Engineers vs Florida's Green Menace

George E. Buker

ENGINEERS VS FLORIDA'S GREEN MENACE

by GEORGE E. BUKER

IN the late 1880s or early 1890s (sources are vague as to the exact time), people living along the St. Johns River were enthralled by the addition of a beautiful floating water plant to the river's scenery. Above a luxuriant green base towered a spike of purple flowers. Steamboat operators were pleased when the tourists admired the drifting bouquets gliding by their vessels. Cattlemen along the river were enthused at the prospect of a new cheap fodder for their stock. They gathered bundles of the floating greenery to carry upriver for propagation in their ponds and streams. Mr. Fuller, owner of the Edgewater Grove, seven miles above Palatka, claimed to have brought this beauty to the St. Johns River, and he believed that "the people of Florida ought to thank me for putting these plants here."[1]

The recipient of this attention was the water hyacinth, a fresh-water, free-floating plant. From its dark green bulblike leaf base grow bright green upright leaves, which serve as sails in the wind, crowned by a tall spike of purple flowers rising three to four feet in height above the water's surface. Below the surface a bushy mass of fibrous roots extend out six to twenty-four inches. The flowers last only a day or two before they fade. Then the flower stalk bends, thrusting the spent flowers and seed pods under water. When ripened, the pod releases the seeds which settle to the bottom or are entrapped in the mass of roots. The seeds remain fertile for seven or more years. During the warm-weather months along the Florida rivers the seeds may produce two crops in their growing season, with a third ready to mature the next spring. However, most of the plants are reproduced by the vegetative process as stolons develop from the healthy parent plant. In a short time these offspring emit their

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1. *New York Sun,* September 20, 1896.

own stolons reproducing more individual plants. The proliferation of the water hyacinth borders on the fantastic, it doubles its area every month of its growing season. The plants are killed by floating down to salt water, or by being exposed to a heavy frost. Thus in Florida, as it has no natural enemies, hyacinth propagation becomes awesome.

Water hyacinths were introduced into the United States at the Cotton States Exposition in New Orleans in 1884. Whether Mr. Fuller got his plants that year or received them later from someone who had obtained them at the exposition is not clear. However, he did put them in his fountain pond at Edgewater Grove. True to form, the plants multiplied, and the excess growth was cast into the St. Johns River.[2] Here propagation continued as clumps of water hyacinths drifted about on the St. Johns at the whim of wind, current, and tide, occasionally massing at some bend in the river until the wind shifted. People, soon noticed these floating gardens.

By 1893 there were acres of hyacinths floating about until a man-made barrier impeded the plant's movement down-river. The Florida East Coast Railroad bridge across the St. Johns River at Palatka had planking extending from one piling to the next almost at the water's surface. Only in the center, where the draw was, could the hyacinths pass the bridge. When a prolonged south wind pushed the floating masses against the bridge, a plant jam occurred. The hyacinth became so entangled, both above and especially below the water, that none of the plants passed the obstruction, even in the center at the draw. For the first time the wide St. Johns was covered from bank to bank. The plant was no longer a picturesque floating garden; now it was becoming a menace to navigation, a green menace.

The next year, 1894, the railroad began rebuilding its bridge, and, when the same low braces from piling to piling were installed, the citizens of Palatka and the St. Johns's rivermen protested this dangerous design. The townsmen called upon their leading banker to state their case. E. S. Crill, president of the East Florida Savings and Trust Company, wrote to C. M. Cooper, his congressional representative, presenting his case accurately and succinctly: "If this bridge is constructed so they can pass

2. U.S. Congress, *Water-Hyacinth Obstructions in the Waters of the Gulf and South Atlantic States,* 85th Cong., 1st sess., 1957, H. Doc. 37, 13.

through they will go out with the tide, and, when they strike salt water, die. If they are kept south of the bridge and work their way above Lake George, it will cost thousands of dollars to keep the channel clear."[3] Crill stressed the urgency of the matter: "No one can realize how fast this plant multiplies and spreads; and when I say acres, I mean acres and hundreds of acres, floating back and forth as wind or tide may carry them."[4] Mr. Crill ended with a prophetic warning: "you could state the matter in such a way as to have the party who has charge of approving the plans for the bridge see that the river was not periodically blocked, as it will cost thousands to remedy what can be done now with little or no extra expense."[5] His plea for aid passed rapidly through the bureaucratic chain from Cooper to Daniel S. Lamont, the secretary of war, to Brigadier General William P. Craighill, the chief of engineers, to Major Thomas Handbury, an engineer in the St. Augustine office for investigation. Crill sent his letter on February 9, 1895; Major Handbury answered the general's letter on April 10, 1895. This was the beginning of a project which remains active to the present.

The story of the water hyacinth may seem to be a reiteration of the old saw that hindsight is clearer than foresight; more importantly the narrative illustrates the district engineers' flexibility and willingness to employ diverse methods to eliminate a problem. That task led the district into new fields beyond the traditional surveys and dredging. As an early participant of the project remarked: "The subject is a novel one. To my knowledge such a condition of affairs has never been the subject of discussion from an engineering standpoint before."[6]

Major Handbury reported that conditions were as had been described by Mr. Crill. However, during the winter of 1894-1895 there had been two freezes on the St. Johns River killing most of the hyacinth. Yet he was convinced that "these small remnants will be quite sufficient to again spread the plant to troublesome proportions."[7] The only solution offered by the major was to

3. U.S. Senate, *Obstructions of Navigable Waters of Florida, and Other South Atlantic and Gulf States by the Aquatic Plant Known as the Water Hyacinth*, 54th Cong., 2nd sess., 1897, Doc. 36, 3.
4. Ibid.
5. Ibid.
6. Ibid., 12.
7. Ibid., 4.

bring the matter to the attention of the railroad officials to see if they would eliminate the offending trestle braces.

The rivermen were afraid this approach was too passive; they wanted more positive action. J. E. Lucas, owner of three steamboats, represented the rivermen. He made a trip to Washington to visit the secretary of war. Lucas was armed with photographs to substantiate his point. One picture showed his three boats in line near the railroad bridge struggling to move through the hyacinth mass. He said that "in three hours they were able to get ahead only 100 feet."[8] Another picture portrayed his crews standing on a large plant floe using axes and saws to cut through the entangled mass in order to free his boats.

Meanwhile, Lieutenant Colonel William H. H. Benyaurd, the district engineer, looking further into the bridge aspect, noted that the actual construction did not follow the design submitted and approved by the secretary of war back in 1894. He determined that the railroad had installed the low braces before the plans were presented. Evidently when local opposition was raised, the offending braces were deleted from the drawings. Thus the drawings were not an accurate representation of the actual work, even before they were submitted for government approval. Yet it was the opinion of the chief of engineers that, under existing laws, there was no way to compel the owners to make alterations to the railroad bridge. However, at a later date, as opposition grew, the Florida East Coast Railroad officials stated that during routine maintenance the bracing would be altered to afford relief.[9] While this action solved one problem, it did not get to the heart of the matter.

In 1897 assistant engineer John Warren Sackett of the engineer office in St. Augustine addressed the basic distress, the fast-growing water hyacinth. At St. Francis on the St. Johns River about twenty miles above Sanford, in the midst of the infested region, he established an experimental station. Sackett concluded that there were three forces available to be used against the hyacinth: natural, mechanical, and chemical. In view of past mistakes made by man in introducing animals and parasitic growth to other regions, such as the English sparrow to North America, the rabbit to Australia, and the Australian lady bug

8. *New York Sun*, September 20, 1896.
9. S. Doc. 36/54/2, 5-8. 13.

to California, he discarded nature as a suitable force to be employed in Florida.

Sackett first tried chemicals. He sprayed an area with a fifty per cent solution of commercial muriatic acid. The tops of the plants died within an hour, but the bulb and roots were not affected. Within a month the new growth was as lush as before the spraying. The experiment was repeated with one hundred per cent solution with the same result. Sackett followed with sprays of fifty per cent and one hundred per cent commercial sulphuric acid and with crude carbolic acid, all to no effect. When he tried a jet of steam at seventy pounds pressure, which shredded the tops, the bulbs and roots put forth new growth. He sprayed kerosene, but nothing happened to the plants. He soaked paper in kerosene and ignited the flammable wads, but the watery plants suffered little damage from the heat and flames. Sackett gave up on a chemical force.

Next he turned to the mechanical approach. Because the hyacinths are ninety-four per cent water, he conducted experiments in crushing the plants using planing mill rollers. This proved effective, for once crushed the plants did not rejuvenate. Sackett then tried towing the plants, because it would be more effective if he could round up the mass and bring it to the rollers. His net, made of three-sixteenths inch cotton line, was 200 yards long. In order for the net to be vertical in the water, one border was weighted with lead while the opposite side had half-inch cork floats attached. The tow boat moved out into the green mass, slowly encircled the hyacinths, and filled the net with plants. Sackett found that conditions had to be perfect. If the wind and current were working in the direction of the tow, things were favorable. But, if the wind or current opposed the direction of movement, or if the tow speed was too fast, the plants would jam up upon the side of the net sinking the cork line and tumble out. The essential elements of a favorable wind, current, and slow tow speed were too critical. It was impossible to tow the green menace.

Results from St. Francis seemed to point to bringing the rollers to the hyacinth. Sackett recommended the construction of a suitable vessel such as a light draft stern-wheeler with outriggers off the bow to gather in the plants and a conveyer system to carry the hyacinths to the rollers. Then, as the steamer

pushed into the floating pack, the plants would be gathered, routed, and crushed in one operation.[10]

The chief of engineers accepted Sackett's proposal and appropriated money for two vessels for the two regions of the United States then infested with water hyacinths– Florida and Louisiana. The winter of 1899-1900 produced killing frosts along the St. Johns River, and the Florida engineers decided to hold up construction on their boat until they had observed the Louisiana steamboat in the field. When Sackett visited Louisiana in August 1900, he was disappointed. Even if he modified his design so as to be six times as effective as the boat then in operation, he realized that "the results would be so meager that very little impression would be made upon the immense fields of the hyacinths in the streams of this district."[11] It seemed as if his work was fruitless.

Meanwhile, the Harvesta Chemical Compounding Company of New Orleans contacted the Florida engineers. It had a spray which it claimed could eliminate the hyacinths. Arrangements were made for the company, under the supervision of the Florida engineers, to begin its experiments at Bridgeport, eleven miles below Palatka on the west bank of the St. Johns River. From August 10 to September 1, 1900, the plants in the cove at Bridgeport were sprayed with Harvesta's solution. Within five to seven days the plants died, shriveling in the process so that the dead plants were easily torn from the living mass. The dead plants continued to float as they decomposed, but they offered little resistance to the passage of boats. The experiment seemed successful, the cost was reasonable, less than a third of a cent per square yard, and the solution safe. The day after spraying a section, a cow wandered into the area and ate some of the sprayed leaves and stalks with no ill effects.

However, the Florida engineers were not putting all their hopes on one solution. While the chemical experiments were under way, Sackett also evaluated a new mechanical method to kill the plants. Joseph Allen of Macon, Florida [?], had invented and patented a device which would tear the hyacinths to shreds. Allen was unable to finance a working model of his machine, but

10. U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers,* 2 vols. (Washington, 1899), II, 1,613-23.
11. Ibid., 1901, 2 vols. (Washington, 1901), I, 1,746.

Sackett obtained some funds from an unexpended balance to build a model. Allen's machine consisted of a horizontal shaft holding a number of knife blades two and a half feet long. The shaft was mounted forward of the bow of a boat about two feet above the surface of the water. When power was applied, the shaft rotated at 350 rpm whirling the blades into the packed plants. Sackett tested Allen's device the first half of September 1900, and he concluded that, with a more rigid construction and more power, the blades would work successfully. Still, he felt that the chemical process would be the better solution.[12]

The following year, the Florida engineers concentrated upon the chemical method. In October the steamer *Le Reve,* a former houseboat rented for private parties, was purchased and fitted with spraying apparatus. The little steamer was equipped with a steam pump, hose, nozzles, and four steel tanks with a total capacity of 3,000 gallons. After the installation of the spraying equipment, there was no room for the Harvesta chemical compound. Thus a lighter was rented for $50.00 a month. It was equipped with a boiler, steam pump, and two 8,000-gallon cypress tanks to hold Harvesta's active ingredient, arsenic acid.

When ready, the engineers steamed up the St. Johns River. From November 20, 1902, until May 7, 1903, *Le Reve* dispensed 242,503 gallons upon Black Creek, Rice Creek, Deep Creek, Blue Springs, as well as the St. Johns River from Palatka upstream to Lake Jessup. Not all went well on this voyage. The engineers received complaints from cattlemen that the solution was killing their stock. On three occasions spraying operations were halted while tests were made to see if the solution was harmful to cattle. The Harvesta Company agreed that its spray was detrimental to livestock, but it stated that not all deaths claimed could be attributed to the company's solution, and the engineers agreed. It was finally determined that the saltpeter in the compound, which contained a good deal of common salt as an impurity, was the ingredient attractive to the cattle. When bicarbonate of sodium was substituted for the saltpeter, the killing properties of the compound on the hyacinths improved, and the cattle seemed less willing to eat the sprayed plants. From then on bicarbonate of sodium was used. Both the company and the engineers felt that the problem had been

12. Ibid., 1,747-48.

solved and spraying resumed. Between November 1902, and January 1904, *Le Reve* dispensed 1,178,602 gallons of compound destroying 14,144,018 square yards of water hyacinths, relieving a serious congestion of the green menace upon the St. Johns River.[13]

Although the Harvesta Company and the Florida engineers were confident that their spraying did minimal injury to cattle along the river, the cattlemen thought otherwise. The stock-raisers stopped complaining to the engineers; they took their objections to the Congress. In the 1905 appropriation for suppressing the water hyacinth a proviso stated that "no chemical process injurious to cattle which may feed upon the water hyacinth shall be used."[14] This provision applied only to Florida; other southern states continued to be sprayed. In Florida the engineers halted all spraying operations.

Once again it was necessary for the Florida engineers to experiment. Late in 1905 a new test station was established at Riviera, two miles below Palatka on the east bank. Here Major Francis R. Shunk tried to find some way to repel cattle from sprayed hyacinth. The major experimented with many substances. His report reads like the work of a medieval alchemist: *Cow manure.*– "Four ounces to 1 quart of water, strained and sprinkled on 1 square yard of hyacinths. The cattle refused to touch the plants the first day, but ate them readily the second day"; *Aloe.*- "One of the most bitter substances known, was tried in varying quantities; 1 dram, one-half ounce, and 1 ounce to one-half gallon of water. The sprayed plants were eaten without hesitation"; *Whale oil soap.*- "One pound dissolved in a gallon of water and 1 quart used per square yard. This seems to be an extremely unpleasant material, but the animals apparently did not notice it and ate the plants readily."[15]

Finally, after a month of trial and error, the hyacinths were sprayed with water in which a decomposed egg had been dissolved. The cattle refused to go near the plants. That night and the following day it rained, still the animals would have nothing to do with the sprayed patch. For eight days the cattle avoided

13. Ibid., 1903, 2 vols. (Washington, 1904), II, 1,185-86; ibid., 1904, 2 vols. (Washington, 1904), II, 1,713.
14. Ibid., 1905, 2 vols. (Washington, 1905), II, 1,318.
15. Ibid., 1906, 2 vols. (Washington, 1906), I, 1,238.

that particular mass of greenery. Unfortunately for the test, a violent storm passed over the station producing a freshet which carried off the egg-sprayed plants. Shunk had no way of knowing how long the mixture would keep the cows away, but long enough, he hoped, to allow the sprayed plants to shrivel up and die. The experiment promised success. All of these tests– there had been twenty-three– had been employed without adding the plant-killing compound. The final step was to combine the successful decomposed albumen with Harvesta's compound. This last process proved the undoing of all previous work, for the plant-killers were also germ-killers. The compounds of arsenic and copper killed the putrefactive organisms so that after a day or two the cattle were munching as contentedly as before. Major Shunk ended his report saying, "It does not appear possible to continue the method of killing the hyacinth by spraying. It therefore seems to be necessary to fall back upon a mechanical method."[16] For the next three decades the Jacksonville District, Corps of Engineers, combatted the green menace by mechanical means only.

During these same decades the water hyacinths spread throughout the state; it was no longer a problem confined to the St. Johns River. The plants began to appear in the west coast streams such as the Hillsborough and the Withlacoochee rivers. The green menace followed the St. Johns River to its headwaters, showed up on the Kissimmee River, and moved south into Lake Okeechobee. In 1918, when the drainage canals were connected to the lake, the water hyacinths made their way into south Florida. The green menace was everywhere.

From 1906 to 1939 the most effective destroyer of the weeds was the sawboat. This craft, designed by Charles R. Short of Clermont, Florida, was an adaptation of, and an improvement over, Joseph Allen's revolving blades. Short used cotton-gin circular saws of twelve-inch diameter spaced five-eights of an inch apart. In addition to the horizontal axle extending forward of the bow, there were two other axles mounted as outriggers on each side of the stern of the seventeen-foot boat. The forward axle had four eighteen-inch circular blades placed so that two were in the center and one at each end of the shaft. This arrangement cut two strips from the pack to facilitate the boat's passage.

16. Ibid., 1,239.

The forward saws cut a six-foot wide swath while the two stern axles cut three-foot swaths. After allowing for overlapping; the sawboat destroyed water hyacinth in ten-foot strips as it moved through the mass. The same saws which cut the plants provided propulsion for the boat. In clear water it could make four to five miles per hour. In the hyacinth pack the speed would be reduced. Behind the sawboat there was a mass of shredded material which would decompose and sink within two weeks if it was not carried downstream sooner.[17]

When used properly, the sawboat was ninety-five per cent successful in killing water hyacinths, but the magnitude of the task prevented the United States hyacinth destruction boats from ridding Florida's waters of the green menace. It was considered more effective in areas of great congestion to have the sawboats cut out large patches from the main plant-jams so that the hyacinths might drift downstream to the sea and extinction. For example, in 1932 the Jacksonville district removed 992,700 square yards of hyacinth jams from Black Creek and 1,617,427 square yards from the St. Johns River at Astor by drifting. The next year the district cleared seventy-two miles of the Withlacoochee River between Pembertons Ferry and the Florida Power Corporation's dam. One 4.6 mile jam between Rutland Bridge and Panasoffkee Run was cleared by drifting. As there had been no work on the Withlacoochee between Dunnellon and the power dam since 1928, the engineers had to remove 293 floating logs, 25 tree tops, 250 small snags, and 100 overhanging trees to facilitate breaking up and drifting the hyacinth."[18]

Mechanical attacks upon the green menace were not confined to United States hyacinth destruction boats. The elevator, a barge-mounted endless belt conveyor for lifting the plants from the water and placing them on the river bank, also was used. In areas where the stream was narrow and the banks firm, draglines were employed to haul the growth on shore. At other times forked grapples on barges or land vehicles removed the hyacinths. In places, bulldozers lumbered into marshes to clear away the plants. Dense plant jams massed against bridge trestles sometimes were broken up by sending men out on the jam with six-

17. H. Doc. 37/85/1, 27-28.
18. *Annual Report of the Corps of Engineers,* 1933, 2 vols. (Washington, 1933, I, 444.

foot timber saws to cut patches from the pack. Other men, using long poles, would cast off the separated patches from the main jam. The most primitive method was to have crews walk along the banks with long handle rakes dragging the plants out of the water onto land where they were left to dry out and die.[19]

By 1939 the district realized that drifting, sawboat operations, and physical removal were not enough. The Jacksonville engineers set up a complex series of floating booms and plant traps to control water hyacinth. Booms across the mouths of tributary streams were used to halt upstream infestation. Some booms were more sophisticated, opening when the current and tide were flowing out and closing when wind and tide were running into the stream. There were traps set up along the navigational routes designed to collect the plants outside the channel so that sawboats or elevators might be used efficiently upon masses of hyacinths. By 1941 approximately 69,559 linear feet of hyacinth traps were in place on the St. Johns River, 32,119 linear feet in the Caloosahatchee River-Lake Okeechobee region, and 12,210 linear feet on the Withlacoochee River.[20] With this arrangement, the waters of the St. Johns River from Jacksonville to Palatka were kept relatively free of plant jams during World War II, which allowed the navy's seaplane squadrons at Naval Air Station Jacksonville to operate upon the river.

Meanwhile, the district engineers were alert for new ways to control the green menace. When blighted worm-infested hyacinths were discovered in the Withlacoochee River, the district tried to isolate the source of the infestation. At the same time infested plants were placed among healthy hyacinths in other parts of the state in the hope of spreading the blight. Neither action proved successful. The cause of the plant damage was not determined, nor was the infestation spread to other waters.[21]

In 1941, as part of the nation's military effort, the weed-killing property of 2, 4-D (2, 4-dichlorophenoxyl acetic acid) was discovered. Five years later, immediately after the war, the United

19. H. Doc. 37/85/1, 27-28; U.S. Army Corps of Engineers, South Atlantic Division, *Comprehensive Survey for Removal of Water Hyacinths and Other Marine Vegetable Growths.* Interim Report, Serial 32, November 1, 1948, 20.
20. *Annual Report of the Corps of Engineers,* 1941, 2 vols. (Washington, 1941), I, pt. 1, 706-07.
21. Ibid., 1940, 2 vols. (Washington, 1940), I, pt. 1, 743; H. Doc. 37/85/1, 36.

States Department of Agriculture, the Jacksonville engineers, and the Everglades Experiment Station of the University of Florida cooperated in testing 2, 4-D on water hyacinths. The tests were successful, and spraying operations were carried out in Florida once more.[22] In addition to 2, 4-D, the military effort during World War II provided the Jacksonville district with helicopters, a new vehicle for attacking water hyacinths. The copter allowed the engineers to survey large tracts for the weed, and it provided a steady platform for spraying from the air. On the water's surface air-boats were able to ride through the most dense plant jams to spray the weed. Through the district's continual efforts, employing both spraying and mechanical means, the green menace was held in check, but there could never be a let up in the task.

The experience of Palatka is an example of the vigilance required. Because of the district's intense work, the water hyacinths appeared to be under control along the St. Johns River. In the spring of 1971, Putnam County officials asked the engineers to restrict their spraying around Palatka. The district agreed, concentrating its efforts upriver in the Lake George-Crows Bluff area. By December helicopters and air-boats had cleared the region fairly well. However, aerial surveys showed that large free-floating mats had drifted downstream where they were shifting from shore to shore as the wind directed. This green menace grew to cover hundreds of acres of the river near Palatka. Navigation was blocked, crab traps were damaged, piers were weakened, and, in some cases, destroyed by the press of the wind-driven plant jams, and, in addition, the plants dissolved oxygen in the water driving off the fish. Thus the relaxing of vigilance around Palatka brought tremendous plant-jams, with its resulting damage to the economy of the lower St. Johns River.

During the winter of 1972-1973 several freezes burned the hyacinths mats. That spring the district launched "Operation Clean Sweep" to spray the plants before the growing season allowed the hyacinths to resume its blockade of the river. For fifty days, from six to eight crews covered the St. Johns River from Jacksonville to Palatka. Over 3,000 acres were sprayed with 2, 4-D. In addition, nature helped when, towards the end of the

22. H. Doc. 37/85/1, 29.

period, high winds and heavy rains flushed out many of the small tributaries. However, the only way to control the water hyacinth was through vigilance.[23]

Operation Clean Sweep became a turning point in water hyacinth control in Florida. It was not that something new happened, in a physical sense; it was a philosophical change. After the clean-up of the St. Johns River in 1973, the aquatic plant control section of the Jacksonville district determined to remain on top of the situation. In the past the water hyacinth had been dealt with when the problem of serious infestation arose. Now it was decided to prevent the plant jams before they occurred.

As a result of this philosophical change in operations, the aquatic plant control section laid down long-range plans to evaluate where the hyacinth were, and to schedule year-round maintenance spraying to keep control over the plants. With the passage of time, more and more variables were included in their master plan, such as the environmental idiosyncracies of plant growth and movement, the spawning period of fish, air and water currents, and both natural and man-made obstructions to plant flows. In addition, the section analyzed its own resources with a view to better utilization of its services. From all of this developed the selective maintenance control plan.[24]

The success of this control plan has been dramatic. With the demise of plant jams, the section no longer has to spray large quantities of water hyacinths, which used to stress the ecosystem because of the large bio-mass of dying and sinking plants covering the bottom. Public displeasure with the corps' water hyacinth activities has dropped because of a chain reaction: there are fewer plants; there are less applications of herbicides; therefore, the section is less visible to the public sector. The person who had been blockaded by the plant jams is now free from that agitation; the person who objected to the use of herbicides is also freed from much of his concern because there are fewer spraying operations.

23. U.S. Army Corps of Engineers, *Proceedings, Conference on Integrated Systems of Aquatic Plant Control, October 29-30, 1973* (Vicksburg, 1974), Appendix, "Operation Clean Sweep," 5-13.
24. J. C. Joyce, "Selective Maintenance Control Plan," *Proceedings, Research Planning Conference on the Aquatic Plant Control Program* (Vicksburg, August 1977), 45-48.

Concurrently in the 1970s the Corps of Engineers began studying biological control of water hyacinths. This project was a direct result of an earlier successful biological control of the alligator weed. Adult insects of the mottled water hyacinth weevil *(Neochetina eichhorniae)* from Argentina were brought into this country. The water hyacinth weevil is a host specific insect, that is, it subsists exclusively upon water hyacinth; no hyacinth, no hyacinth weevil. These insects went through a brief quarantine in California before being placed in quarantine cages in a laboratory in Fort Lauderdale. Here they were supplied with hyacinth leaves and stems for feeding and egg-laying. The eggs were carefully removed, counted, and washed in a solution to kill any fungus spores which might have been left by the adult insects. Then the eggs were placed in new hyacinth stems. Thus this first generation of mottled water hyacinth weevils had been raised with no contact with the immigrant weevils beyond the laying of the eggs.

The first generation was released in August 1972 at Collier Estates in Fort Lauderdale. The egg required seven to ten days before the emergence of the larva. Three months were spent in the larva stage. This was followed by a transformation, inside an underwater cocoon, to the pupal stage. Fourteen days later, inside the cocoon, the adult weevil emerged to begin feeding on the hyacinth.[25]

Because the insect's life span is about a year, it should produce continuous overlapping generations in Florida. However, in its natural habitat, the hyacinth weevil increases slowly. Although it was impossible to know beforehand the effect North American predators would have on the population growth of the insect in Florida, the field results were successful, and the laboratory colony grew. In the mid-1970s the hyacinth weevil was spread throughout the state. Today, 1982, there is no large infestation of the green menace which does not support a colony of hyacinth weevils.[26]

Six years after the introduction of the hyacinth weevil, another biological control was added. Between September 1978 and June 1979, a hyacinth moth *(Sameodes albiguttalis)* was liberated

25. "Operation Clean Sweep," 5-7.
26. Interview with Jim McGehee, aquatic plants control section, Jacksonville District, Corp of Engineers, August 24, 1980.

in twenty locations throughout Florida in an attempt to establish self-perpetuating field populations. The northern-most release was near Palatka. After the first winter the moth could not be found in the Palatka area; therefore, the second massive release took place in the south along Alligator Alley. By 1981 the hyacinth moths had successfully created colonies and had moved north as far as DeLand.[27]

It is not expected that the water hyacinth weevil nor the hyacinth moth will eliminate the plant, but used with the present mechanical and chemical methods of control the green menace aspect of this exotic floating plant has been eliminated. The selective maintenance control plan has integrated all three aspects of hyacinth control. Jim McGehee of the aquatic plant control section said: "It's a success now— the story of control of water hyacinths. We have managed to get it back to acceptable levels where it is not causing problems. We finally managed to do what people have been trying to do since about the turn of the century."[28] Joe Joyce, chief, aquatic plant control section, voiced a new concern of his section: "One of the drawbacks of that success is that there is no visible problem. You can't really show somebody the water hyacinth problem other than by stopping what you're doing and let it re-develop."[29]

The Jacksonville district engineers had to broaden their technical horizon in order to cope with Florida's water hyacinths infestation. In some respects the green menace was a harbinger of the diverse problems facing the Corps of Engineers as society becomes aware of modern urban-man's impact upon the environment. Today beach erosion and water pollution join flood control as engineering problems. Yet the district engineers willingness to break from an older mold to experiment with novel solutions to answer the hyacinth problem should give encouragement that the same flexibility will be applied to these more recent problems.

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27. T. D. Center, *Release and Establishment of Sameodes Albiguttalis for Biological Control of Waterhyacinth,* Technical Report A-81-3, February 1981 (Vicksburg, 1981), 72; taped interviews with Joe Joyce and Jim McGehee, aquatic plants control section, Jacksonville District, Corps of Engineers, May 6, 1981. Tapes in possession of author.
28. Taped interview with Jim McGehee, May 6, 1981. Tape in possession of author.
29. Taped interview with Joe Joyce, May 6, 1981. Tape in possession of author.