides* (Mart.) Griseb., native to South America, was introduced into the United States prior to 1897 near Mobile, Alabama. Growing in both aquatic and terrestrial habitat, it rapidly developed to problem levels in most southern states where it outcompetes native vegetation and interferes with navigation and recreational use of streams, lakes, and reservoirs. Initially, major problem areas developed in Louisiana, Florida, and South Carolina.

Alligatorweed is less susceptible to herbicides than other aquatic plants, and research was initiated during the late 1950s to examine potential control methods. The Corps of Engineers funded the Department of Agriculture to search the native habitat of alligatorweed for candidate biocontrol agents. Efficacy and host specificity studies were conducted on numerous insect species associated with alligatorweed in Argentina, and promising species were later tested in quarantine in the United States.

BIOCONTROL AGENTS

After seven years of research, three insect species (Figure 1 and Table 1) were approved for release in the United States:

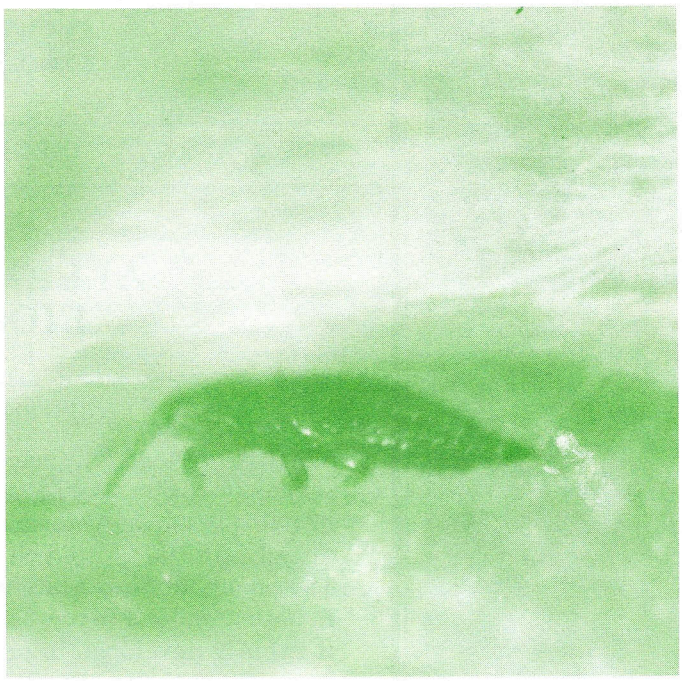
- Alligatorweed flea beetle
- Alligatorweed thrips
- Alligatorweed stem borer

Release of the flea beetle was approved in 1963, and initial releases were made in California and South Carolina (1964), followed by releases in Florida and Mississippi in 1965; Georgia (1966); Texas, North Carolina, and Alabama in 1967, Tennessee (1968); Arkansas (1969); and Louisiana (1970). Coulsen (1977) described the impacts of flea beetles on alligatorweed in each state during the period from 1959 through 1972. Significant impacts were noted on alligatorweed after insect populations became established, and greatest impacts occurred in areas where the population peaked in early June. Such population peaks closely correlated with environmental factors (e.g., temperature) that occurred in an area along and south of a line from Savannah, Georgia, to Jasper, Texas.

Field release of the thrips was approved in 1966, and initial releases were made in California, South Carolina, Florida, and Georgia in 1967. These releases were followed by releases in Mississippi and Texas in 1968 and in Alabama in 1969. Although effectiveness of this biocontrol agent in the United States has not been well documented, thrips effectiveness in South America was found to be increased in the presence of flea beetles (Coulsen 1977).

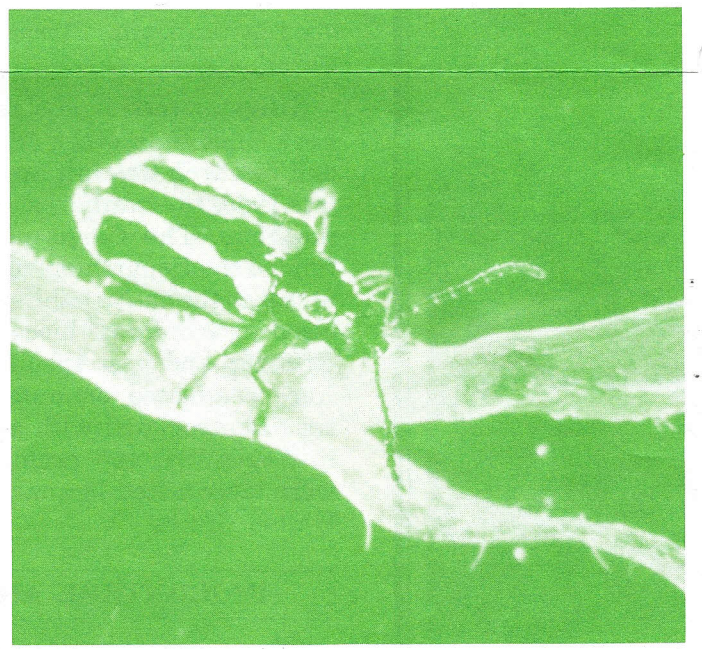
The stem borer was approved for release in 1970, and releases were made in Florida, Georgia, North Carolina, and South Carolina in 1971 and in Alabama in 1972. Limited information has been obtained on stem borer effectiveness. It was thought that the stem borer might become more widespread than the other biocontrol agents due to its ability to survive the colder winters that occur in the northern limits of the range of alligatorweed.

Alligatorweed (in foreground)



Alligatorweed thrips

Alligatorweed stem borer



Alligatorweed flea beetle

Figure 1. Alligatorweed and its biocontrol agents

Table 1. Alligatorweed Biocontrol Agents

Insect	*Description*
Alligatorweed flea beetle *Agasicles hygrophila* Selman and Vogt (Coleoptera: Chrysomelidae)	The flea beetle has a 30-day life cycle, and both adults and larvae feed on the alligatorweed. Adults feed on mature leaves, and females lay eggs on the underside of the leaves. Larvae produce circular feeding pits on leaves and also feed on stems. The flea beetle feeds preferentially and completes its life cycle only on the aquatic form of alligatorweed. (Maddox 1968)
Alligatorweed thrips *Amynothrips andersoni* O'Neill (Thysanoptera: Phlaeothripidae)	Life cycle of thrips is approximately 28 days, and both larvae (juvenile stage) and adults feed on alligatorweed with their sucking mouth parts. Damage most often occurs on the newest leaf tissue in the plant crown. Affected leaves dry and curl, and thrips are often found on the curled leaves. (Maddox and Mayfield 1979)
Alligatorweed stem borer *Vogtia malloi* Pastrana (Lepidoptera: Pyralidae)	The stem borer has a life cycle of approximately 39 days. Only the larvae feed on alligatorweed. Feeding occurs within the hollow inflated stems of the aquatic form of the weed, causing reduced nutrient flow. This process usually starts at the apical portion of the plants. Infested stems often appear wilted, become dried, and fall over. (Maddox 1970)

1982 SURVEY

By 1971, all three insects had been released in the United States for the management of alligatorweed (Coulsen 1977). In 1982 a survey was made by the Aquatic Plant Control Research Program (APCRP) to estimate the current acreage of alligatorweed in southeastern states and to describe the effectiveness of biocontrol agents in controlling alligatorweed in each state. Information was obtained from Federal and State agencies conducting alligatorweed control operations and from a field survey.

The information obtained from Federal and State agencies was designed to place major emphasis on the extent of alligatorweed problems and the effectiveness of biocontrol agents in each area. Information was also sought on methods used in control programs, numbers of acres treated, and environmental factors that might limit effectiveness of biocontrol agents, such as low temperatures.

Field surveys were conducted in ten southeastern states (Figure 2) in June and October 1982 to determine the current status of alligatorweed and biocontrol agents. Site selections were based on three factors:

- Total alligatorweed acreage from surveys by Federal and State agencies

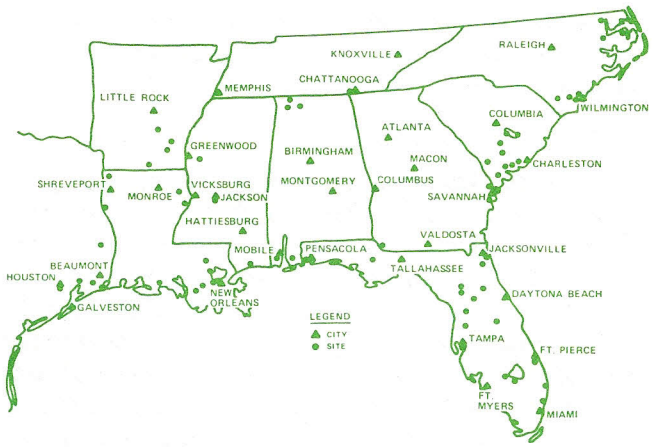


Figure 2. Alligatorweed sampling sites

- Number of biocontrol release sites (historic data)
- Geographic distribution of alligatorweed (historic data)

Sites for the field survey were located throughout each state where original releases were made in known problem areas. Qualitative data were collected on the general abundance of alligatorweed and biocontrol agents and on the vigor of the alligatorweed population.

STATUS OF PLANT AND INSECT POPULATIONS

Alligatorweed was found in nine of the ten states during the field survey, but its distribution varied on a regional basis. Information is presented by regions in which states having similar results are discussed together.

Gulf Coast States

This region had the largest infestation of alligatorweed in the United States in 1963: Louisiana ranked first, southern Alabama third, and Florida fourth in total acreage (South Carolina was second). Alligatorweed is not now considered to be a major aquatic plant problem in these states. A few locally serious problems have developed since release of biocontrol agents, but the insects have greatly reduced the number of these occurrences.

The largest populations of all three biocontrol agents were found in these states. The flea beetle and stem borer occurred in all four states and appeared to be responsible for most of the observed control. Thrips were found only in Louisiana, Florida, and Mississippi. Terrestrial alligatorweed at sites having large thrip populations was significantly stressed. Insect populations

develop in early spring, and population sizes are sufficient by the middle of the growing season to severely impact the alligatorweed.

Atlantic Coast States

Varying amounts of alligatorweed occur in South Carolina, Georgia, and North Carolina. South Carolina reported approximately 2,000 acres of alligatorweed in 1981, representing a reduction of 28,000 acres since 1963. Reduction in the acreage of alligatorweed was also reported for Georgia. North Carolina does not survey alligatorweed, but the Corps' field surveys revealed that alligatorweed was more extensive than the 372 acres reported in 1963.

Biocontrol agent populations in these states are limited by environmental factors (e.g., temperature and water level). Cold temperatures limit the impacts of the biocontrol agents in North Carolina. The flea beetle was not found in North Carolina, and the stem borer was observed only late in the growing season when the alligatorweed population was largest. The flea beetle and the stem borer appeared to be effective on aquatic alligatorweed in South Carolina and Georgia; however, terrestrial alligatorweed is especially troublesome in South Carolina where it accounts for almost half of the alligatorweed acreage.

Northern Tier of States

Tennessee, northern Alabama, and Arkansas have isolated alligatorweed problem areas. Tennessee Valley Authority (TVA) officials indicated that alligatorweed occurred as small isolated mats in Tennessee; however, no alligatorweed was found during either field survey. The acreage of alligatorweed in northern Alabama increased from less than 100 acres in 1963 to more than 800 in 1981. Alligatorweed in northern Alabama is subjected to freezing temperatures that impact the plants, but the plant population redevelops rapidly during summer. The alligatorweed infestation in Arkansas in 1963 was limited to 122 acres in the southeastern portion of the state. State estimates for 1981 indicate that there were only 50 acres of alligatorweed; however, extensive mats still occur at many of the original release sites.

TVA officials have instituted a management plan for the biocontrol of alligatorweed in northern Alabama. Flea beetles and thrips are obtained from the US Army Corps of Engineers Jacksonville District's Aquatic Plant Control Operations Support Center early in the growing season and dispersed on alligatorweed at key locations (Figure 3). This procedure has provided excellent control when conducted at the same location over a period of years. The alligatorweed problem observed in Arkansas appeared to be locally serious, but no management program is being conducted. Biocontrol agents migrate into Arkansas late in the growing season, and their impact appears to be minimal.

Texas

Alligatorweed occurs along the eastern border and Gulf Coast of Texas. Environmental factors (e.g., flooding or droughts) produce greater impacts on the biocontrol agent populations than on

June 1982 October 1982

Figure 3. Effects of seasonal release of biocontrol agents in northern Alabama

the alligatorweed population. Biocontrol agents were unevenly distributed on the 18,000 acres of alligatorweed reported by the Texas Parks and Wildlife Department. Insect populations in Texas should be managed to provide larger, more uniform populations of the biocontrol agents.

DISCUSSION

Flea beetles and stem borers provide adequate control of the aquatic form of alligatorweed in most southeastern states. Biocontrol agents have been effective in most Gulf Coast states where alligatorweed had been a major problem (Table 2). The degree of success in other problem areas varied from minimal control in some areas to none in others.

After initial successes using flea beetles were achieved in South Carolina and Florida, only limited efforts were made to distribute the thrips and stem borer. Records indicated that flea beetles were released in eleven states, thrips were released in seven states, and stem borers were released in five states. The limited number of states where stem borers were released did not limit distribution of this highly mobile insect; it was found in seven of the ten states in 1981. The thrips, which are flightless, have a much more limited distribution. Thrips were found in only five of the ten states, and were not widely distributed in any state. Increased distribution of the thrips, the only biocontrol agent that impacts terrestrial alligatorweed, may assist in alleviating alligatorweed problems in areas where other species are ineffective.

Water-level fluctuations impact biocontrol agent populations both directly and indirectly. Direct impacts occur when flooding eliminates insects from the vegetation or submerses the vegetation, precluding its use as an insect food source. Droughts may indirectly impact the insects. Alligatorweed grows in the terrestrial form when dewatered, which eliminates the plant as a food source and habitat for the flea beetle and stem borer. Although the thrips will feed on the terrestrial form, they are not highly mobile and do not rapidly invade terrestrial alligatorweed populations.

The geographic ranges of the biocontrol agents do not coincide exactly with the geographic distribution of alligatorweed. In areas where insect populations are not maintained or do not occur early in the growing season, other management schemes should be developed and employed to control the alligatorweed problem.

Managers should be aware that these biological agents are tools for controlling alligatorweed, and their populations should be routinely monitored to achieve maximum effectiveness. The APCRP has produced Instruction Report A-81-1, "The Use of Insects to Manage Alligatorweed," which is extremely useful to managers.

Table 2. Summary of Plant and Insect Surveys

Location	Acreage of Alligatorweed 1981*	Number of Sites Visited 1982	Alligatorweed Abundance 1982				Insect Abundance, 1982						Evaluation of Alligatorweed Problem
			Terrestrial		Aquatic		Flea Beetle		Thrips		Stem Borer		
			Jun	Oct	Jun	Oct	Jun	Oct	Jun	Oct	Jun	Oct	
Southern Alabama	No survey	3	Mod	Mod	Mod	Spa	Mod	Abs	Abs	Abs	Abs	Abs	(1)
Arkansas	50	4	Spa	Spa	Mod	Mod	Abs	Abs	Abs	Abs	Abs	Abs	(2)
Florida	950	17	Spa	Spa	Mod	Spa	Hev	Mod	Spa	Spa	Mod	Spa	(1)
Georgia	100	3	Mod	Mod	Mod	Spa	Mod	Mod	Abs	Abs	Abs	Abs	(1)
Louisiana	169,000	11	Mod	Mod	Hev	Spa	Mod	Mod	Spa	Abs	Mod	Spa	(1)
Mississippi	No survey	3	Spa	Spa	Spa	Spa	Spa	Spa	Spa	Spa	Abs	Spa	(3)
North Carolina	No survey	7	Mod	Mod	Mod	Mod	Abs	Abs	Abs	Abs	Spa	Mod	(2)
South Carolina	2,000	10	Spa	Spa	Mod	Spa	Abs	Mod	Abs	Abs	Spa	Spa	(3)
Tennessee	No survey	1	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	Abs	(4)
Texas	18,000	5	Mod	Mod	Mod	Spa	Mod	Spa	Spa	Spa	Mod	Spa	(3)
TVA System**	825	3	Spa	Spa	Hev	Spa	Mod	Spa	Spa	Spa	Abs	Spa	(5)

NOTES: Mod — moderate; Spa — sparse; Abs — absent; and Hev — heavy.

(1) No problem, should monitor insect population.
(2) Has problems, should introduce insects each year.
(3) Has minor problems, should monitor insect population.
(4) Has no problem.
(5) Has minor problem that is being controlled. Has a good management plan; needs to continue.

*Information from Federal and State agencies.
**Includes northern Alabama.

A more detailed report of the alligatorweed survey will be published in FY 86.

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AQUATIC PLANT CONTROL RESEARCH PROGRAM

This bulletin is published in accordance with Army Regulations 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited and will be considered for publication so long as they are relevant to the management of aquatic plants as set forth in the objectives of the APCRP, which are, in general, to provide tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: J.L. Decell, US Army Engineer Waterways Experiment Station, PO Box 631, Vicksburg, MS 39180-0631, or call AC 601/634-3494.

ROBERT C. LEE
Colonel, Corps of Engineers
Commander and Director

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