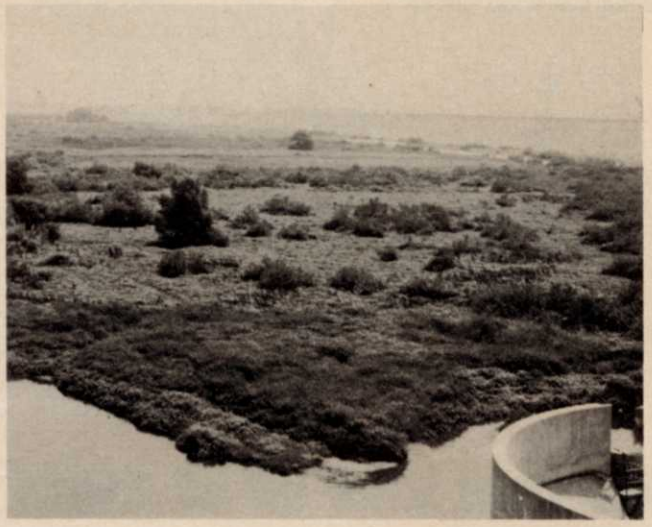
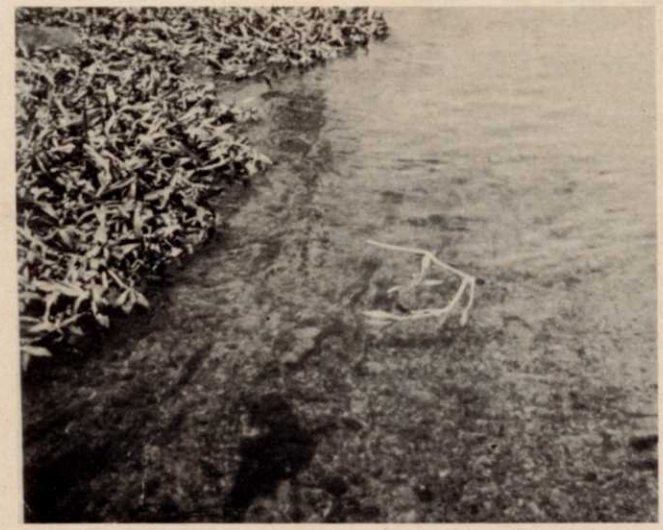
Alligatorweed not only choked the waterways but encroached on the turfgrass areas in the city of Whittier. Here the weed is thriving on dry ground along a private residential parkway.



Looking from the top of the Whittier Dam into the Rio Hondo basin reveals a sea of alligatorweed. This weed displaces a great amount of storage water and fragments are often carried away by the public.



There goes a "start of another plant." This floater was found on the Rio Hondo River. Alligatorweed propagates through the spread of plant nodes. Seed is seldom if ever found in the United States.

Alligatorweed Control Program Saves

Problem Identification

By WESLEY G. HILL & ROBERT G. DONLEY
Deputy Agricultural Commissioner and
Agricultural Inspector, respectively
Weed and Vertebrate Pests
Los Angeles County, Calif.

ALLIGATORWEED, a real southerner from South America, has been choking North American waterways for nearly 85 years. Literally millions of dollars have been spent on research and control methods to eradicate this weed from waterways throughout the southern states.

More recently, this pest which produces no viable seeds in the United States, has been reported in other sections of the country, and more particularly in southern California. As early as 1946, a University of Southern California botanist recorded the presence of the weed along the Rio Hondo River north of the Whittier Narrows Dam.

Ten years later plants were observed along a five-mile segment of the river. Subsequent investigation showed spot infestations in the concrete bottom of the Los Angeles River. Heavy mats of the weed extended out over the edge of the flowing Rio Hondo River where the bottom was unimproved dirt. In the basin behind the Whittier Narrows Dam, alligator weed had increased to solidly cover an area of forty acres. This represented the largest single find of plants.

In the San Gabriel River, alligatorweed was found in numerous places, especially along ten miles of unlined river bed. Additionally, a total of 19 satellite infestations have been located on private and public property in Los Angeles county from 1966 to the present. In almost every case, the origin of these finds can be traced to alligatorweed infested soils removed from the site of the parent infestation.

In Tulare county, the situation was somewhat different. Alligatorweed was first found in December 1965 near Porterville and Visalia. Concern was expressed about the rapidity of infestation because two large flood control and recreation lakes had just been completed only a few miles from both findings. Game and pan fish could be endangered by reduction in oxygen supplies. Many of the desired fish would then be killed and predatory fish populations would begin to rise.

Also, researchers were worried about decaying mats of Alligatorweed which produce hydrogen sulfide, a gas toxic to fish and other organisms. Recreations in other ways could be hampered.

Of prime interest though was agriculture's dependency on water throughout the San Joaquin Valley. Alligatorweed infestations were reported to reduce delivery

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Eradication

California Waterways

Analysis And Control

By WILLIAM R. CLARK
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THE CONTROL of alligatorweed has proven to be quite a complex operation. Even with several years of successful control and eradication in Tulare County and more recently in Los Angeles county, we cannot hope to let down our guard against this formidable aquatic weed.

The actual methods of control are becoming more sophisticated as our knowledge about the effectiveness of various environmental protection chemicals increases.

When the urgency of needed action was determined in 1966, the California department of agriculture and the Tulare county agricultural commissioner's office launched a concentrated offensive to eradicate the weed. With an Eradication Agreement formulated, our job was to conduct field trials and find a solution to the problem. Public and private awareness of the problem was in our favor. In short order, everyone concerned with alligatorweed was soon helping in test plots, contributing time and talent, making access roads, shifting water schedules and anything else needed to further enhance testing. All told, local, district, state, Federal, private and public individuals, organizations and corporations joined in the program.

To date over 350 field test plots with various chemicals and combinations thereof have been tested. Almost every chemical and method of control have been tried.

Foremost in our minds was the need for materials that would be safe in the water and safe to apply. It should be pointed out that tests conducted in Tulare and Los Angeles counties were made taking into account all environmental relationships. The fish and game commission as well as the bureau of chemistry for the State of California were deeply involved in securing the label deviation and subsequent registration on the product use. Additionally, our present method of control has been approved by the state. This does not mean that the product use may be adopted by other states without first checking with that state's officials.

Our initial thinking was that environmental protection chemicals would play a major role in the eradication program. Those with longer residual activity should be likely candidates. However, this was not necessarily the case.

The bare ground materials were all investigated with sodium-chlorate at 1200 pounds per acre showing the best results. Karmex diuron at over 100 pounds per acre

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This is what many of the ditches in Tulare County looked like before treatment. Note bottom is completely covered with an alligatorweed mat. Water movement is all but stopped.

After treatment with Vapam and oil the same ditch now is highly visible. No alligatorweeds are actively growing. An eradication program can be an effective tool in keeping unwanted vegetation under control.

This is alligatorweed, one of the toughest aquatic weeds to control in existence. Note hollow stem, small flower, opposite leaves, nodes and root. This weed easily finds a home almost anywhere.

ALLIGATORWEED ERADICATION PROBLEM IDENTIFICATION *(from page 14)*

of water by 80 percent in some channels. And to top it off, mosquito populations, which thrive in infested waterways, were becoming difficult to control.

Thus, in 1966 the California department of agriculture and the Tulare county agricultural commissioner's office launched a concentrated effort to eradicate alligatorweed. Surveys of over 300 miles of waterways disclosed 72.6 acres (29 miles) of infested channels and a small amount creeping into irrigated cropland.

The problem was complex and staggering to imagine. A better understanding can be gained, however, by noting that *one* measured plant produced *56 feet of lateral foliage growth in one season.* Upwards of four tons of root growth per acre in the top four inches of soil and a depth of fleshy roots three or more feet into the soil have been reported. The hollow, crisp stems of the plant are buoyant, break off readily and float downstream to create new infestations. Nodes occur every two to eight inches and quickly produce roots or foliar growth.

Back in Los Angeles county, we weren't overly concerned initially with the alligatorweed infestation because of its reported aquatic nature. At first it appeared the weed had nowhere to go except into the ocean where it would perish in the salt water. However, this was not the case.

As we continued our investigation, the situation that unfolded had all the drama and intrigue of a motion picture thriller. The Rio Hondo and the San Gabriel rivers converge to within one mile of each other at the Whittier Narrows. The dam straddles both rivers at that point. Above the dam, the Rio Hondo is unimproved for two miles and the San Gabriel for about three and a half miles. Below the dam the Rio Hondo is concrete-lined and the San Gabriel remains dirt-bottom for another 7.2 miles before it becomes concrete-lined to the ocean.

Additionally, each river below the dam can be diverted into several hundred acres of adjacent groundwater replenishment basins. This is the basis of a major flood control/replenishment system operated by the Los Angeles County Flood Control District.

Silt deposited by flood waters in the basin area displaces water storage capacity by about 20 acre-feet annually. Full storage capacity is needed about twice a year. On the other hand, this silt soil is highly desirable to nurserymen for potting soil, to contractors for a variety of fill-dirt needs and to householders wanting some easily accessible free soil. Since the silt deposits had to be removed for water storage space, the county was happy to provide it to taxpayers.

But the plot became more complex when it was discovered that the soil contained nodes, stems and other parts of alligatorweed. Movement of soil perpetuated the spread of the plants.

In 1970 we put a hold on the soil. The U.S. Army Corps of Engineers and the Los Angeles County Flood Control District, agreed to halt soil movement out of the area. In addition, Los Angeles county joined Tulare and Kings counties in being proclaimed an alligatorweed eradication area by the California department of agriculture. This strengthened our legal control over infested premises, but because of the area's size and accessibility to the public, it didn't completely halt unauthorized soil removal.

Also in 1970, an infestation of alligatorweed was discovered at Puddingstone Reservoir, a county park's recreational facility about 26 miles from the parent infestation. We obtained funds from the county fish & game commission to subsidize detection surveys at all similar county facilities having standing bodies of water. No additional infestations were found. But the threat of an outbreak was ever present.

The problems we faced that year were acute. Without water, crops turn brown, floods cannot be contained and disaster is eminent. Because Tulare county was already in a testing and control program, many of their methods of control were quickly adapted to Los Angeles county.

We are currently operating on a financial arrange-

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ALLIGATORWEED ERADICATION ANALYSIS AND CONTROL *(from page 15)*

resulted in chlorosis or a yellowing of the alligatorweed foliage. In tests in Los Angeles county, soil active materials such as the substituted ureas and the uracils were ineffective due to the extremely sandy soil and the huge volumes of water covering much of the area several times during the year.

Generally we found that we could eliminate the aerial portions of the plant with applications of contact herbicides. Silvex also performed well in burning back vegetative growth, however it and other phenoxy herbicides are not highly effective on root kill.

Most translocative materials were tried. Amitrole and dicamba looked fair. Studies by USDA and others indicate that whereas translocated herbicides move freely in the main part of the alligatorweed transport stream, they do not translocate from the main stream of the system to the buds at each node, or to any other inactive growth tissue.

Growth regulators and fertilizers were looked into. Fumigants were encouraging. Tarping with black polyethylene for 92 days, where temperatures under the tarp reached 190 degrees, only produced chlorotic whitening with recovery after removal of the plastic. Methyl bromide under tarps worked well where there was no water in the root zones. But carbon bisulfide injections proved too hazardous (flamability) and like methyl bromide proved too time consuming and ineffective on large scale operations.

Many adjuvants were tried in combinations and singly.

Los Angeles county tests produced different results than those in Tulare County. Test pilots administered by the University of California in 1963 showed Tordon 22K picloram weed killer to be ideal for the task. Away from water, product effectiveness and economy made it hard to surpass. It was ruled out in 1968, however, for lack of registration and possible hazards due to the nature of the infested area.

Likewise, a combination of Amitrole and Silvex looked promising. It controlled alligatorweed located away from the water, but was less effective on plants growing near the water's edge.

The Tulare County test program was slightly more advanced than the Los Angeles County program. Thus, we concluded, after a thorough analysis of the test data, that a combination of VPM or Vapam soil fumigant and paraquat applied as a foliar drench was the most effective method of control. Application rates were one quart Vapam, one pint paraquat and eight ounces surfactant in 25 gallons of water per 100 square feet. This combination showed excellent results within a very short period of time. The Vapam affected the root zone and the paraquat controlled foliar growth.

In November 1967, county, state and irrigation district spray crews began treatment in ditches near Porterville and Visalia. Private applicators were contracted to treat (under project supervision) other areas.

Applications were made with the same degree of precision demonstrated in the test plots. Areas were staked off into 100 square feet plots and rigs were calibrated to spend five minutes per plot. In heavily infested areas, where the mat of foliage measured nearly two feet deep, penetration was slow and difficult. This prevented, in some cases, complete contact with all foliar portions of the plant. Usually new plants formed from the nodes of

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ALLIGATORWEED ERADICATION ANALYSIS AND CONTROL *(from page 53)*

these untreated alligatorweeds. However, burning the top growth a few days after treatment reduced regrowth tremendously by destroying the nodes previously not harmed. Overall results were unbelievably successful.

Incidental to our tests we found that frost damages all foliar portions of alligatorweed except the nodes. We have applied Vapam and paraquat at temperatures ranging from 30 degrees to 90 degrees. Optimism results for us are achieved when applications are made in temperature from 65 degrees to 75 degrees.

In 1968 we perfected the use of high emulsion type weed oil as a substitute for paraquat. This resulted in even greater penetration of foliage and a substantial reduction in use cost. The rate used was one gallon weed oil, one quart Vapam, two ounces surfacant in 25 gallons water applied on 100 square feet.

The Vapam-oil spray plus burning gives control nearing 95 percent. The regrowth is retreated by spraying and in areas where penetration is difficult (steep banks and soil types) "pot holing" is employed. This is done by digging a basin, or loosening the soil around individual plants and filling with spray mixture. In some areas five pounds per acre of diuron is added to the mix to control annual weeds, making it easier to find any regrowth.

Amitrole has also been used in the summer months to weaken or stress the alligatorweed plants for winter pot hole control measures.

Our alligatorweed program in both Tulare and Los Angeles counties is now in the search and destroy phase. To prevent small unseen infestations we found it necessary to establish a clean ditch program. Consequently we have now concentrated more effort in this area. Common annual weed species are best controlled with diuron (Karmex) or simazine (Princep) at 10 pounds per acre, and in areas where feasible, bromacil (Hyvar X) at 5 pounds per acre. Where Johnsongrass is established, we have used MSMA and Dowpon C.

Probably the most difficult weed to control for us is smartweed. It grows rapidly and can completely hide any small alligatorweed in short order. Where no susceptible crops are present we use 2,4-D amine. Ammate X is substituted in areas bordered by crops.

The combination aquatic and ditch bank weed control program is paying off. Only a few widely scattered alligatorweed plants are in evidence today. Those that are found are treated with dicamba at the rate of one ounce to five gallons water. Only 30 single small plants were found this past fall in Tulare County and all of these have been treated.

It should be pointed out that other means of weed control have been utilized in addition to chemicals. When it could be done, burning of trash weeds helped remove old growth. An L.P. gas burner boom, mounted on a 4-wheel drive vehicle was a big help.

Physical removal of spot infestations with a backhoe completely eliminated the problem. Weeds and soil removed in this method were hauled to a black-topped apron where they were spread out and treated with Vapam. The entire area was treated with Vapam and refilled with clean soil.

In some waterways we completely reshaped the system, moving the infestation up to the bank where it could be spread out and treated. Removal of willows, dead trees and bamboo, plus the building of a roadway, enhanced the flood control and water movement and made alligatorweed control more successful.

In Los Angeles County, helicopters equipped with Amchem's microfoil boom have been used over much of the infested area. While application costs are high with this type equipment, we have been able to apply Silvex at rates of 2-, 4-, and 8-pounds (active ingredient) per acre with a high degree of success.

Additionally, biological control methods, in the form of the flea beetle, have been introduced on alligatorweed. Early releases failed to establish. Later the beetle successfully colonized along a half-mile of a river in Los Angeles County, but did spread far from the water. Heavy flooding in 1969 flushed out all the beetles and the project was abandoned.

Finally, the awareness of individuals to the alligatorweed problem has been most rewarding. Cooperation by land owners in doing whatever needed to be done and continued surveillance by all has made this project a success. The status of alligatorweed can now be changed from a problem to a nuisance. □

Work crews from the Lower Tule Irrigation District remove alligatorweed with a backhoe. Mats of the weed become so thick that water cannot flow along the ditches.

ALLIGATORWEED ERADICATION PROBLEM IDENTIFICATION *(from page 52)*

ment whereby funds from three areas are used to subsidize our eradication program. The state-county agreement provides $7,000; the Los Angeles County Flood Control has budgeted over $50,000; and, the U.S. Army Corps of Engineers District has been asked for $13,000 and is cooperating in the control efforts.

Our program objectives are: 1. to remove the foliar mats of alligatorweed by use of foliar sprays or by hand. Each node in the stem is a reproductive part which can infest or re-infest if care is not taken in normal removal procedures. 2. to kill the perennial root structure of the plants.

Through these objectives we have been able to appreciably diminish the original 40 acres of alligatorweed mat. This has been aided somewhat by the removal of 800,000 tons of soil under quarantine restrictions that have accumulated over several years of silt deposit. Though large quantities of alligatorweed roots remain in the area, the working agencies have prevented reestablishment of the previous mat. They have also attempted to maintain general vegetation control in an effort to chip away at the rootstock of alligatorweed.

It should be pointed out that general vegetation control in the entire infested area is a constant battle. Ample sub-surface water or occasional inundations bring forth a variety of brush species and broadleaf and grassy annuals and perennials. Yet it is needed in order to more quickly identify and control alligatorweed.

As the downstream reinfestation potential is reduced by our eradication efforts behind the dam, we expect to begin eradicative work on the infestations in the spreading grounds. Then too, we will pay closer attention to alligatorweed growing in the cracks of the concrete river bottom.

Our program will lead to success. This is evidenced by the excellent eradication program in Tulare county. Perhaps of more importance is the awareness we've created of a specific weed problem and the potential threat it harbors to agriculture and recreational fresh waters in California. Agencies, departments, individual citizens and others have expressed genuine concern and cooperated in making the eradication program for this tri-county area work.

We recognize that as we make progress the workload becomes bigger. Spraying big mats is easy. Finding isolated surviving plants, hidden in a jungle of other vegetation requires hours of intensive search by dedicated men. It is this dedication that is the foundations for a successful alligatorweed eradication program. □