THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
HYDRILLA ERADICATION PROGRAM
ANNUAL PROGRESS REPORT 2009

PROTECTING CALIFORNIA'S WATERWAYS

Prepared by Patrick Akers, Supervising Scientist,
with the assistance of Program Staff

INTRODUCTION

This report covers the work of the California Department of Food and Agriculture (CDFA) Hydrilla Eradication Program in 2009. It begins with an introduction to hydrilla and a brief history and overview of the program. A section follows on "highlights and lessons" of the season, touching briefly on events of importance or interest. The report then describes each of the current, active eradication projects in detail, including a section on CDFA's annual survey of the Sacramento/San Joaquin River Delta.

CDFA is the lead agency in California on hydrilla[1]. The Hydrilla Eradication Program's mandate is to protect the state's water systems from this weed by finding and eradicating it from California. As the lead agency, the CDFA runs the Program, but does so in cooperation with county agricultural commissioners and other federal, state, county and city agencies, Native American tribes and private individuals and entities. In addition, the Program received financial and in-kind support in 2009 from the California Department of Boating and Waterways, California Department of Water Resources, United States Department of the Interior-Bureau of Reclamation, the Lake County Department of Agriculture and the Lake County Department of Public Works.

The CDFA is committed to an 'early detection and rapid response' strategy for the eradication of hydrilla. When an infestation is found at an early stage, the population is still small, and the eradication effort costs less and causes less environmental impact than if it were detected later, when populations are larger and more widespread. 'Rapid response' involves bringing the most effective eradication methods to bear as quickly as possible. There are many examples the Program's history of 'early detection and rapid response', and the CDFA considers this to be one of the keys to its success.

THE THREAT OF HYDRILLA

Hydrilla (*Hydrilla verticillata*) is a non-native, aggressive, submerged water weed. Once hydrilla invades an aquatic ecosystem, it drives out all native and introduced aquatic plants, creating a pure stand. Its competitive edge comes from several different mechanisms. For one, hydrilla can grow under lower light conditions than nearly any other species (only one percent of sunlight), allowing it to grow up underneath other plants and to survive at greater depths. Its ability to use low light also lets it start photosynthesizing earlier in the morning than other plants. This allows it to capture most of the carbon dioxide that has entered the water during the night. For plants growing under water, the availability of carbon dioxide often limits their growth.

[1] California Food and Agricultural Code, Sections 6048 and 7271.

Hydrilla can also use bicarbonate as a carbon source, in addition to carbon dioxide. When it uses bicarbonate, it increases the alkalinity of the water, which also inhibits native species.

Hydrilla also has excellent survival and dispersal strategies. Seeds play a very small role in its spread, and most populations do not produce any seed at all. Instead, the plant breaks apart very easily and small pieces of stem, no more than one inch long, can produce entirely new plants. Hydrilla also produces special survival structures on the stems (called “turions”) and roots (called “tubers”). The turions break off the stems in the fall and can drift for long distances before sinking to start a new plant. Each tuber also produces a new plant, and a single tuber can lead to the production of several hundred others in the course of one growing season. The tubers can survive for four to seven years in the sediment before sprouting, even if no water is present for much of that time. The long survival time of the tubers creates the major challenge in eradicating the plant.

Hydrilla’s speed of growth is also impressive. The plant is between 93 to 95 percent water, so it can create huge volumes of biomass with very few resources. As a result, it can grow very rapidly, doubling its biomass every two weeks in summer conditions. Hydrilla also branches profusely as it approaches the water surface, densely filling the entire water column up to 20 feet deep and shading out other plants. Recent research has shown that, when a hydrilla plant begins to grow to the surface, it can grow 10 feet in eight days. The same study showed that on average, if started with a single nine-inch rooted shoot (a stem with growing tip), by the end of five weeks, results ended up with a total of over 3,200 inches (267 feet) of stems and tips. This is an increase of 356 times in five weeks. This was, of course, under good growing conditions.

As a final competitive edge, when hydrilla was introduced into the United States, it came without the various natural enemies that evolved with it, such as insects and diseases specialized for attacking it. It grows very aggressively in a wide variety of water conditions and temperatures, so few habitats are safe from it. The tangled mats it forms have a variety of economic and ecological impacts.

Many of the potential economic impacts of hydrilla have not been fully studied, but even if a small fraction of the potential were realized, the results would be very alarming. In particular, mats of hydrilla can reduce the flow of water in canals and ditches up to 85 percent, which would devastate a society that survives by moving large amounts of water. Similarly, the mats can clog and damage dams, power plants and other water control structures. In one documented instance, hydrilla blocked the intakes of the St. Stephen hydroelectric facility on Lake Moultrie, South Carolina, in 1991, forcing repairs and causing loss of power generation that cost $4,650,000. In addition, the infestation cost $1.2 million for emergency treatment alone. Hydrilla also seriously interferes with boating and fishing, and heavy hydrilla infestations decrease fishing stocks. The plant can also increase the risk of drowning. These various impacts can seriously damage tourism and the economies it supports. In one analysis, hydrilla coverage increased 400 percent between 1983 and 1992 on Lake Seminole in Georgia, leading to reduced tourism with an estimated loss of about $13 million per year to the local economy.

The ecological impacts of hydrilla are several. Because of its rapid and dense growth, it drives out all other plant species and destroys any existing native plants. Many people do not realize this, but plants only give off oxygen and use CO_2 when there is light, which is to say, in the day time. At night, plants use oxygen and give off CO_2, just like animals. Beneath a heavy stand of hydrilla, oxygen levels in the water fall so low at night that fish could not survive there very long. Similar effects on oxygen and acidity can contribute to increased releases of nutrients from

sediments. Such increases can lead to algae blooms and die-offs, which are signs of a polluted lake.

Aside from effects on water chemistry, the dense mass of plant material in the water alters habitat structure and food-web relationships for fish, which can lead to changes in fish populations. For instance, sunfish and bass are ambush-type predators that attack from cover. Increased plant cover can lead to larger numbers of these species, which can lead to lower salmon and trout populations. At some point, hydrilla infestations become so dense that they even interfere with hunting by bass and sunfish, so fish populations tend to decline in general in very heavy infestations.

Although some birds feed on hydrilla, generally bird populations also decline in a heavily infested area. Through a biological quirk, hydrilla even threatens bald eagles. Hydrilla encourages the growth of certain toxic blue-green algae. Coots eat the poisonous hydrilla, and then eagles eat the poisoned coots. Biologists have documented over 100 eagles killed by prey animals poisoned this way.

Fishermen and wildlife enthusiasts sometimes argue that hydrilla improves habitat for fish and other wildlife. While it is true that some cover with hydrilla, up to 30 to 40 percent of an area, will often provide food and shelter for various animals, the plant usually does not trouble itself to stay at a population level where it is helpful. Instead, it continues to expand until it monopolizes nearly every resource to itself. In addition, there are native species of underwater plants that are just as good or better for wildlife, without the threat of runaway population explosions.

Hydrilla has two forms, monoecious and dioecious. The definition of the two forms depends on the distribution of male and female flowers among the individual plants, but, more important for human concerns, they also have differing and complementary environmental requirements. The monoecious form appears to prefer more northern conditions, while the dioecious form is prevalent in the south. Both forms seem to do well in much of California.

HISTORY AND OVERVIEW OF THE PROGRAM

Hydrilla has been found in various places in the United States, as well as California. The dioecious[2] form of hydrilla was first identified in Florida in the 1960's, where it is believed to have been introduced in the 1950's. The infestation spread rapidly throughout the southeastern states and into Texas and Arizona. The dioecious form first appeared in California in 1976 in a 31-acre man-made lake in Marysville in Yuba County. The monoecious form was first detected in the United States in the Potomac River, near Washington, D.C., in the 1980's. It has since spread into a number of the southern and eastern states, into Washington State, and was first found in California in 1993 at an aquatic nursery in Visalia in Tulare County.

In 1977, after the first California hydrilla find, the California Legislature mandated[3] that the CDFA Secretary initiate a survey and detection program for hydrilla, and eradicate it wherever

[2] The dioecious form of hydrilla has flowers of one sex only on each genetic individual. Monoecious individuals have individual flowers with only staminate or pistillate parts, but these occur on the same plant. Dioecious plants often branch freely near the water surface, forming large submerged mats near the water surface. In contrast, monoecious plants tend to branch freely near the rooting point, producing many stolons and a forest of vertical shoots, which can fill the entire water column with plant material. The genetic or ecological significance of this apparent dimorphism is unknown.

[3] California Food and Agricultural Code Article 9, Section 6048.

feasible[4]. In 1985, after hydrilla was found in Redding next to the Sacramento River, the Governor of California declared a "State of Emergency" for the eradication of that infestation[5]. In 1994, the CDFA Secretary also declared an "emergency situation" in regard to the hydrilla infestation discovered that year in Clear Lake[6]. Similar declarations have been issued for most of the current hydrilla infestations[7].

Since 1976, hydrilla has been introduced into California waterways 29 separate times in 18 counties[8] (not counting detections in plant nurseries-see following paragraph). Of these 29 separate hydrilla introductions, the Hydrilla Eradication Program has eradicated hydrilla from 19 sites in the following 12 counties: Los Angeles, Monterey, Riverside, San Bernardino, San Diego, San Francisco, Santa Barbara, Shasta, Sonoma, Sutter, Tulare and Yuba (Table 1, Plate 2). The Hydrilla Eradication Program is currently eradicating[9] hydrilla from 10 locations in the following nine counties: Calaveras, Imperial, Lake, Madera, Mariposa, Nevada, Shasta, Tulare, and Yuba. Actually, this year, with the declaration of eradication of the Chowchilla River / Eastman Lake infestation, Madera and Mariposa Counties move from the "infested" to the "uninfested" category.

Plate 1. The "hydrilla hook", a small grappling hook, with hydrilla

Hydrilla has been detected in plant nurseries and aquaculture vendors five times, the last two occurring in 2004. In March 2004, hydrilla was detected in a plant nursery in northern Los Angeles County, and in November, hydrilla was also detected in an aquaculture wholesaler in Alameda County. In each case, the county department of agriculture took the lead on removing all hydrilla plants and plant parts from the infested area, and the CDFA Pest Exclusion Branch and Hydrilla Eradication Program personnel worked with the vendor to prevent reintroductions.

Every year, Program crews survey all known infested waterways and many high-risk lakes[10], ponds, reservoirs, streams, canals and other waterways in the state. High-risk areas include the Sacramento/San Joaquin River Delta and other high recreational-use water bodies and waterways within quarantine zones[11]. Surveys generally employ two methods. Working from either the shore or from boats, crew members visually scan the water surface and water column for suspicious plants. They supplement the visual scan by throwing a small grappling hook (Plate 1), which is dragged

[4] A Hydrilla Science Advisory Panel was convened after each hydrilla outbreak. These panels have always found hydrilla eradication to be feasible.

[5] "Proclamation of a State of Emergency," issued by Governor George Deukmejian, October 23, 1985; terminated October 23, 1989.

[6] "Proclamation of a Project Regarding the Eradication of Hydrilla," issued by CDFA Secretary Henry Voss, August 12, 1994.

[7] Calaveras, Madera, Mariposa, Nevada, Shasta, and Tulare counties.

[8] The CDFA considers hydrilla infestations to be separate introductions if they appear more than two or three years apart.

[9] California Code of Regulations, Title 3, Division 4, Sections 3281 and 3410; California Code of Regulations, Section 3962; CDFA Plant Quarantine Manual, Section 3410.

[10] High-risk lakes, streams, etc. are those within five miles of Clear Lake, one mile either side of the Sacramento River near the Riverview Golf Course, three miles of the Yuba canal, and one mile of Bear Creek, the west fork of the Chowchilla River, and the Springville ponds.

[11] Quarantine zones are established by declaration of the CDFA Secretary and are areas within eradication areas that have restrictions as to water use, access, or the intensity of survey.

along the bottom and through the water to snag any long-stemmed vegetation such as hydrilla. Occasionally, divers conduct underwater surveys[12]. Surveys generally start when the water temperature climbs above 10 degrees Celsius[13] (50 degrees Farenheit[14]) in the spring and water flows in streams fall to a safe level. They generally end when water temperatures fall below 10 degrees Celsius in the fall. Active growth of hydrilla occurs between 10 degrees Celsius and 35 degrees Celsius (DiTomaso and Healy 2003, page 102). The Hydrilla Eradication Program also follows up on all reports from the public on potential new infestations. The last finds of hydrilla were in 2004 and 2005, when three infestations appeared in Nevada County. No new hydrilla infestations have appeared since then.

The Hydrilla Eradication Program uses an integrated pest management approach to eradicate hydrilla. In 2009, the Program used (alone or in combination) manual removal, small scale dredging, lining of water bodies, biological control and aquatic herbicides. The major aquatic herbicide was a fluridone slow-release pellet formulation[15] applied at 90 to 150 ppb[16], depending upon the size of the water body. Other herbicides used in particular situations include a copper ethylenediamine liquid formulation[17] (applied at one ppm[18]) and a fluridone liquid formulation[19]. In the past, the Program has also used water draw down and drying of the hydrosoil, followed by soil fumigation, large and small scale dredging and burying as eradication methods.

Based upon recommendations from science advisory panels, the Hydrilla Program has generally followed a standard protocol in determining eradication. Program staff intensively treat and survey an infested site for a minimum of three growing seasons after the last hydrilla detection, followed by a minimum of another three seasons of intensive survey without treatment. Therefore, the CDFA considers hydrilla eradicated from a site only after a minimum of six years without finding any plants. Longer periods of negative surveys may be warranted, depending upon the circumstances. The most recent Technical Review Panel, in October 2009, suggested that three years of follow-up treatment is probably not long enough, especially in large infestations and when depending solely on herbicides. This is because herbicides do not affect the dormant tubers. An herbicide must simply lay in wait for the tubers to sprout and the plants to appear above the sediments. It is unclear just how long tubers can remain dormant, but four to seven years is an often quoted figure. The last panel suggested that eradication does not depend on any fixed time criterion for follow-up treatment. Instead, they suggested trying to follow tuber health and depletion in the eradication site, and using the disappearance of tubers as a guide for the time of follow-up treatment. This approach presents challenges, both in accurately following tuber depletion and in relating this to the absolute absence of plants. It is

---

[12] Surveys are conducted by two methods, visual search of the water column and physical samples. Trained biologists and support staff conduct visual searches to locate individual plants or mats that are visible in the water column or on the water surface. The crews conduct the visual searches from boats, canoes, or kayaks; by wading in shallow streams and lakesides; and by swimming using sight buoys and face masks, depending upon the circumstances. Because visual searches from the surface are sometimes hampered by poor visibility, the Program occasionally contracts divers for underwater surveys. Physical samples are taken using a modified grappling hook, usually thrown from a boat or canoe. Personnel trained in identifying hydrilla carefully examine the retrieved plant material. In either case, visual searches or bottom samples, if hydrilla is found, the number of plants or size of the infestation is recorded along with the physical location (by using a global positioning system technology and measured from known landmarks). Representative specimens from new locations are sent to the CDFA Plant Pest Diagnostic Center, Botany Laboratory for confirmation.

[13] C = Centigrade

[14] F= Fahrenheit

[15] Sonar® SRP brand, SePRO Corporation.

[16] One ppb = one part per billion = one microgram per liter.

[17] Komeen® brand, Griffin Corporation.

[18] One ppm = one part per million = one milligram per liter.

[19] Sonar® AS brand, SePRO Corporation.

not uncommon in tuber surveys to take a large number of sediment cores without finding any tubers, yet plants may be clearly visible in the area. However, the suggestion is a worthy one, as any information about tuber disappearance is clearly better than none.

In addition to surveying and treating for hydrilla, the Hydrilla Eradication Program monitors aquatic herbicide concentrations in water in order to protect the state's waters. The CDFA performs monitoring as policy, and also ensures to comply with the National Pollution Discharge Elimination System (NPDES) General Permit issued by the State Water Resources Control Board. The NPDES is a provision of the Clean Water Act to regulate and protect "waters of the United States" from pollution caused by point sources. This system was extended to aquatic pesticide applications by the Ninth Circuit of the United States Court of Appeals in its decision in *Headwaters, Inc. et al. v Talent Irrigation District*, March 12, 2001. To comply with the NPDES General Permit, the Hydrilla Eradication Program monitors fluridone concentrations in Clear Lake and in the Riverview Golf Course Ponds in Shasta County, copper concentrations in Clear Lake and in Bear Creek in Calaveras County, diquat concentrations in Island Drive Pond in Redding and triclopyr concentrations in Clear Lake or in the Anderson Park Ponds. The Hydrilla Eradication Program also monitors individual treatments to confirm that concentration targets are attained, and at the request of the public in regards to the use of treated water. The monitoring done for the NPDES General Permit is published in a separate report.

The status of all current and historical sites in the Hydrilla Eradication Program is summarized in Table 1 and Plate 2.

Plate 2. Current Hydrilla Eradication Projects, 2009

Table 1. Status of Hydrilla in California, by County, 1977 – 2009

COUNTY	YEAR*	DESCRIPTION OF WATERWAY	SIZE	STATUS**
Calaveras	1988	Bear Creek, Units 2 to 11	5 miles	Survey
	1988	Stock Pond	0.5 acres	Active
	1996	Bear Creek, Unit 1	0.75 miles	Active
Imperial	1977	Imperial Irrigation System	270 acres of ponds, 600 miles of canals, drains	Survey, Survey, Active
Lake	1994	Clear Lake	690 of 43,000 acres	Active
Los Angeles	1980	Eight ponds	2 acres	Eradicated
	1983	One pond	< 1 acre	Eradicated
	1985	One pond	< 1 acre	Eradicated
	2004	One pond (nursery)	< 0.5 acre	Eradicated
Madera/ Mariposa	1989	Eastman Lake /Chowchilla River	1800 acres and 26 miles of river	Eradicated
Monterey	1978	Pond	0.01 acre	Eradicated
Nevada	2004	One pond	0.6 acres	Active
	2005	Two ponds	2.8, 0.1 acres	Active
Riverside	1977	One pond	< 1 acre	Eradicated
	1984	One pond	< 1 acre	Eradicated
	1985	Three ponds	< 1 acre	Eradicated
San Bernardino	1988	One pond	< 0.01 acre	Eradicated
San Francisco	1988	One pond	2 acres	Eradicated
San Diego	1977	Lake Murray	160 acres	Eradicated
	1977	One pond	<1 acre	Eradicated
Santa Barbara	1977	One pond	0.12 acre	Eradicated
	1993	One pond	< 0.01 acre	Eradicated
Shasta	1985	Seven ponds	133 acres	Eradicated
	1986	Four ponds	23.5 acres	Eradicated
	1994	Two ponds	13 acres	Active
	1996	Four ponds	39 acres	Active
Sonoma	1984	Spring Lake	72 acres	Eradicated
Sutter	1985	One pond	< 0.01 acre	Eradicated
Tulare	1993	Three ponds	0.6 acre	Eradicated
	1996	Seven ponds	20 acres	Active
Yuba	1976	Lake Ellis	30.8 acres	Eradicated
	1990	One pond (Shakey's)	6 acres	Re-activated 2007
	1997	13 ponds	20 acres	Active
	1997	Canal	3 miles	Active

*Year first detected at a given site.
**Eradicated = No hydrilla found at site in six or more years of intensive survey following the last treatment.
Survey = No hydrilla found at site in last three to six years, intensive surveys continue.
Active = Hydrilla detected within the last three years, an active treatment program continues.

2009 SEASON HIGHLIGHTS AND LESSONS

1) The Program reached a true milestone this year. The Chowchilla River – Eastman Lake project passed the seven-year mark with no hydrilla found anywhere in the system. With this achievement, the Program will declare the infestation eradicated. Congratulations to all the pioneers who undertook this daunting challenge, and who, with hard work and persistence, overcame all the uncertainties to bring the project to a successful conclusion.

2) The Clear Lake project may be turning the corner on the recent resurgence of hydrilla in the lake. In 2008, the situation was threatening. Project crews found 196 "spots" with hydrilla in 2008 as compared to 72 in 2007, and many of the plants were large and reached the surface. Many of the finds were also near the outlet of the lake, which was particularly troubling. However, in 2009 the crews could find only 76 spots with hydrilla, and the plants were much smaller and sicklier than last year. In addition, there were no finds near the outlet. The number of acres needing treatment with fluridone increased from 573 at the end of 2008 to 690 in 2009, a much smaller increase than in 2008.

3) Many other projects continued their trend of no plants. Five seasons have now passed without any plants in Tulare County's Costa Lake infestation and in Calaveras County's Bear Creek and Mokelumne Hill infestations. Three seasons have now passed for Shasta County's Riverview Golf Course and Anderson City River Park infestations. The three separate infested ponds in Nevada County also have had no plants for three years.

4) Inspired by the concrete lining of the infested section of the Oregon House canal in 2008, the Yuba County Weed Management Area, the Agricultural Commissioner's Office, and the Resource Conservation District undertook the lining of another 1,500 feet in 2009, with contributions from CDFA. Undaunted by the experience, they are working towards lining another 2,000 feet or so in 2010.

5) The Department of Water Resources decided to continue its support for the Hydrilla Program, and to modestly increase it, after considering the threat the plant represents and the anxious situation in Clear Lake.

6) 2009 marked the third year of intense drought in many of the areas where hydrilla is found. The conditions did not affect operations in most projects, except that sometimes the work was moved forward in the season to avoid situations with very low or no water. Perhaps associated with the drought and very low water levels in Clear Lake, a huge bloom of bluegreen alga (a *Lyngbya* cyanobacterium) made conditions miserable for entire communities for at least two or three months along the easternmost shores of the lake. One or two hydrilla locations were heavily covered, especially management units 56 and 57 near the outlet. Perhaps coincidentally, no hydrilla plants appeared in that area in 2009, while at least a couple dozen were found in 2008.

7) With the return of hydrilla in Clear Lake, an outside reappraisal of the project seemed in order. In late October, 2009, four outside experts (Dr. Lars Anderson of USDA-ARS, Dr. Tyler Koshnik of Sepro research and development, Rachel Woodfield of Merkel Associates and the Caulerpa Eradication Project, and Scott Ruch of Ruch Logic and the Department of Boating and Waterways' submerged vegetation evaluation project) met for two days to review the project and suggest ways to improve it. The Technical

Review Panel made close to forty recommendations, most of which were technical refinements. They did not recommend any major strategy shifts, except in determining the time to end treatments. Here they could not recommend a fixed period of follow-up treatment, except to note that three years was too short. Instead they recommended trying to develop biological assessments to determine the hydrilla's health in the lake, and they suggested some methods to explore. The panel also recommended that the goal of the project remain the eradication of hydrilla from the lake.

8) Program staff made several presentations during 2009. Dr. Akers made presentations on the Clear Lake Hydrilla Project to the Lake County Board of Supervisors and the Clear Lake Advisory Subcommittee, and gave a presentation on the general hydrilla program to the Department of Water Resources. He also gave talks on the behavior of the herbicide fluridone in Clear Lake and on the search for watermilfoil weevils in California at the Western Aquatic Plant Management Society conference. Biologist David Kratville gave a talk on aquatic plant identification and control to the Santa Cruz/ Monterey weed symposium.

9) The effort to contain and eradicate South American spongeplant continued its seesaw progress in 2009. No major new infestations appeared, but the cat-and-mouse pattern of shifting finds continued in flowing water infestations such as the San Joaquin River and the irrigation systems in western Fresno County. As has been the case, in any one location the population is relatively easy to reduce to very low levels, but then the plant pops up in a connected location. The infestation in the Kings River area is looking very promising, however. Furthermore, in the Redding pond infestation, hardly any plants appeared after a single light treatment at the beginning of the season. Photos and observations suggest that the plants probably have not set seed there since about 2007, so perhaps the seed bank is reaching its limit.

10) The biologist working in Yuba County tried a new dry-ground treatment for water canals on the canal in the Oregon House infestation late in 2008. The treatment uses a liquid fluridone formulation, which is applied in the late fall when the canal is empty. It is thought to act as a pre-emergent treatment for the following season and was intended to control other plant species that interfere with survey, as much as for the hydrilla. The effects seemed modest, at least for the pondweeds that are now the most common problem in the ditch. We will repeat the treatment this year.

11) The Yuba biologist also stocked four new triploid grass carp at an infested pond in Oregon House, after the two that were stocked there last year seemed to disappear. Hopefully the carp escaped predation this season and have grown large enough to have an impact on plant growth. He will evaluate carp's effectiveness in controlling the hydrilla during the upcoming season. This is the first place where the Program has used grass carp outside the Imperial Irrigation District.

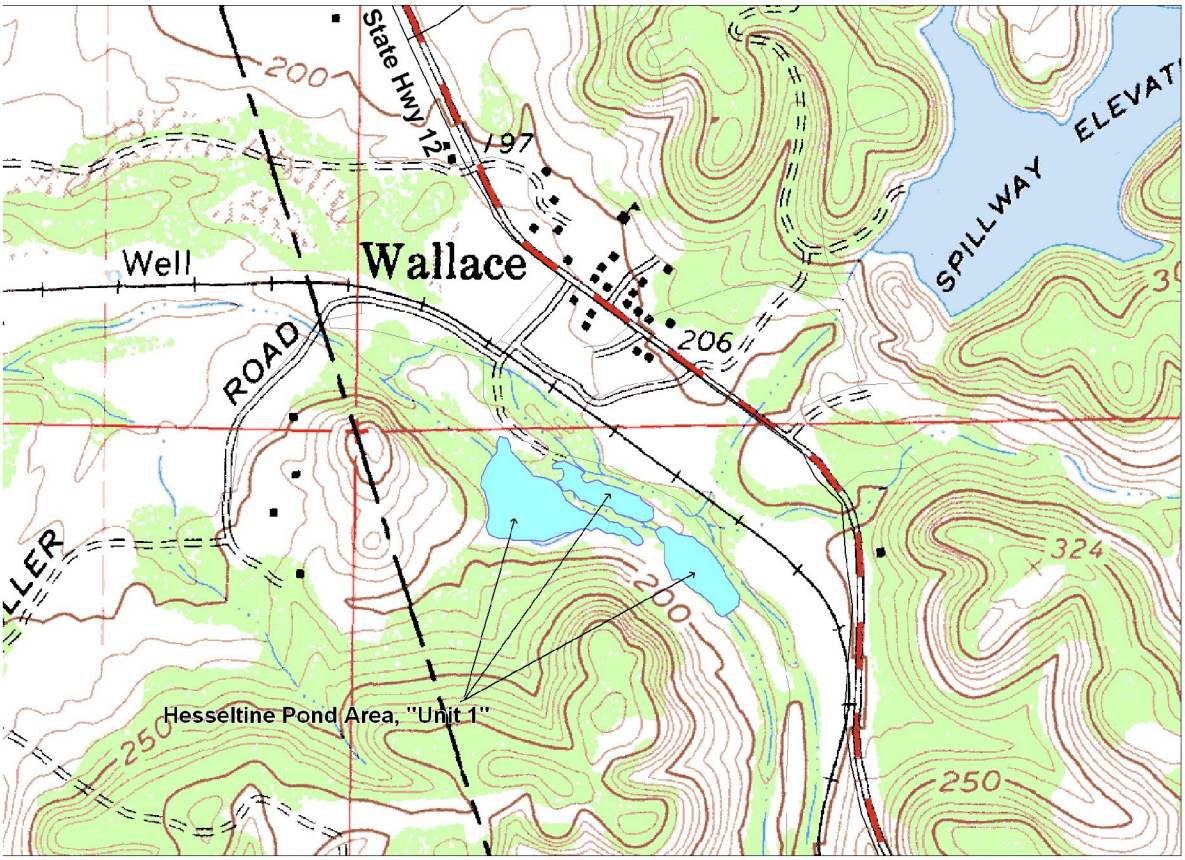
ACTIVE, ON-GOING SURVEY AND ERADICATION PROJECTS, IN DETAIL

CALAVERAS COUNTY *(Lead: Florence Maly)*

CDFA biologists believe that there have been two separate infestations of dioecious hydrilla in Calaveras County, based on their separation by distance and watershed. The first infestation was detected in May 1988, and was in ponded areas along Bear Creek between the towns of Burson and Wallace, as well as in three isolated ponds (Plate 3). The Calaveras County Hydrilla Eradication Project (Calaveras Project) began soon after the plants were found.

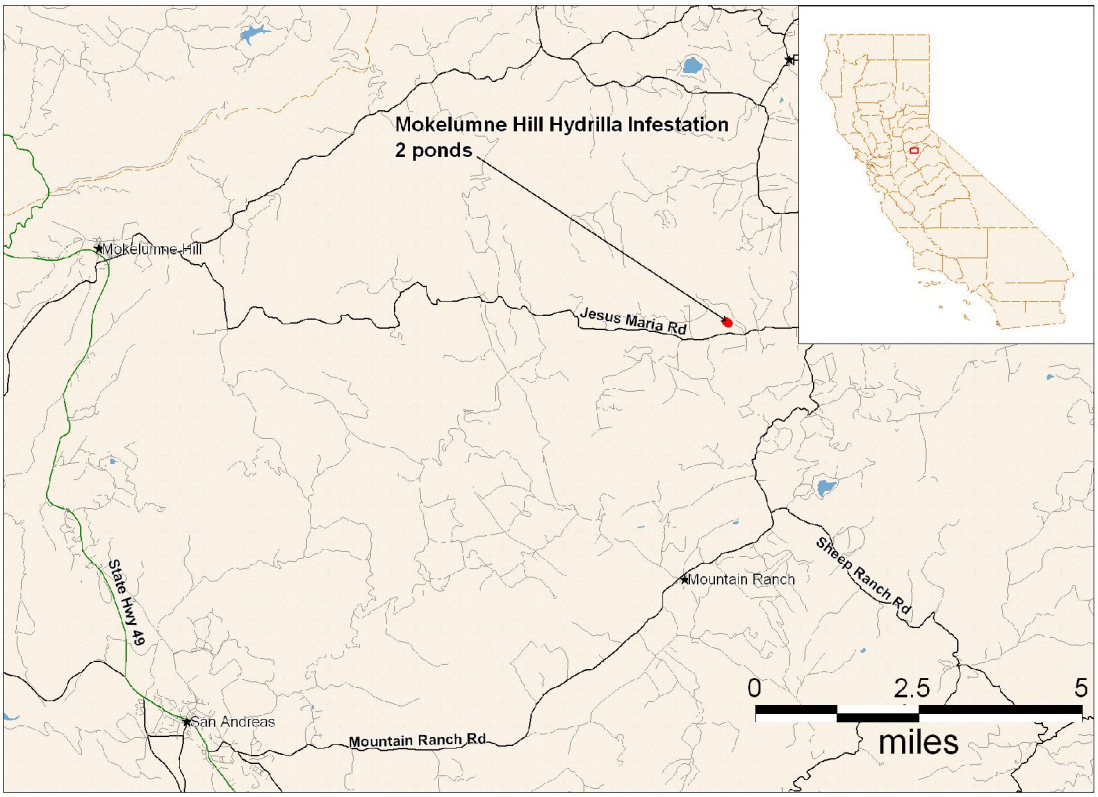
The Project is a cooperative effort between the CDFA and the Calaveras County Department of Agriculture. The CDFA convened a Scientific Advisory Panel that made recommendations as to survey, treatment and public education (Stocker. R.K. and L.W.J. Anderson *et. al.* 1988). The Bear Creek infestations are of particular concern because Bear Creek enters the Sacramento-San Joaquin River Delta at Disappointment Slough in San Joaquin County, only about 26 miles downstream from the Hesseltine Pond area (Unit 1), the lowest infested area on the creek.

Plate 3. Active Bear Creek Hydrilla Infestation Area, near Lake Comanche



Later in 1988, the survey crews discovered a separate infestation in two ponds located near Mokelumne Hill, about 30 miles from the Bear Creek area (Plate 4). The two Mokelumne Hill ponds are 0.45 and 0.15 acres in size and are used for watering cattle. Six other cattle ponds surround them.

Plate 4. Mokelumne Hill Infestation Site



Survey of the Bear Creek Drainage

To track the work on the project, project biologists divided the Bear Creek drainage into 11 management units. All of the originally infested isolated ponds and most ponded areas in the Bear Creek drainage project are approaching eradication. Project crews have not detected any hydrilla plants in Management Units 6 through 11 of Bear Creek since 1996. They have not detected any hydrilla plants in Units 3 through 5 (the Perock and Baker ponded areas) since 1998. In addition, no hydrilla has been detected in Unit 2 since July 1999. In 2009, the crews surveyed two times in Units 2, 3 and 5, finding no hydrilla. No surveys occurred in the other units, as these were dry for most of the summer.

In contrast to the upstream management units that are approaching eradication, the Hesseltine area (Unit 1) has had recent hydrilla detections. Unit 1 is a series of ponded and swampy areas, totaling approximately 10 acres (Plate 3). The main ponded area (Hesseltine "main pond") is located about one half mile downstream from Unit 2 and measures approximately 3.6 acres. The pattern of water flow through the area has been changing in the last several years, which caused the expectations for the main pond to also alter a few times. Until about 2005, a large leak in the East Bay Municipal Utility District (EBMUD) aqueduct kept water flowing in Bear Creek from about Perock Pond (Unit 3) down that kept Hesseltine Pond from ever drying up. EBMUD repaired the leak in late 2004, causing the areas in Hesseltine Pond that once had hydrilla to thoroughly dry out in 2005. Program staff accordingly believed that this particular infestation was doomed. However, the property owner blocked the outlet to the pond during the

winter of 2005-06, trying to maintain its volume. With the good rainfalls of that year, the water levels in the pond stayed high all through the summer and fall of 2006, although the creek completely dried up just upstream and downstream of the pond. With this new development, Program staff returned to the usual survey-and-treat strategy. The main 3.6-acre pond was able to maintain its size and depth during dry 2007, although the swampy areas just upstream dried out by mid summer. 2008 and 2009 were also very dry, and all the area dried out to a large extent each year by mid summer. Even the main pond was much reduced in size and depth. The areas where hydrilla had been found dried out as well.

In 2004, project crews detected two hydrilla plants (Table 2). The crews surveyed Unit 1 seven times in 2005, five times in 2006, three times in 2007 and 2008, and twice in 2009, finding no hydrilla. In 2009, the first survey was conducted on June 23, when the water temperature was 29 degrees Celsius (85 degrees Farenheit). The last survey was conducted on September 28; the water temperature was 24 degrees Celsius (75 degrees Farenheit). Other aquatic vegetation detected in the Hesseltine ponded area included coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*), naiad (*Najas* species), mosquitofern (*Azolla* species), various pondweeds (*Potomageton* species), watermeal (*Wolffia* species), duckweed (*Lemna* species), chara, water primrose (*Ludwigia* species), watermilfoil (*Myriophyllum* species) and cattails (*Typha* species). Azolla was a severe problem in 2006 but not since 2007, perhaps because of fluridone treatments in 2006 that were designed in part to control it.

Table 2. Number of Hydrilla Plants and Tubers Found and Removed from Bear Creek, Calaveras County, 2000 - 2009

Unit 1 – Hesseltine Ponded Area							
YEAR	**2000**	**2001**	**2002**	**2003**	**2004**	**2005-08**	**2009**
Mats	0	0	5	0	0	0	0
Plants	0	10	18	3	2	0	0
Tubers	-	46*	69*	-	2**	0	0

*Most tubers were recovered by dredging operations
**1 plant from tuber, 1 plant from turion.

Treatment of the Infested Management Unit in the Bear Creek Drainage

Since the first hydrilla find in Unit 1 in 1996, Project personnel have treated all find sites with various combinations of physical removal and applications of copper ethylenediamine and/or fluridone herbicide. Areas immediately surrounding locations where plants have been detected in the last three years have been dug out and treated with fluridone herbicide, in a quick-release pellet formulation (Sonar PR) to provide rapid build-up of the herbicide, while still taking advantage of its long residual effectiveness. This was the fifth year without plants, so there was no treatment.

Survey and Treatment of Mokelumne Hill

The Mokelumne Hill infestation has been troublesome, with hydrilla re-appearing after absences of one to a few years since it was found in 1988. No hydrilla plants have been found in the smaller of the previously infested ponds since 1998, but plants were detected in the larger pond in 2002, 2003 and 2004. No plants appeared in either pond in 2005-08, nor in 2009, making this the fifth year without plants.

Calaveras Project crews surveyed all ponds on the property twice in 2009. The first survey was on June 25, when the water temperature was 23 degrees C (74 degrees F). The last survey was on September 29, when the water temperature was 21 degrees C (70 degrees F). In 2004, 10 hydrilla plants were detected in pond three, the main infested pond (Table 3). None have been found in the last four years. Other aquatic vegetation detected included chara, naiad, watershield (*Brasenia schreberi*), coontail, water primrose, American, slender and curly leaf pondweed (*Potamogeton species*) and water buttercup.

The infested pond was not treated in 2009.

Table 3. Number of Hydrilla Plants and Tubers Found and Removed from the Stock Pond Near Mokelumne Hill, Calaveras County 2000 - 2009

YEAR	2000	2001	2002	2003	2004	2005-08	2009
Mats	0	0	4	0	0	0	**0**
Plants	0	0	1	22	10	0	**0**
Tubers	0	0	49	2	24	0	**0**

Surveys outside the Quarantine Zone

Calaveras Project personnel surveyed all access points on Bear Creek from the Calaveras-San Joaquin County line west to Thornton Road in Stockton, approximately 26 miles. No hydrilla was detected.

FRESNO OFFICE GENERAL DETECTION SURVEYS *(Lead: Florence Maly)*

The Hydrilla Program crew in Fresno takes care of the Calaveras, Chowchilla/Eastman and Tulare Springville projects, as well as working on occasion in Imperial County. With the Chowchilla project beginning to taper off, the crew has had more opportunity to expand its detection efforts. Much of this work has been in conjunction with survey and control work for South American spongeplant, which has appeared in a number of locations around the San Joaquin Valley. This work has focused on the San Joaquin River drainage below Friant Dam, the Kings River drainage and associated canals near Reedley and in canals and ditches in the Firebaugh area. The crew detected no hydrilla.

IMPERIAL COUNTY *(Lead: Imperial Irrigation District)*

Imperial Irrigation District (IID) personnel first detected dioecious hydrilla in Imperial County in June 1977 in the All American Canal. The IID is a gravity-fed irrigation system that delivers water from the Colorado River via the All American Canal through a network of lateral canals, ponds and reservoirs to farmers' ditches, which in turn, water the farms of the Imperial Valley. Drainage canals (drains) then carry the runoff and seepage to the New and Alamo Rivers. IID personnel conducted surveys in 1988 and found that the hydrilla infestation covered, to a greater or lesser degree of plant density, 320 canals extending approximately 600 miles, 32 ponds comprising 161 surface acres and 79 privately owned delivery ditches (farmers' "sides").

The CDFA, IID, USDA-Animal and Plant Health Inspection Service, California Department of Fish and Game (CDFG), and Imperial County Department of Agriculture formed a cooperative agreement in 1981 to research and develop control and eradication methods for the IID. Between 1981 and 1984, the main control methods were mechanical removal of plant mats and

mechanical dredging. In 1984, the IID received permission from the CDFG to stock the west side of the IID (the infested area) with triploid grass carp (*Ctenopharyngodon idella*) (TGC)[20]. The TGC has been the main control and eradication method since that time, supplemented by hand removal of individual plants, sealing of cracks in concrete-lined canals with epoxy to prevent hydrilla emergence and mechanical dredging when necessary. The IID stocks the TGC on a yearly basis at a target rate of up to 100 fish per mile for canals infested with aquatic vegetation, and up to 100 fish per acre for infested ponds.

While the IID continues to employ the TGC for control of hydrilla and other aquatic vegetation in the canals (delivery system), the fish cannot be placed in the drains or farmer's side canals, because water levels undergo large and rapid changes. Therefore, in 2004, when hydrilla was again detected in the Wildcat Drain (hydrilla was found here in 2002 and 2003) officials from CDFA, Imperial County Department of Agriculture, and IID surveyed and mapped the entire drain. A total of 5.1 miles of the drain was divided into 15 units, based on topography. Hydrilla was seen in Units 2 through 13. IID personnel removed as much of the hydrilla as possible following the mapping.

A follow-up survey in October 2005 revealed the continued presence of hydrilla in the Wildcat Drain. Plants were also seen in another drain, the Wisteria, located southwest of the Wildcat Drain. The Wisteria Drain flows into the Greeson Drain, which in turn, makes its way to the New River and the Salton Sea.

In response to these finds, Fresno Hydrilla Project crewmembers and IID workers spent six weeks in the winter of 2005-06 hand-removing all visible hydrilla plants from both drains. Additional sections of the Wildcat, Wisteria, Rice and Greeson Drains were surveyed and no hydrilla plants were detected.

Hand removal activities were resumed in November 2006, with IID crews continuing to remove plants in 2009.

LAKE COUNTY *(Leads: Patrick Akers and Russ Huber)*

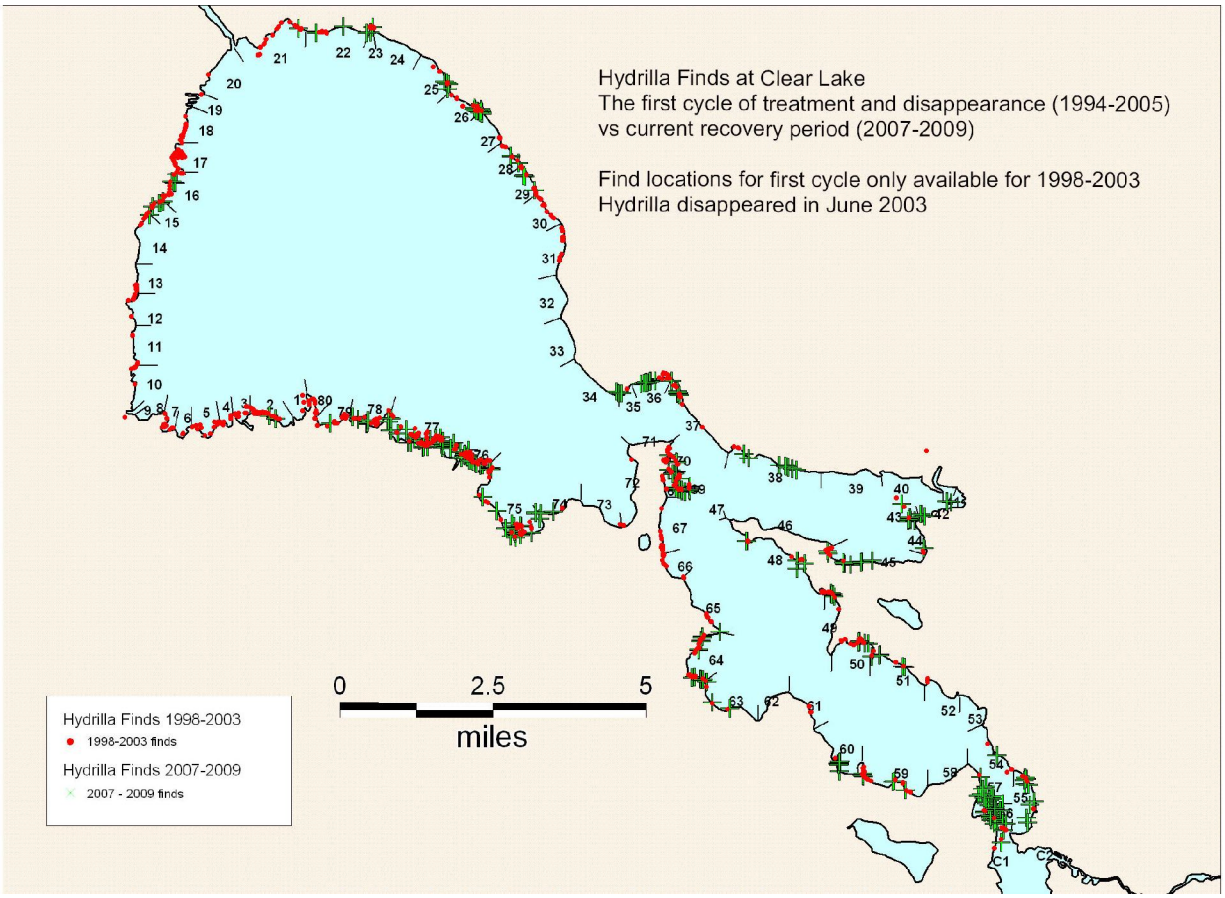
Plants disappeared for the first time from Clear Lake on June 23, 2003, but they returned in 2007. Treatments continued during 2003, 2004, and 2005 after the hydrilla disappeared. Surveys also continued, without finding a single plant. The three seasons without plants met the criterion to end treatments. 2006 was the first year since the beginning of the Clear Lake Project in 1994 that no herbicides were applied. No plants appeared in 2006, but they came back in 2007 and treatments resumed. The plants made a very strong showing in 2008, but in 2009 the number of plant finds declined noticeably, as did the vigor of the plants.

[20] The biological control agent, the triploid grass carp (*Ctenopharyngodon idella*) (TGC) is used to consume hydrilla and other aquatic vegetation. When used in confined areas, and in adequate stocking rates, the TGC can suppress a population nearly to extinction. However, to prevent establishment of a wild population, the CDFG Code requires that only sterile fish be stocked. (TGC roe is put through a high-pressure treatment that gives each egg a triploid chromosome complement and makes the fish sterile). Nonetheless, the CDFG is concerned that the sterility might not be absolute, so they have tight restrictions on TGC use. According to the CDFG Code, the TGC cannot be deployed in any open water bodies that empty into natural waters of the state (CDFG Code, Sections 6440-6460). Therefore, all use of the TGC must be in areas that are contained with gates and screens, which severely restricts TGC use. Despite this limitation, the use of the TGC can be very effective in ponds and canals where the inlets and outlets can be screened to contain the fish.

Program managers did not assume that the detection of no plants in Clear Lake in 2003 through 2006 implied that the lake was free of hydrilla. CDFA surveys are thorough, but no survey system can hope to detect a single small plant amongst the mass of aquatic weeds in a 43,000-acre lake. In addition, treatments with fluridone slow-release pellets continued through 2005. The purpose of this herbicide is to kill hydrilla plants as they emerge from underground tubers. If the herbicide performs as intended, it kills plants when they are small, and very difficult to detect. Fluridone remains in the bottom sediments for an extended period, so it can mask a remnant infestation. Program biologists suspected that there were still tubers in Clear Lake that could continue to sprout. They increased the number of boat crews from two in 2006 to three in 2007 to intensify the survey at a time when the hydrilla might be recovering from earlier treatments.

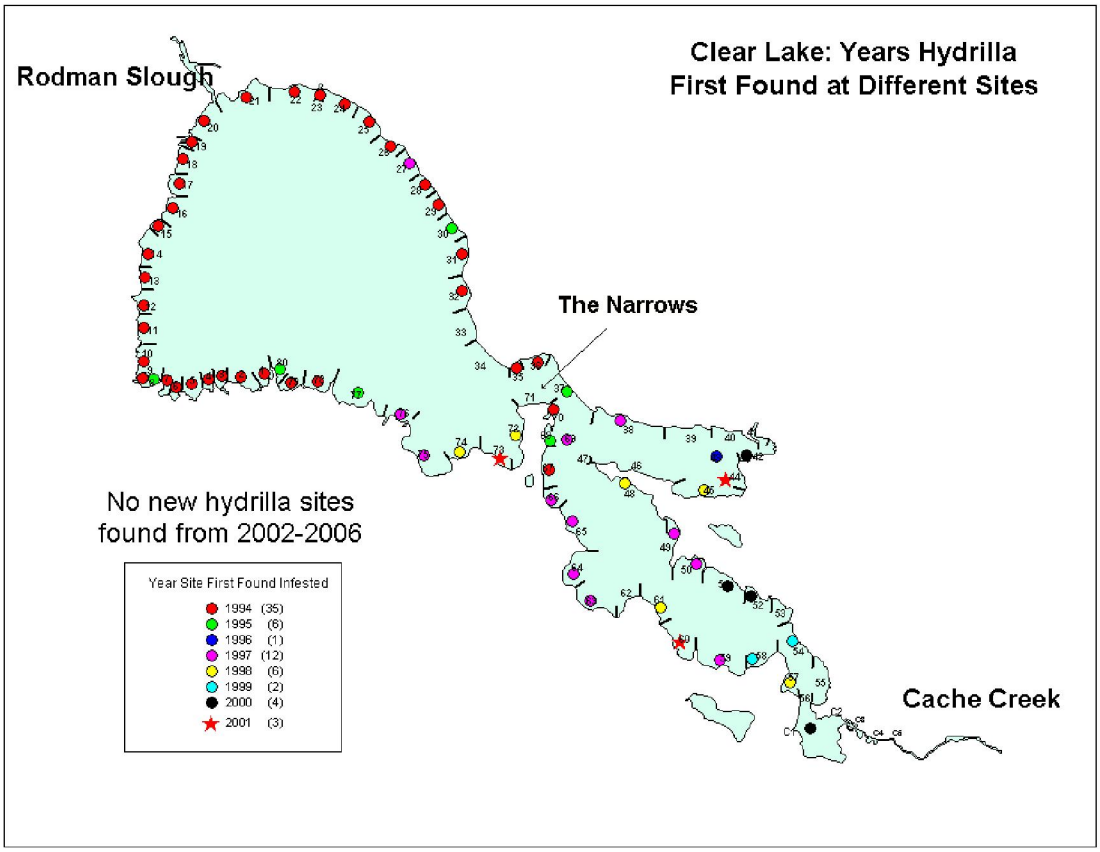
The current resurgence of plants clearly comes from tubers that were able to survive the three-year no-plant follow-up treatment. A review of the history of plant finds around the lake through the entire project show that plants that appeared in 2007-2009 largely appeared where plants had been during the first elimination of the plants during 1994 through 2003 (Plate 5). Further, the 2007-09 plants appeared in many parts of the lake all at once; the finds did not concentrate in one or a few locations. This was unlike the pattern of the original infestation, which was concentrated on the western shore of the lake (Plate 6). If the plants had been re-introduced to Clear Lake, it would likely have been at one or a few locations and not in widespread places all at the same time.

Plate 5: Plant find locations from 2007-2009 compared to finds in 1996-2003



The Clear Lake Project is a cooperative effort of the CDFA, the Lake County Department of Agriculture and the Lake County Department of Public Works. Clear Lake is the largest freshwater, natural lake completely within California's borders[21]. It is almost 22 miles long and eight miles wide, has a surface area of approximately 43,000 acres, and has about 100 miles of shoreline. Clear Lake is located roughly 90 miles north of San Francisco. The lake is relatively shallow, with an average depth of approximately 26 feet. Because it is shallow and has winds most afternoons, Clear Lake's waters move and mix significantly, so it does not strongly develop the temperature-based layering (thermocline, stratification) that is typical of most lakes, not even in late summer. Water temperatures range from mid to high 30's degrees Celsius (86+ degrees Farenheit) in the summer to five to 10 degrees Celsius (40 to 50 degrees Farenheit) in the winter. Temperatures are ideal for hydrilla germination and growth from April until mid-October, especially the monoecious form that is in Clear Lake.

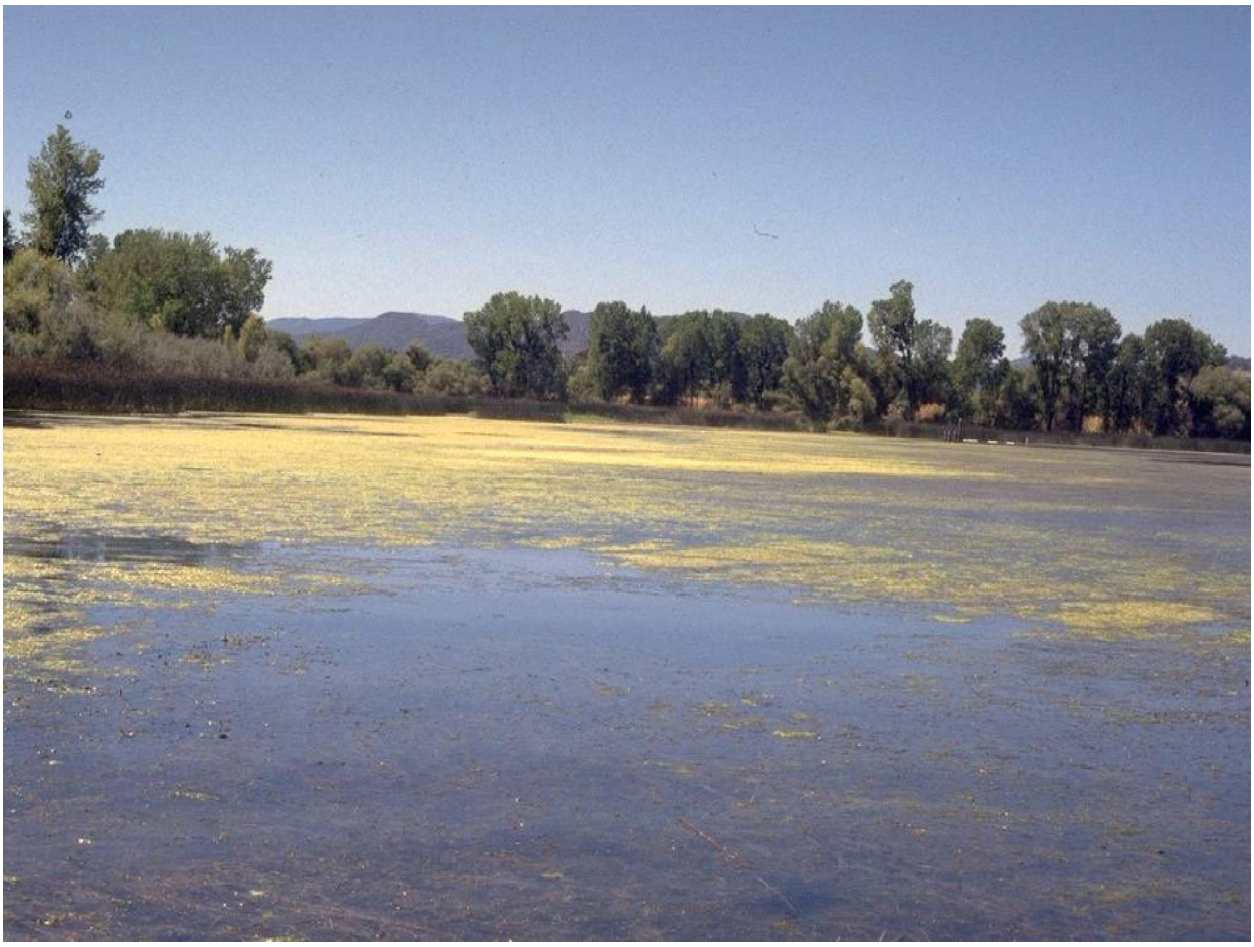
Plate 6. Map of Clear Lake in Lake County Showing Location of Hydrilla Program Management Units and the Year Hydrilla First Detected in Each Unit.



[21] Clear Lake is a popular fishing and water sports recreational lake. Clear Lake has often been described as the "Bass Capital of the West." The Lake is host to a number of bass tournaments throughout the year. There are also catfish, crappie, hitch and bluegill in the lake. There is also carp bow hunting.

Hydrilla was first found in Clear Lake on August 1, 1994, during a routine detection survey by personnel from the CDFA and the Lake County Department of Agriculture (Plate 7). The CDFA and Lake County biologists responded rapidly and applied copper herbicide to some infested areas within two weeks of the first detection. In addition, the CDFA, with the cooperation of the Lake County Agricultural Commissioner, put Lake County under quarantine[22]. The CDFA and Lake County biologists conducted the initial delimiting survey in 1994 and found that 175 to 200 surface acres along the shoreline of the upper arm of Clear Lake were infested (Plates 6, 7). Infestation levels varied from a few scattered plants to dense populations covering many acres. In addition, in both 1994 and 1995, thousands of hydrilla fragments were visible at some of the boat ramps at the western end of the lake. The CDFA convened a Scientific Advisory Panel in 1994 (Stocker, R.K. and L.W.J. Anderson *et. al.* 1994), which recommended a survey, treatment and public education program.

Plate 7: Hydrilla in Clear Lake, 1994, in the area of Big Valley, before treatments started.



[22] Because of the heavy recreational use of the lake, and the high risk that contaminated recreational equipment, clothing, or vehicles could spread hydrilla plant fragments, tubers, or turions around the Lake, or out of the Lake to nearby ponds, lakes, and streams (particularly Cache Creek), the CDFA and Lake County restricted movement of watercraft, motors, trailers, fishing gear, and other vehicles and equipment until they were inspected and cleaned of aquatic vegetation at the boat docks and ramps. These restrictions are still in place.

Clear Lake Project personnel divided the lake's shoreline into 85 (originally 80) management units in order to better organize eradication efforts (Plate 6). These management units were based upon landmarks for ease of navigation; they are not equal in length or area. These management units also vary in width but usually extend about 500 to 600 feet from shore toward the center of the lake, where the water is 15 to 20 feet deep. In 2003, all of the management units were surveyed and mapped using global positioning system/global information system technology to increase accuracy of herbicide treatments, and to better coordinate aquatic vegetation management activities with the Lake County Integrated Aquatic Vegetation Management Program[23].

Survey of Clear Lake

Surveying for hydrilla in Clear Lake is a challenge. Surveys cover from the shoreline out to 600 to 800 feet from the shore, so the area to be surveyed in one circuit of the lake's 100+ miles of shoreline is about 7,300 acres (about 11 square miles). Hydrilla is also hard to find in Clear Lake. The crews found 76 plants in 2009, but that represents a very small part of a 43,000-acre lake. Finding each plant took an estimated 95 to 105 hours of actual search time on the water.

The Project attempts to survey every management unit every three to four weeks during hydrilla's growing season. Surveys always represented at least 40 percent of the Clear Lake Project's activities, and that percentage continued to increase as management units reached the three-year criterion for ending treatments during 2002 to 2006. Presently survey represents at least 85 percent of the crew's time.

In 2005, project crews conducted 549 surveys of the management units for an average of 6.4 surveys per unit. In 2006, the crews surveyed the management units on average once every four weeks, conducting 495 surveys for an average of 5.9 surveys per unit. In 2007, even though hydrilla returned and treatments resumed, the crews surveyed 719 management units, for an average of 8.5 visits to each unit. In 2008, the crews accomplished 744 surveys, for an average of 8.75 visits to each unit, or about once every 3.4 weeks. In 2009, the crews accomplished 750 surveys, for an average of 8.82 visits to each unit. As the season ran from about June 1 to November 31 this year, that averaged to about one survey of the entire lake every 2.9 weeks.

No hydrilla plants were detected in 2004, 2005 or 2006, but they reappeared in 2007 (Table 4). Previously, the last plant found in the lake had been on June 23, 2003. In 2007, about 72 "spots" of hydrilla were found (Plate 6). In 2008, about 196 spots appeared. Most were single plants, but many were large clumps up to several yards across and topping out at the water's surface, especially during September and October, 2008. In 2009, the crews found about 76 plant locations. This year the plants were in general much less vigorous than last year. Only a couple plants reached the surface, and none was larger than a yard or two in diameter. Most finds were just a few weak stems. The first plant was found on June 9 (July 9 in 2007 and June 17 in 2008), in Unit 60, in the eastern section of the lake. The last find was on November 12 (November 15 in 2007 and December 9 in 2008) in Unit 69 near the Narrows. The first survey in 2009 was on June 8 and the last on November 23. The water temperature at the time of the first survey was 20 degrees Celsius (68 degrees Farenheit) and was 10.6 degrees Celsius (51 degrees Farenheit) at the last survey.

[23] The Clear Lake Integrated Aquatic Vegetation Management Program is a permit system to allow the public and Lake County to conduct weed control operations in Clear Lake. The program is operated by the Lake County Department of Public Works.

The plant finds this year were scattered around the lake (Plate 6a and b), as was also indicated by their appearing in 24 management units (Table 4), but that was a decrease from the 34 management units in 2008. Many finds were in isolated locations, but there were two or three hotspots. This year, hotspots were again near the State Park in Units 76 and 77 and around Anderson Island just east of the Narrows in Units 68 and 69. A number of plants also appeared in Units 78, 79, 36 and 37. Hotspot locations have occasionally changed during the last three years. In 2007, the major hotspot was in Soda Bay, Unit 75, with some plants near the outlet in Unit 55. That hotspot has never produced any plants since 2007. In 2008, the largest hotspots were near the State Park in Unit 77, near Anderson Island in Units 68 and 69, and near the outlet in Units 55, 56, and 57. A number of plants, some very large, also appeared around Rattlesnake Island in Units 43 and 44. Some of the hotspots have lasted only one year, such as Soda Bay and Units 56-57. On the other hand, Anderson Island (Unit 69), the area around the State Park (Units 76, 77), and Rattlesnake Island (Units 43 and 44) have produced hydrilla fairly consistently. Fortunately, the hotspot that appeared in 2008, down near the outlet (Units 55-57), produced no plants in 2009.

This year (2009) the timing of finds during the season shifted from 2007 and 2008, and in an interesting way (Plate 9). In 2007, the greatest numbers of plants appeared in late August through September. In 2008, the peak came later, largely in late September and October. This year, the pattern reversed itself. The peak came in late July and August. Early in the season, it looked as though the population was going to take off, but it was then shut down, perhaps by the treatments.

Other aquatic plant species detected in Clear Lake in 2009 included coontail, curlyleaf pondweed (*Potamageton crispus*), American pondweed (*P. nodosus*), Illinois pondweed (*P. illinoensis*), egeria, common elodea, Eurasian watermilfoil (*Myriophyllum spicatum*), sago pondweed (*Stuckenia filiformis*), smartweed (*Polygonum* species), water hyacinth (*Eichhornia crassipes*), coontail, water primrose, spatterdock (*Nuphar luteum*) and spiny and southern naiad. The few water hyacinth found were removed.

Plate 8a. Hydrilla Finds in Clear Lake, 2007 - 2009: Western section of the lake.

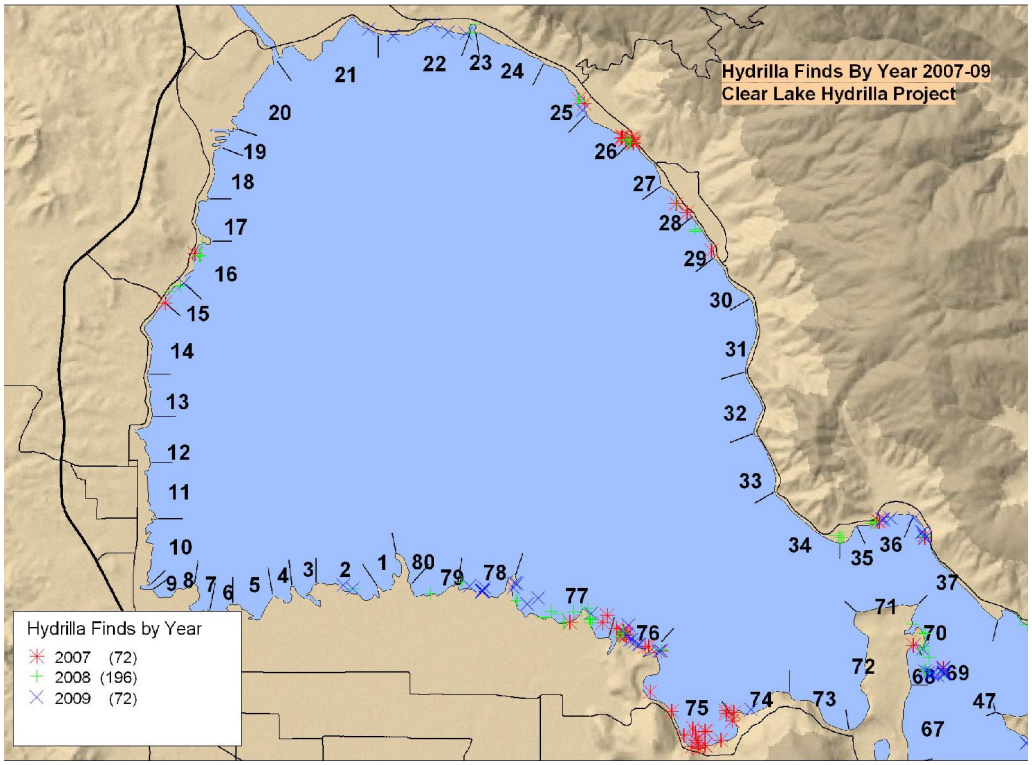


Plate 8b. Hydrilla Finds in Clear Lake, 2007 - 2009: Eastern section of lake.

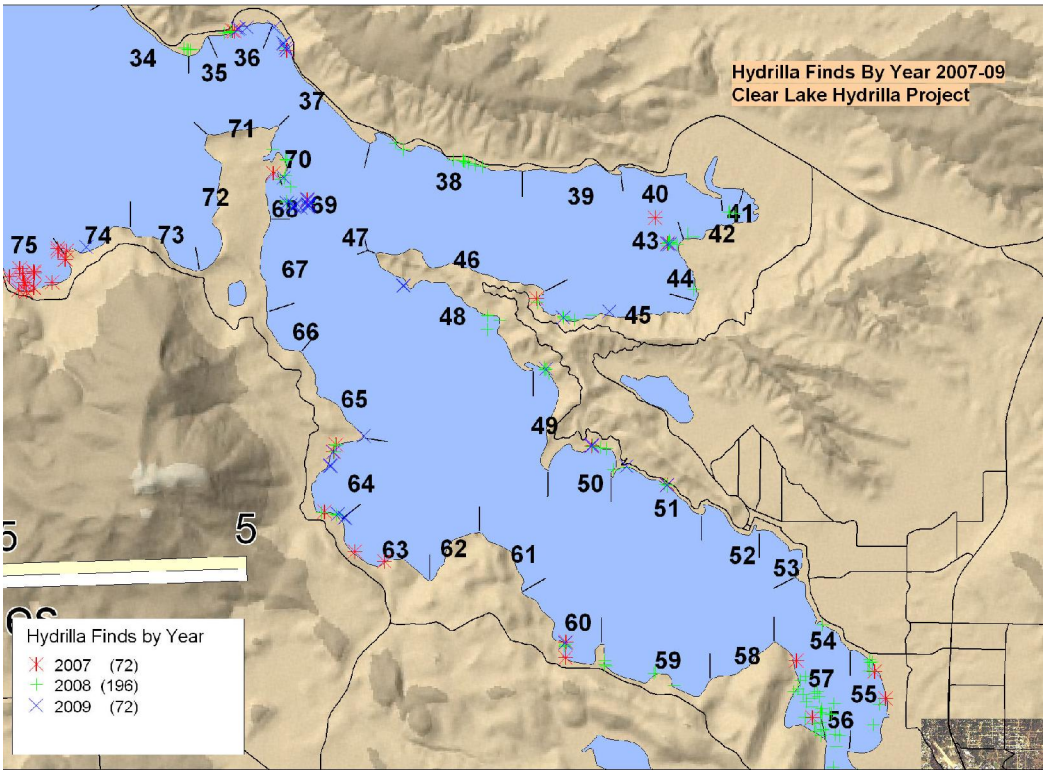


Plate 9.

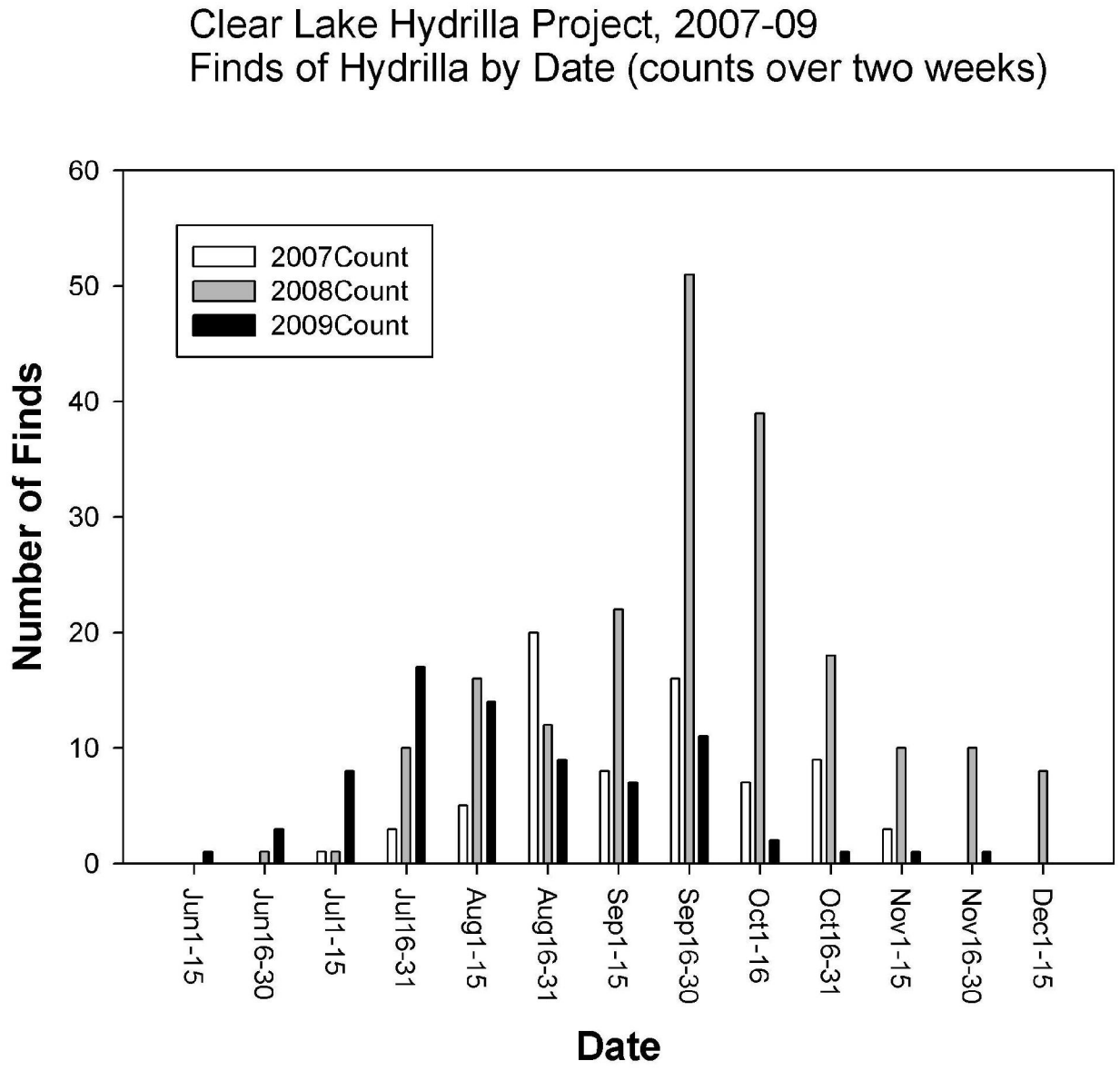


Table 4. Level of Hydrilla Infestation in Clear Lake, Lake County by Number of Infested Management Units* and Number of Finds 2000 to 2009

	2000	2001	2002	2003	2004 – 2006	2007	2008	2009
Number of Management Units with "Finds"	31	21	6	1	0	24	34	**24**
Number of Hydrilla "Finds"	67	41	12	1	0	72	196	**76**

*The management units were originally defined with reference to natural landmarks for ease of location, survey, and treatment. Management units are not identical in size or shape.

Clear Lake crews survey the deeper center sections of the lake in mid to late summer every year. This period was chosen because any hydrilla plants growing in the deeper sections of the lake would have reached the water surface by this time, and would be fairly easy to detect. In 2009, project crews made four center section surveys. No hydrilla has ever been detected in deep-water sections of the lake.

In addition to surveys, the Clear Lake hydrilla crew also does boat and trailer inspections for hydrilla before and after major fishing and boating events. In 2008, they conducted 180 boat and trailer inspections. No hydrilla was found.

Treatments of Clear Lake

Herbicide use in Clear Lake had dropped during 2002 through 2006, but that trend reversed itself beginning in 2007, continuing in 2008 and 2009 (Table 5). The Project used 2,206 pounds of elemental copper this year. This was down from the 5,292 lbs used in 2008, because the number of new finds was less this year. Each new find receives a single initial treatment with copper at 1 ppm. The treatment is very effective at burning back any hydrilla present, and it greatly reduces the amount of biomass that might otherwise tie up fluridone. If no new hydrilla sites were found next year, use of copper would drop dramatically. However, some copper was used this year to locally re-treat some areas where hydrilla was re-growing even within treatment areas. Fluridone is used for the remainder of the treatments.

Table 5. Aquatic Herbicide Used by the CDFA in Clear Lake, Lake County 2000 - 2009

Copper, pounds, as active ingredient							
2000	**2001**	**2002**	**2003**	**2004 – 2006**	**2007**	**2008**	**2009**
117	62	28	5	0	4352	5292	**2206**

Fluridone, pounds, as active ingredient									
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1,149	1,335	1,440	1,256	520	219	4.5	570	912	**1140**

The Clear Lake Project's use of fluridone had also decreased until 2006 (Table 5) as management units reached the three-year criterion for the end of treatments. That trend also reversed itself in 2007. In 2005, project crews treated 137 acres with fluridone slow-release pellets and none in 2006 (except for a five-acre area to maintain access to a survey area). In 2007, the Project established 248 acres of treatment areas, all of which will require treatment with fluridone for at least three years. During the 2008 season, the 196 finds required creating 62 new treatment areas covering an additional 325 acres. With adjustments and merging of treatment areas before the start of the season, 2009 started with about 599 acres under treatment. During 2009, the 76 finds required bringing another 120 acres under treatment. Treating the existing and new acreage required 1,140 pounds of fluridone in 2009. For the start of the 2010 season, about 719 acres will require treatment. That area will expand if there are any finds outside existing treatment areas.

Clear Lake is a weedy lake, and the Lake County Department of Public Works has an ongoing program for the management of general aquatic weeds. They contract with private applicators to control nuisance weeds in high-use areas, and they issue permits for private groups to control weeds in the lake. These permits require the permittee to identify the location of all proposed treatments, the method of treatment, and any aquatic vegetation present. The CDFA lead person at Clear Lake approves these permits before treatment can commence. In 2009, there were 124 permits for chemical treatments.

Surveys Outside of the Quarantine Zone

In 2009, Project crews surveyed only Blue Lake. Water levels were so low, due to a third year of drought, which the crews did not attempt to survey Cache Creek.

Public Information and Awareness

Public information and awareness are essential components of the Clear Lake Project. Since public access to the lake is not restricted and there are hundreds of access points, fishermen, guides, outfitters, fishing tournament organizers, boaters and other users of Clear Lake need to know how to prevent the spread of hydrilla within the lake or from Clear Lake to other lakes and streams. Clear Lake Project personnel distributed approximately 800 informational pamphlets to businesses and government agencies around Clear Lake.

In 2009, Clear Lake Hydrilla Eradication Project personnel made several presentations about the project. The project was highlighted in a presentation at the Western Aquatic Plant Management Society Conference in March. Patrick Akers gave presentations to the Lake County Board of Supervisors in February and to the Clear Lake Advisory Subcommittee in August. In addition, several informal discussions of the project occurred at other events during the year.

Technical Review Panel

This October, the Program convened a Technical Review Panel of four outside experts to review the Clear Lake Project and recommend any improvements. Participating in the TRP were: Dr. Lars Anderson of United States Department of Agriculture-Agricultural Research Service and University of California, Davis; Dr. Tyler Koshnick, Director of Research and Development for the manufacturer of Sonar; Rachel Woodfield, of Merkel Associates and who led the eradication effort against caulerpa in San Diego; and Scott Ruch, late of Remetrix, who provides the evaluation of treatment effects for the Department of Boating and Waterways' efforts to control egeria in the Delta. The group spent a day and a half discussing the project. They suggested a number of refinements for both survey and treatment, but supported the overall goal of eradication and the general approach. Their review and recommendations will appear in a separate report.

Study on Fluridone Distribution in Sediments

In conjunction with staff from Sepro, which manufactures Sonar (fluridone), Program staff started a preliminary study of the distribution of fluridone in the sediments of the lake. It has long been known that fluridone prefers sediments over water. In some ways, sediment may act as a slow release device that keeps the fluridone close to where new hydrilla plants appear, as they grow out of the sediment. This may be critical to fluridone's effectiveness in Clear Lake.

The Project treats just a small part of Clear Lake (one or two percent), and the lake has so much mixing of its water that the concentrations of fluridone in the water are generally very low. Even in treatment areas they are usually too low to be effective. So the question becomes, how can fluridone control the hydrilla in the lake? A small early study indicated that fluridone may concentrate just at the sediment surface, which could provide most of the effect on hydrilla. The current study is expanding on that early work.

MADERA AND MARIPOSA COUNTIES *(Lead: Florence Maly)*

The Chowchilla River – Eastman Lake Project stands as a fine example of daring, persistence, and hard work, making it a classic among weed eradication projects. With 20 years of effort, the Chowchilla Project leaders and crews have seen this project through from its daunting beginnings to achieve eradication this year, the seventh year with no hydrilla found anywhere in the system.

In June 1989, personnel from the CDFA and Madera County Agriculture Department detected dioecious hydrilla in Eastman Lake during a routine survey of aquatic sites in the county. Eastman Lake is a 1,800-acre reservoir that belongs to the United States Army Corps of Engineers (USACE) and is used for flood control, irrigation, recreation and wildlife habitat. The survey crews found scattered patches of hydrilla along the northern section of the lake and along the eastern and southeastern shoreline, amounting to 100 infested acres.

During an extensive survey of all known water bodies in the vicinity of Eastman Lake, survey crews detected hydrilla upstream of the lake in the west fork of the Chowchilla River. After a thorough survey, the crew determined that approximately 26 miles of river were infested. Plant density at different sites ranged from single plants to dense patches.

The CDFA, Madera County Department of Agriculture, Mariposa County Department of Agriculture and United States Army of Corps Engineers initiated the Madera and Mariposa Counties Hydrilla Eradication Project (Chowchilla/Eastman Project) in 1989, right after the first detections were made. The Project cooperators issued a quarantine for all of Eastman Lake and for the infested portions of the Chowchilla River, closing the areas to recreational use. Project crews treated the infested sections with copper. The lake was then drawn down to minimal pool to expose the infested areas, which were treated with metam-sodium (Vapam). After a few follow-up spot treatments with copper, survey crews have not detected hydrilla in Eastman Lake since 1993. As a result, quarantine restrictions have been progressively lifted.

Survey of Eastman Lake

Because hydrilla plants and tubers have been detected upstream of Eastman Lake in the Chowchilla River, surveys of the lake continued until the hydrilla was eradicated in the river. The lake was surveyed three times in 2007, twice in 2008, and twice in 2009. Hydrilla was absent. Rainfall was very scarce in the Chowchilla area in 2007, 2008 and 2009, and the river and lake were very low, even early in the season. The first survey of the lake in 2009 was relatively early, on May 20 through 22, when the water temperature was about 23 degrees Celsius (73 degrees Farenheit). The last survey was also early due to low water. It occurred on July 2 through 9, when the water temperature was about 28 degrees Celsius (83 degrees Farenheit). Other aquatic vegetation detected included various terrestrial weeds and algae. Water levels in the lake approached minimum pool.

Survey and Treatment of the Chowchilla River

In 2005, project crews conducted between two and three surveys of each management unit along the river. In 2006, the entire river was thoroughly surveyed once, and known hot spots were checked twice. The same occurred in 2007, except the timing was much earlier, as 2006 was very wet and 2007 was exceedingly dry.

In 2008 and 2009, the crews conducted a very thorough survey of the entire river over the course of several weeks. Known hot spots were checked twice. The 2008 survey was in mid-summer, while the 2009 survey was earlier because of low water. The first 2009 survey was on May 12, when the water temperature in the river was 21 degrees C (70 degrees F). The last survey was on July 13, when the water temperature was 23 degrees C (74 degrees F).

For the seventh year in a row, no hydrilla plants or tubers were detected in any of the 38 management units (Table 6). The last hydrilla in the river was found November 6, 2002, which was the only find of the year when two plants were found together. Seven years with no plants will be taken as adequate for eradication in this project.

Other aquatic vegetation detected in the river included elodea, curlyleaf pondweed, chara, coontail, azolla, duckweed, cattails, naiads, Eurasian milfoil, water primrose, algae and water buttercup.

Table 6. Number of Hydrilla Plants and Tubers Found and Removed from the Chowchilla River Project, Madera and Mariposa Counties 2000 – 2009

Year	**2000**	**2001**	**2002**	**2003-08**	**2009**
Plants	19	5	2	0	**0**
Tubers	1,789	23	3	0	**0**

Though no hydrilla was detected in 2005, project crews treated the two areas where hydrilla was detected in 2001 and 2002, marking the last treatment in the river. In 2001, hydrilla plants had been found in Management Unit 2 near Raymond Bridge, and in 2002, plants were found upstream in Management Unit 29. Each area was treated once with fluridone slow release pellets at 90 ppb each on July 13. A total of 0.25 pounds of fluridone active ingredient were used in 2005. Since 2005 was the third year of treatment with no plants, no treatments were made in 2006, 2007, 2008, or 2009.

Surveys Outside of the Quarantine Zone

Project crews surveyed all the access points on the Chowchilla River downstream of Eastman Lake.

NEVADA COUNTY *(Lead: Jonathan Heintz)*

Overview of Projects

Hydrilla was found in a pond in a waste transfer station in July 2004 in Nevada County. In 2005, probably as a result of heightened awareness, two more infestations were found in the County. One infestation was found at the County Fairgrounds in late February 2005, and a second was found in late December in a small irrigation pond about six miles south of Grass Valley. For clarity, the infestations will be treated separately.

Waste Transfer Station Fire Control Pond

Many details concerning the infestation and initiation of the eradication project were presented in the 2004 report, and only a summary of those is provided here.

On July 21, 2004, a representative of an aquatic plant management company found hydrilla in a fire control pond at the Nevada County Transfer Facility near Grass Valley. The CDFA and the Nevada County Department of Agriculture then started the Nevada County Hydrilla Project.

Project biologists mapped the pond (Plate 9) within two weeks. Several hydrilla mats were clearly visible in the northeastern third of the pond, including one that was fairly large. The pond is 0.6 acres in area, averages 18 feet deep, and has a rubber liner. It provides water for fire emergencies and to cool a wood waste chipping operation. The chipping operation requires substantial amounts of water several times a month. The Transfer Facility site itself is a 'no-runoff' site, and is surrounded by a drainage canal and several ponds to capture runoff. Two surveys for threatened and endangered species determined that treating the infested pond would not pose a threat. The frog population in the infested pond proved to be non-native bullfrogs.

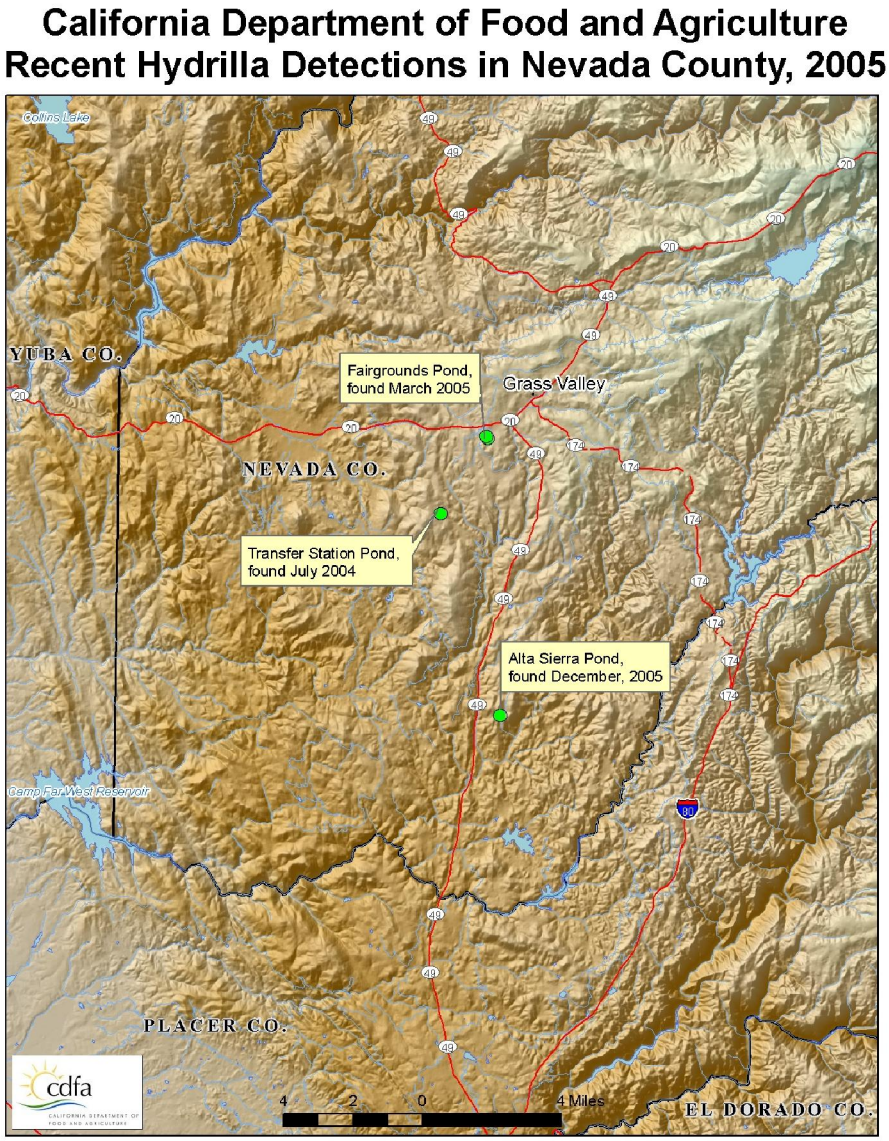
The Office of Administrative Law added Nevada County to the listed state hydrilla eradication areas on August 5. On August 23, the Secretary of Agriculture signed the Proclamation of an Eradication Project.

In early August 2004, CDFA divers free-dived the pond at the northeast end where the hydrilla mats were most visible. Divers reported several inches of sediment at this end of the pond, and recovered several tubers in the sediment. Dr. Lars Anderson of the USDA-ARS also did a pre-treatment survey of the density of the hydrilla infestation, finding an average of 2.3 ± 0.7 kilograms of hydrilla (dry weight) per square meter (Anderson, Lars W.J., 2004, Unpublished data, USDA-ARS Exotic and Invasive Weed Research Unit). The survey also showed that most of the water column was filled with hydrilla, even where it was not clearly visible at the surface.

Survey and Treatment of the Fire Control Pond

The Project biologist surveyed the pond once a month in 2009, beginning in late June and ending in September. No hydrilla was found on any survey. The pond was treated once in June with fluridone to reach a concentration of 90 ppb (1.5 pounds of active ingredient). Because the pond is isolated and has little flow, a single treatment was warranted. Water sampling showed that the fluridone remained at effective levels through the winter.

Plate 10. Map of Ponds currently known to be infested in Nevada County



Nevada County Fairgrounds Pond

On February 22, 2005, a county biologist on a mosquito survey saw plants that he suspected might be hydrilla in the main pond at the County Fairgrounds. He reported his observations to the County Agricultural Commissioner's Office. John Mills, the Deputy Commissioner, sent a sample to the CDFA Botany Lab, which confirmed the plant as hydrilla. On February 24, CDFA biologists made the first assessment of the pond. On March 23 and 25, they screened the outlet of the pond and carefully surveyed the pond and environs. Raking and visual surveys indicated that the pond bottom was nearly 70 percent covered with hydrilla, but later soil core sampling, taking a four-inch diameter core at each of 29 locations, recovered no tubers and only one fragment of hydrilla. Surveys of the ponds and streams in the area found no other hydrilla locations.

The major function of the pond is the irrigation reservoir for the fairgrounds, but it is also a popular local fishing spot, locally known as Lions Lake because the Lions Club holds an annual fishing derby there. High-accuracy GPS showed that the area of the pond is 2.75 acres, and boat transects showed that the average depth is about 5.5 feet. Most of its water comes from the Nevada Irrigation District flume, which runs through the Fairgrounds near the pond, but during rainstorms the pond can receive considerable runoff. The pond was formed by a dam or berm and is not directly in the bed of the local stream system, which leads to Squirrel Creek and the Yuba River. During dry weather, little or no water leaves the pond, but during storms significant amounts can overflow into the local stream. Reference sources indicated that there was an endangered plant in the area, and by June, after working with Department of Fish and Game experts and the CDFA's environmental compliance officer, project personnel found two populations of the Scadden Flat checkermallow (*Sidalcea stipularis)*. One population lies uphill of the pond area and away from any influence from it, but the other population lies about ½-mile downstream from the pond. The plants do not reside directly in the stream but do grow in the riparian area nearby. Because of the presence of the checkermallow and the use of the pond water for irrigation, project personnel limit the application rate of fluridone in the pond to 20 ppb at any time. In past practice, this level has proved to not be toxic, even to sensitive species of plants, and still controls the hydrilla.

Survey and Treatment of the Fairgrounds Pond

The Project biologist surveyed twice a month in 2009 beginning in late June. The last survey was September 15. No plants were found during the surveys. The pond was treated three times with fluridone slow release pellets, in July, August and September at 20 ppb per application. The treatment employed a total of 2.2 pounds of fluridone active ingredient.

Valkenburg Lane Pond

On December 21, 2005, an employee of the Nevada County Irrigation District, who had attended a training session on hydrilla, was checking a section of the Nevada County Irrigation canal for another purpose, when he noted suspicious plants in a small irrigation/recreational pond just downhill from the canal. He informed the Nevada County Agricultural Commissioner's Office. Brian Steger, from the office, took a sample and sent it to the Botany Laboratory at the CDFA Plant Pest Diagnostics Laboratory. The lab verified the plant as hydrilla, probably dioecious, on December 23. The pond is within the town limits of Alta Sierra, off Lime Kiln Road, about six miles south of Grass Valley. It is about 0.1 acres in area and five to 10 feet deep. The pond is formed by a small berm and does not have any significant connection to the local stream system. Its situation also limits local runoff into the pond and any potential overflow.

A group of biologists from the Commissioner's Office and the CDFA Hydrilla Program visited the pond before the end of the year and found it approximately 95 percent covered with hydrilla. On January 20, 2006, a crew from the Hydrilla Program surveyed all the ponds between the Valkenburg Pond and Wolf Creek, and also surveyed the irrigation canal for several hundred yards both upstream and downstream of the pond. They found no plants. The crew set up cage screens on the outflow pipe.

Surveys and Treatments of Valkenburg Pond

The treatments of 2006 and 2007 brought the hydrilla populations down to where no plants were visible in the pond by early 2008. The Project biologist surveyed the pond twice a month in 2009, beginning in late June. The last survey was in late September. No hydrilla appeared during the season. He treated the pond with fluridone slow release pellets three times, at 20 ppb each, in July, August, and September, using a total of two ounces of fluridone active ingredient.

SHASTA COUNTY *(Lead: Ed Finley)*

The Shasta County Hydrilla Eradication Project (Shasta Project) is a cooperative effort between the CDFA and the Shasta County Department of Agriculture. The Shasta Project began in 1985 after the dioecious form of hydrilla was detected in seven ponds located next to the Sacramento River. Due to the close proximity of the river and the potential threat to California water ways, the Governor of California issued a "Proclamation of Emergency" to empower eradication efforts. Surveyors in 1986 detected hydrilla in four additional ponds. The CDFA convened a Scientific Advisory Panel in 1986, which recommended a survey, treatment, and public education program (Stocker, R.K. and L.W.J. Anderson *et. al.* 1986). Based on these recommendations, Shasta Project crews chemically treated and filled in with soil four of the 11 ponds. Shasta Project biologists also treated the remaining seven ponds with herbicides for several years. By 2000, surveys showed that no hydrilla plants were detected in the 11 ponds and the CDFA considers hydrilla to be eradicated at these locations.

However, in 1994, hydrilla was detected in two interconnected ponds in River Park in Anderson, about eight miles south of Redding, and in 1996 it was detected in a pond system at the Riverview Golf Course in Redding (Plate 10). These infestations appear to be unrelated to the previous ones. The Shasta Project initiated a treatment program of aquatic herbicides and manual removal.

Survey and Treatment in the Anderson River Park Ponds

The Shasta Project crew detected no hydrilla in the two Anderson River Park Ponds from 1999 to 2004, but in 2005 hydrilla returned to one of the ponds. The ponds were surveyed and treated with fluridone in 1999, 2000 and 2001, and were surveyed, but not treated, in 2002, 2003 and 2004, as per the eradication protocol. In addition to surveys from shore and canoe in 2002 and 2004, the CDFA contracted a crew of divers from the Shasta County Sheriff's group to survey the large pond. No survey found any plants. In 2004, the ponds were surveyed 10 times between May 17 and October 22. Six weeks prior to the last survey date, the Project crew used triclopyr to treat water primrose that was encircling the large pond and to improve visibility and access. The last survey was very intense, and employed a crew in a canoe and a crew of divers. The crew in the canoe surveyed the entire pond by visual inspection and by repeatedly dragging the grappling hook. The divers focused on previously infested areas of the pond, where hydrilla was last detected in 1999. No survey detected any hydrilla.

Following the 2004 surveys, the Shasta County Department of Agriculture and the Hydrilla Eradication Program declared the infestation as eradicated in early 2005. Even though the infestation was declared eradicated, CDFA crews generally continue to occasionally visit previously infested ponds, with decreasing intensity as time passes without finding plants. Unfortunately, in the last week of July 2005, three plants were found in the pond, again

demonstrating hydrilla's capacity for surprises. The plants were dredged and the whole pond was treated three times with fluridone, each time to achieve a concentration of 30 ppb.

The re-appearance of plants in 2005 re-initiated the complete eradication cycle. The hydrilla crew surveyed the ponds 17 times in 2006, and plants continued to emerge. The first survey was on May 31 and the last was on November 15. The first finds were five plants on May 31. The crew found two more plants in June, 11 plants in July, 12 in the first two weeks of August, and over 100 plants on August 22. The last find, a single plant, was on September 8. In total, approximately 130 plants appeared in 2006.

The crews treated the infested pond in 2006 with hand digging, dredging and herbicides. Between June 2 and August 11, the crews dug and dredged a total of 26 plants. The Program delayed fluridone treatments in 2006 to give the plants an opportunity to appear because fluridone lasts several months and will mask infestations. The first treatment occurred on August 25, just after the plants made their major flush. Four treatments were made at two-week intervals with fluridone slow release pellets. The first treatment was at 50 ppb, and the remaining three were each at 30 ppb, giving a total rate of 140 ppb and using 25.9 pounds of active ingredient. On August 23, prior to the first fluridone treatment, the crew treated the part of the pond that had plants with 2.6 pounds active ingredient of copper ethylenediamine complex (Komeen), at 1 ppm. This treatment removes the top growth of all aquatic vegetation, which allows more fluridone to remain and attack newly emerging hydrilla.

Because hydrilla made a strong appearance in 2006, treatments started earlier in 2007, 2008, and 2009. In 2009, the crew treated the hydrilla with Sonar SRP on June 26 and August 24 at 50 ppb of fluridone each time. The treatments used a total of 507 pounds of Sonar SRP, representing 25 pounds of fluridone. No copper was used this year. Crews also used some triclopyr and diquat to treat obstructing vegetation. The main target was water primrose.

No hydrilla appeared in the Anderson Ponds during the 2007, 2008 or 2009. The crews surveyed the ponds 13 times in 2007, nine times in 2008, and three times in 2009. The first survey in 2009 was on June 26 when the water temperature was 27 degrees C (81 degrees F) and the last survey was on December 1 when the water temperature was 11 degrees C (52 degrees F). Other aquatic plants noted were egeria, *Elodea sp.*, water primrose, nitella and chara.

Plate 11. Map of Infestation at Riverview Golf Course, Redding.

Survey of Riverview Golf Course Ponds

The Riverview Golf Course infestation consists of four interconnected ponds. The pond farthest upstream is approximately 30 acres in size and is adjacent to but outside the golf course. Project personnel refer to it as "Rother's Pond." It is fed by a small canal from the Sacramento River. The next three ponds are on the golf course, and, heading downstream, are approximately six, two and one acres in area. Water returns to the Sacramento River by a small stream from the one-acre pond. The one-acre pond and return stream often go partially or completely dry in the late summer. When Shasta Project crews first surveyed these ponds in 1996, they found the 30-acre pond to be infested in the lower 15 acres, where the infestation ranged from scattered single plants to small clumps. The six-acre pond was moderately to heavily infested, and the two small ponds were heavily infested.

The crew found 12 plants in 2005 in Rother's Pond and three in 2006, but there were no plants in 2007, 2008 or 2009 (Table 7). There were 18 surveys of Rother's Pond in 2008, beginning on June 10 and ending on November 21. In 2009, the crew inspected Rother's Pond 11 times. The first survey was on June 11 when the water temperature was 19 degrees Celsius (67 degrees Farenheit), and the last survey was on December 3 when the water temperature was 9 degrees Celsius (49 degrees Farenheit).

No plants have been found in the lower three ponds since 2002. The crew surveyed the lower ponds eight times in 2009, and again found no hydrilla. The first survey was on June 11 when the water temperature was 21 degrees C (69 degrees F), and the last survey was on October 15 when the water temperature was 10 degrees C (50 degrees F). In 2008, the crew surveyed the six-acre, two-acre and one-acre ponds six times between June 23 and November 13.

Other water plants noted during the surveys were elodea, egeria, water primrose, nitella and chara. Other water plants noted during the surveys were cattails and water primrose.

Table 7. Number of Hydrilla Plants and Tubers Found and Removed from Redding Golf Course Ponds, Shasta County 2000 - 2009

	YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rother's Pond	Plants	1	9	18*	1	0	12	3	0	0	0
	Tubers	0	0	0	0	0	0	0	0	0	0
Riverview Golf Course Ponds 1, 2, 3	Plants	32*	31	10	0	0	0	0	0	0	0
	Tubers	0	0	75**	0	0	0	0	0	0	0

*Estimated from narrative descriptions.
**Dredging operation in 2002 in main infested area; no dredging done in other years.

Treatment of Riverview Golf Course Ponds

The treatment strategy for the Riverview ponds was different in 2006 from other years. Rather than beginning treatments early at the beginning of June, they were delayed until late in July. The delay was meant to allow the plants to grow large enough during the early part of the season to let them be found readily. In previous years, the crew treated only the lower, 15-acre originally-infested area. Beginning in 2006, treatments were made to the entire 30-acre pond, but no treatments are made directly to the smaller downstream ponds. The lower three ponds have not had any hydrilla in several years, and, in addition, water sampling shows that fluridone spreads readily to them from Rother's Pond (see 2006 report).

After giving the hydrilla the opportunity to reveal itself in 2006, treatments to Rother's Pond began earlier in 2007, 2008, and 2009. In 2009, the crew made two applications to Rother's Pond using fluridone slow release pellets at 50 ppb each time, to achieve a total concentration of 100 ppb[24]. Applications occurred on July 21 and September 15. A total of 1,040 pounds of Sonar SRP were used, representing 79 pounds of fluridone. No copper herbicides were used this year.

Starting in late July and for most of the treatment season, the Riverview Golf Course pumped irrigation water from the Sacramento River in order to avoid using fluridone treated water from Rother's Pond[25].

[24] Rother's Pond is large enough to qualify for a higher total seasonal application rate (150 ppb) than the smaller ponds (90 ppb), as per the Sonar® SRP label.
[25] In 1996, the golf course superintendent was concerned that fluridone treated irrigation water might injure the turf or ornamentals on the course. For this reason, Rother's Pond was not treated with fluridone in 1996 in order to avoid any possibility of phytotoxicity. The golf club developed an alternate water source in 1997, and fluridone has been applied to the pond since 1997.

Survey Inside and Outside the Quarantine Zone[26]

Because of budget constraints, the seasonal crew was eliminated at the Redding office this year. No general detection surveys were done. In the recent past, 200 to 300 ponds and stream sites were checked each year.

TULARE COUNTY *(Lead: Florence Maly)*

There have been two separate infestations of hydrilla in Tulare County. In 1993, a biologist for the Tulare County Department of Agriculture detected monoecious hydrilla in three small ponds that belonged to an ornamental wholesale nursery near Visalia. The CDFA and Tulare County biologists, with the cooperation of the owner, emptied the ponds to dry out the hydrosoil, and then fumigated with metam-sodium. The ponds were never refilled with water and remain dry to this day. The CDFA crews continued to survey these ponds for several years, but no hydrilla was ever found. The CDFA considers the hydrilla in these ponds to be eradicated.

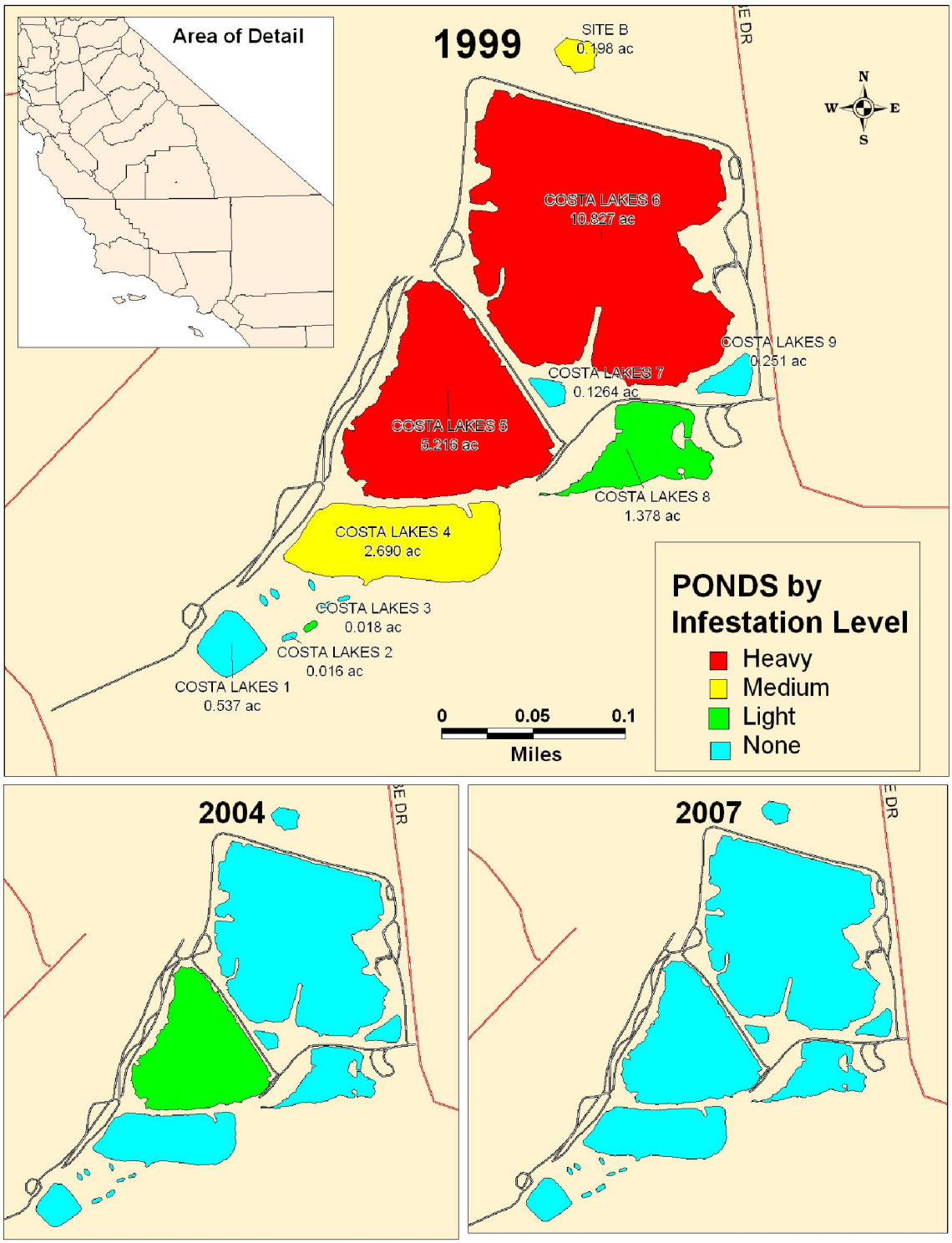
On October 7, 1996, a second infestation appeared in a fishing resort southwest of Springville and east of Porterville (Plate 12). The Tulare County Hydrilla Eradication Project (Tulare Project), which is a cooperative effort between the CDFA and the Tulare County Department of Agriculture, began soon thereafter. This resort is adjacent to the Tule River and is approximately two miles upstream from Lake Success[27]. The hydrilla is of the dioecious form.

Delimitation surveys by project crews determined there were five infested ponds on the resort and one infested pond on an adjacent downstream property. The infested ponds ranged in size from 0.02 acres to 10.8 acres with a total surface area of 20 acres (Plate 12). The infestations in the ponds ranged from very dense to just a few scattered plants. Four other non-infested ponds were also on the resort. Additional ponds have been created since the initial hydrilla detection. Most of these are relatively small (less than 0.1 acre) and the owners use them for fish breeding. There are now a total of 15 ponds.

[26] Hydrilla infested counties are "Eradication areas" by California Code of Regulations, Section 3962. "Quarantine zones" are reduced areas within "Eradication areas" and are the specific water bodies in the county where there are restrictions as to water access or use, as per California Code of Regulations, Section 3410.

[27] Lake Success is a 2,450-acre reservoir managed by the USACE and is used primarily for flood control and agricultural purposes, although it is also popular for recreation.

Plate 12. Map Showing Change in Hydrilla Infestation at the Springville Ponds from the Year of First Detection, 1996, to Current Year, 2009



Survey and Treatment of the Springville Ponds

Project crews surveyed all 15 ponds on the resort property and the one infested pond off the property between four to eight times in 2006, five to six times in 2007, three to five times in 2008, and four to five times in 2009. In 2009, the first survey occurred over April 9 to 24, when the water temperature was about 18 degrees Celsius (65 degrees Farenheit). The last survey was on November 23, when the water temperature was 11 degrees Celsius (52 degrees Farenheit). Originally, in 1996, there were five infested ponds; by 2004, the only pond that had any hydrilla was number five, where 10 mats were found (Plate 12, Table 8). In 2005, nine surveys in that pond detected no hydrilla, and neither did eight surveys in 2006, six in 2007, five in 2008, or five in 2009. Because of high turbidity and algal and blue-green algal blooms in the pond, the water visibility is poor. Crew members have developed a technique of cruising the pond while sitting on a kayak with a survey hook tied to one leg. Using this method, they can repeatedly cover the pond, stop quickly when they feel any resistance, and carefully tug on the obstruction. Because of their technique and the soft bottom of the pond, they can often bring up a plant with its root crown intact. Other aquatic vegetation detected in these ponds included elodea, curly leaf, American, and small leaf pondweeds, chara, azolla, water primrose, duckweed, naiads, nitella, cattails and algae.

Table 8. Number of Rooted Hydrilla Plants and Tubers Found and Removed from the Springville Ponds, Tulare County 2000 – 2009

YEAR	2000	2001	2002	2003	2004	2005-08	2009
Mats	0	0	0	0	10*	0	**0**
Plants	9**	37***	0	0	0	0	**0**
Tubers	1,749***	243***	0	0	0	0	**0**

*Pond 5 only.
**Ponds 5 and 6.
***Pond 6 only.

Since the project began, the eradication treatments have included hand removal of plants, copper and fluridone herbicides and small-scale dredging of tubers. In 2008, Pond 5 was treated twice with Sonar SRP for a total concentration of 70 ppb. Since this was the fifth year with no plants, no herbicide was applied this year.

Surveys Outside of the Quarantine Zone

In 2009, Tulare Project crews surveyed Lake Success, the large reservoir on the Tule River downstream from the infested ponds. No hydrilla was detected.

YUBA COUNTY *(Lead: Jonathan Heintz)*

Yuba County has had three distinct hydrilla infestations: Lake Ellis, Shakey's Pond and Oregon House. The first two infestations were considered eradicated. The first hydrilla infestation in California was in Lake Ellis, a 31-acre ornamental lake in the center of Marysville. Dioecious hydrilla was found there in 1976. In 1979, Program personnel drew down the lake, removed the hydrosoil and treated the infested areas with metam-sodium (Vapam). Six plants re-appeared in 1980 in one small location. The biologists then treated the entire lake with endothall and copper ethylenediamine complex, with special attention paid to the infested location. By 1981, the lake was free of hydrilla and eradication was declared in 1984. The

second infestation in Yuba County was discovered in 1990 in Shakey's Pond. It may have become infested as a result of hand carrying infested material to it from Lake Ellis in the 1970's, or as a contaminant in a planting of bass from Florida. Hand removal and aquatic herbicide treatments reduced the number of plants in the pond until only one plant was found in 1996, when the pond received three treatments of fluridone. No plants were found in the pond after 1996, and this infestation was also considered eradicated after 2002. That status continued until 2007, when a follow-up inspection found hydrilla in the pond. More details will follow the discussion of the Oregon House infestation.

Oregon House: The On-Going Eradication Project

On August 7, 1997, a third infestation of hydrilla appeared in Yuba County near Oregon House (Plate 13), about halfway between Marysville and Grass Valley, north of Highway 20. A visitor to a local winery suspected that hydrilla was in one of the ponds on the grounds and reported it to the Yuba County Department of Agriculture. Yuba County biologists investigated, found hydrilla and sent a sample to the CDFA Plant Pest Diagnostics Lab for confirmation. Scientists at the United States Department of Agriculture, Agricultural Research Service (USDA-ARS) Exotic and Invasive Weed Unit confirmed it to be the monoecious type.

The Oregon House Hydrilla Eradication Project (Oregon House Project) started after this first detection. The Project is a cooperative effort between the CDFA and the Yuba County Department of Agriculture. Biologists conducted delimitation surveys at the winery and found a total of five infested ponds (ranging from 0.15 to 3.0 acres in size and nine to 13 feet deep) and an infested ornamental fountain[28] (Plate 13). The winery uses two of the ponds, Ditch Pond and Tank Pond, to irrigate the vineyard. Project crews also conducted delimitation surveys within a three-mile quarantine zone and detected additional infestations on three private properties: the Spiers 1, 2, and 3 Ponds (3.8, 0.5, 0.4 acres) and the Clouse and Ronen Ponds (1.9 and 0.1 acres) (Plate 13). The two smaller Spiers Ponds were used for rearing catfish. Another 40 ponds were surveyed and found not to be infested.

In 2000, project survey crews on routine surveys detected three additional infested ponds. These were Reservoir 23 (0.25 surface acres), Davis (0.37 acres) and Citron (0.22 acres) Ponds (Plate 13). Reservoir 23 is also used for irrigation at the winery. In 2003, surveys detected a single hydrilla plant in Spiers Pond number 5. Project staff had surveyed this pond multiple times per year since the beginning of the project. A plant fragment probably floated down to it from Spiers Pond number 1, via a small creek. In 2007, the Project biologist discovered a new pond (named Cornejo) in the area that had been dug recently. It proved to be infested.

Although hydrilla was first found in a pond, they are all are downstream of and fed by an infested canal (see below). Final eradication of the hydrilla in the ponds is not possible as long as the canal remains infested and can provide plant fragments to re-infest them. Therefore, the strategy has been to keep the populations in the ponds under surveillance and suppressed, but not pushing all out for eradication, until the infestation in the canal has been destroyed.

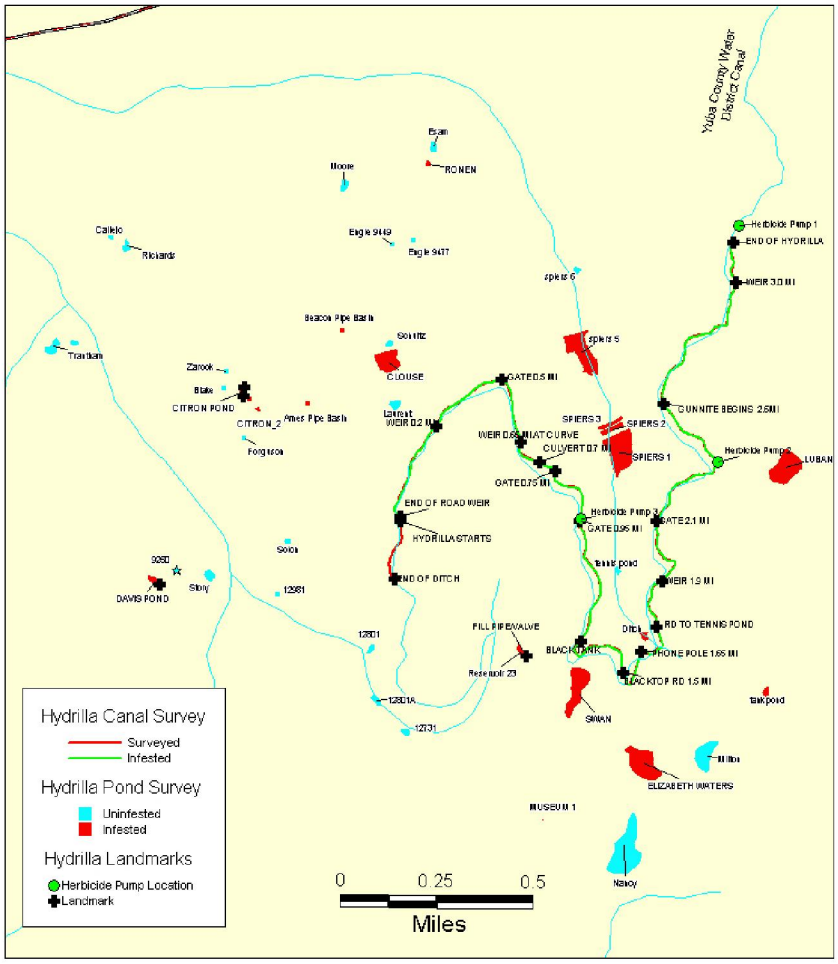
[28] The infested water lilies in the ornamental fountain were removed, the hydrilla plants and tubers destroyed, and the water lilies repotted and returned.

2009 Survey of Ponds within the Quarantine Zone

Project staff visited most ponds every two weeks in 2009, focusing on ponds that have had hydrilla in recent years. Visits started in mid June when water temperatures ranged from 19 to 24 degrees Celsius (66 to 75 degrees Farenheit). In the three ponds used for irrigation by the winery, two produced hydrilla this year. Reservoir 23 had one plant, which was immediately treated with a copper herbicide. The Ditch Pond had three plants, growing in area historically known to have tubers. The area was dug and dredged for tubers and treated with copper like Reservoir 23. Of the three irrigation ponds, only Tank pond did not produce hydrilla this year. Other aquatic vegetation noted during the surveys included coontail, egeria, Eurasian watermilfoil, and two forms of algae, nitella (Nitella species) and chara (Chara species).

Plate 13. Hydrilla Infested Ponds near Oregon House, and Hydrilla Infested Portion of Yuba County Water District Canal

Oregon House Hydrilla Eradication Project, Yuba County



Of the 11 ponds not used for irrigation, hydrilla was detected in three in 2009, as compared to five in 2008 (Table 9). Each pond has its own hydrilla history. In 2006, Citron Pond was heavily infested by mid season. This year the plants were much smaller and scattered. Clouse Pond, which had over 50 plants in 2006, was free of hydrilla for the last three years. Two ponds, Elizabeth and Swan, had not produced any plants for at least six years (Table 9). In 2008 the crew focused an intense survey on the two ponds. They managed to find a single plant in Swan but Elizabeth remained free of plants. Neither pond produced plants this year. Davis Pond had been clear for several years, but produced a few plants in 2006. It then produced no plants in 2007, 2008 and 2009. The four Spiers ponds have been free of hydrilla for the last three years, as well as small Ronen pond. One big recent surprise was in 2007 in Luban Pond. It had been free of hydrilla for three years, but in 2007 at least one-third of the pond was very heavily covered by plants. Since the pond is isolated, the crew has been trying experimental treatments, occasionally using copper and fluridone if the population became too persistent. In 2009 less than 50 plants were sighted during the growing season.

Table 9. Presence (+) or Absence (-) of Hydrilla Plants or Tubers in the Yuba Ponds Near Oregon House, Yuba County 2000 – 2008

Hydrilla Detections (Plants or Tubers) in the Yuba County Ponds

YEAR

Pond Type	Pond Name	Pond Size (Acres)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Irrigation	Ditch	0.2	+	+	+	+	+	+	+	-	+	+
	Reservoir 23	0.3	+	+	+	+	-	-	+	-	-	+
	Tank	0.2	+	+	+	+	+	+	-	-	-	-
Non-Irrigation	Citron	0.2	+	+	+	+	-	+	+ (extremely heavy)	+ (many)	+ (many, small)	+ (many, small)
	Clouse	1.9	-	-	+	+	-	+	+	-	-	-
	Cornejo									+ (new)	+	-
	Davis	0.4	+	-	-	-	-	-	+	-	-	-
	Elizabeth	3.1	+	-	-	-	-	-	-	-	-	-
	Luban	3.0	+	-	+	+	-	-	-	+ (very heavy)	+	+
	Ronen	0.1	-	dry	dry	+	-	+	+	-	-	-
	Spiers 1	3.8	+	+	+	+	-	+	+	-	-	-
	Spiers 2	0.5	-	+	dry	dry	+	-	?*	-	-	-
	Spiers 3	0.4	-	dry	dry	dry	-	-	?*	-	-	-
	Spiers 5	3.5	-	-	-	+	-	+	+	-	-	-
	Swan	2.7	-	-	-	-	-	-	-	-	+	-

*? = suspicious-looking plants but could not be hooked for confirmation.

Treatment of Ponds within the Quarantine Zone

Water bodies were treated according to the conditions observed in the ponds and management goals and constraints. However, the biologist's field notes were lost late in the season, so details on treatments are not available this year.

Several ponds received special treatments in recent years:

In Citron Pond, the biologist is working with the owner to try to avoid damage to some specimen fish and landscaping plants around the pond. This pond had a heavy re-emergence of hydrilla in 2006. During the first week of October that year, the biologist and a crew harvested three pickup loads of hydrilla from the 0.2 acre pond and applied two treatments of diquat, a contact herbicide less toxic to fish than copper. In 2007, we obtained a permit from the Department of Fish and Game to release sterile triploid grass carp in this pond, as it is artificial and isolated from the local stream system. Two fish were released in September 2007. This is the first time the Hydrilla Program has released grass carp outside the Imperial Irrigation District. During repeated surveys in 2008, the biologist could never find the carp, and the hydrilla continued to appear in substantial numbers, although the plants were small. The owner was becoming frustrated with the hydrilla and asked for more aggressive treatment. In 2008 and 2009, the project biologist treated the pond with copper, treating only one-third of the pond at a time and using curtains to try to contain the herbicide and minimize the effects on the fish. The treatment burned back the plants without any observable damage to the fish. In 2009, we received permission from California Department of Fish and Game to re-stock four triploid grass carp, which were placed in the pond in late July 2009. This year the fish were spotted on a few occasions. The biologist also dredged the north end of the pond in 2009, removing approximately 1500 tubers. They were for Tomas Barr of University of California, Davis, for ongoing research on methods to control tubers.

Once the heavy infestation in Luban pond was discovered in 2007, Program biologists decided to use the situation to try new treatment methods. Working with Dr. Lars Anderson of USDA-ARS, crews sampled plant densities in the pond and then applied two treatments of imazamox at 300 ppb each, on September 6 and 11, 2007. On a short visit to the area on January 7, 2008, heavy mats of hydrilla were easily retrieved from the pond, indicating the imazamox did not have much effect, and the situation did not improve through the spring and early summer. Project managers hoped to try a treatment with the new aquatic herbicide penoxsulam during the 2008 season, but could not make arrangements in time with Dr. Anderson. Finally, to contain the infestation, the biologist treated the pond with endothal on July 8, and followed up a week later with an application of fluridone at 30 ppb. This treatment resulted in plants completely disappearing from the pond by the end of summer. The penoxsulam treatment was finally applied in 2009, with applications in June, although plant numbers were already low. Water samples showed levels of penoxsulam much lower than targeted rate at the end of the season. However, CDFA and UC Davis staff sampled for tubers before the treatment and at the end of the season and plan to continue the study in 2010.

The Yuba County Water District Canal

While surveying Oregon House in 1997 after finding hydrilla in a winery pond, the Project biologists found that the lowest 3.1 miles of an 18-mile irrigation canal were infested with hydrilla (Plate 13), in the area where it passes through the winery. In addition, two other small basins, which are used to transfer water from the canal, were also found to be infested (Ames (0.01 acres), and Beacon (0.02 acres)). The Yuba County Water District (YCWD) owns the canal and

runs water in it between April and October. The canal is the source of hydrilla for all the ponds, thus eradication of the hydrilla in the canal is essential to the success of the entire Project.

From 1997 to 1999, Project biologists tried several treatment methods in the canal, with mixed results. A method to meter copper herbicide into the flowing water proved promising in 2000 and has been used ever since. The method uses electric pumps at three stations, one mile apart along the canal, to apply the herbicide to the water for four hours. The rate of application decreases from station to station to maintain a one-ppm concentration of copper along the canal. Visual observations in 2000 indicated that this method was relatively effective in controlling the hydrilla top growth. In 2006, the Project Biologist improved the delivery system for the copper herbicide so that the treatment duration could be increased from four hours to 12. Also in 2000, project biologists started raking[29] and digging tubers in the canal, which has proved effective, though labor intensive and time consuming. In 2001, an acetic acid treatment was tried with promising results (Spencer, D. and G. Ksander, 2001), although the conditions required for treatment are so exacting that the method is not very practicable.

Survey and Treatment of the Yuba Water District Canal

Project personnel visited the canal about once every two weeks this season. Project biologists divided the 3.1-mile infested section of the canal into management units 50 meters in length, starting from the upstream limit of the infestation, leading to a total of 65 units.

Project biologists have noted a decrease in the number of plants and tubers removed from the canal in the past several years, indicating a continuing decrease in the tuber bank. The crews removed 2,696 tubers and plants in 2005 and 1,175 in 2006, but they found only 170 in 2007, approximately 100 in 2008, and only about 20 plants in 2009. Many of the heavily infested sections of the canal were lined with concrete in 2008 and 2009 (see below), which helped contribute to the few plants found this year. All plants were dug out, so no copper treatments were made this year.

Late in 2008, Project staff decided to try a newly available treatment method for canals. This method involves using fluridone essentially as a pre-emergent herbicide. Once the water was turned off in the canal in October, the crew treated the dry bottom with a liquid formulation of fluridone, Sonar AS. Fluridone tends to bind to sediments. Rains during the winter move it slightly down into the soil profile. Studies have shown that the fluridone will remain down in the soil when the water returns to the canal in the spring. The water picks up no residue of fluridone so there is no danger in using the water for irrigation, and the fluridone is available to act on small hydrilla plants sprouting from tubers. The project biologist plans a repeat application of the treatment for 2010, to control hydrilla and other plants that interfere with surveys.

The two transfer basins for the canal also have a history of hydrilla. Plants were detected in Ames in 2003. The irrigation district dug out this basin with a backhoe in 2004 and no plants were found that year. Two plants were found and removed in 2005, but none were found in 2006 and 2007. A few plants appeared in 2008, and all were dredged out to remove any tubers. Plants appeared again in 2009 and the biologist took care while removing them to not send fragments of hydrilla downstream. Working together, the project biologist and the canal company have decided to line or pipe the basin in 2010 before the irrigation season starts. The

[29] The rake method is simply to use a garden rake to sift the sediment in the canal bottom and sides to remove any hydrilla plants, tubers, roots, and root crowns. Screens are placed downstream of the raking operation to catch any floating hydrilla fragments.

Beacon holding basin is concrete-lined and was cleaned of all sediment and hydrilla by project biologists in January of 2002. No hydrilla has been detected there since.

In addition to hydrilla, project biologists find several other aquatic plants in the canal, including elodea, American pondweed, sago pondweed and cattails. In places, the population levels are quite high, making survey difficult and interfering with treatments. The plants also develop a heavy cover of algae, which complicates survey and treatment.

Lining of the Yuba County Water District Canal

In April 2007, Program staff began developing a $100,000 contract to line the most heavily infested section of the canal with concrete, in an attempt to put an end to this infestation. The contract was awarded on March 27, 2008, and provided for lining approximately 3,500 feet of the canal. Work began on March 31 and finished April 9. The contractor used a custom-designed bucket on a four-wheel-drive backhoe to remove sediment from the canal and contour its profile, then sprayed three to four inches of concrete on the cleaned surface (see 2008 report for photographs). The work was challenging because of access issues, but was very well done.

The canal lining accomplished by the CDFA encouraged the Yuba County Agricultural Commissioner, Louie Mendoza, and his staff to work with the Yuba and Sutter Counties Weed Management Areas and the canal company to continue the effort and try to line all of the most heavily infested parts of the canal, a total of about 9000 feet. They organized an effort, with the help of a $20,000 contribution from the Hydrilla Program, to line another 1500 feet in April of 2009, and are working to line about 2000 feet in both 2010 and 2011. These efforts will go a long way to putting an end to this infestation. No plants have ever been found in a lined section.

Shakey's Pond, Survey and Treatment

Dr. Anderson reminded Program staff in late August, 2007, that Shakey's Pond had been infested, although the infestation had been declared eradicated about 2002. When the Oregon House Biologist went to survey the pond, he found small clumps of hydrilla scattered among very dense stands of other aquatic weeds such as egeria. Treatments began in about a week.

The heavy plant biomass originally in the pond would have interfered with the hydrilla taking up fluridone. Accordingly, Project biologists used copper to quickly take down the mass of plants. However, killing too much biomass at one time might cause oxygen depletion and lead to a fish kill. To minimize that possibility, the Biologist treated one-third of the pond at a time. No fish mortality was noted. The copper treatments occurred on September 4, 14 and 21, to reach a concentration of 1 ppm of copper in each treated area. The copper treatments cleaned up the pond very thoroughly, and the biologist applied two treatments of fluridone at 45 ppb during October 2007. Those treatments established the fluridone in the sediments to wait for new plants emerging in 2008.

Water samples taken early in the 2009 treatment season revealed that the concentrations of fluridone remained above levels needed to control hydrilla. Treatments were delayed until September when one application of fluridone at 45 ppb was applied. The pond was surveyed monthly by kayak and boat. Only three plants were found in 2009. They were small and sickly and were removed with tubers attached.

SURVEY ONLY PROJECTS

The Sacramento-San Joaquin River Delta Survey

Each year since the mid-1980s, CDFA personnel have conducted a survey of the Sacramento-San Joaquin River Delta and the lower reaches of the tributary rivers for hydrilla[30]. The annual survey is conducted in September when hydrilla plants would have reached the surface and formed dense mats. The crews also note the presence of other aquatic weeds.

Survey of the Sacramento/San Joaquin River Delta

Staff from the Fresno Hydrilla Program office conducted the 2009 Delta Survey, which covered ten days from September 7 through 18 and employed two to four crews. Surveys of larger waterways, such as Old River, Middle River, major canals and many of the major sloughs, were conducted from motorboats. All areas with a high risk of infestation were thoroughly surveyed, both visually and by means of the hydrilla hook to verify submerged weeds.

The marinas, launch ramps, and some of the smaller channels and sloughs were surveyed by canoe. Smaller watercraft allowed the crews to get closer to shore and boat slips, resulting in a more thorough survey.

The following waterways were surveyed:
Old River southeast of River's End Marina to rock dam, Fabian and Bell Canal, Grantline Canal, Old River from Frank's Tract to Grant Line/Fabian Bell Canals, Italian Slough and Widows Island, Quin's Island, North Canal, Victoria Canal, Middle River from Connection Slough to Victoria /North Canals, North Victoria Canal, Woodward Canal, Indian Slough, Orwood Cut, Railroad Cut, Whiskey Slough, Smith Canal, Calaveras River to I-5, Empire Cut, Turner Cut, Fourteenmile Slough, Latham Slough, Connection Slough, Deep Water Channel from Disappointment Slough to end at Port of Stockton, Hog I Cut, Old River/Holland Cut bet. Holland Riverside Marina & Sand Mound Slough, Holland Cut, Columbia Cut, Ward Cut, Tinsley Island, Bear Creek, Pixley Slough, Disappointment Slough, Honker Cut, Bishop Cut, White's Slough, Potato Slough.

Marinas and launch ramps:
Rivers End Marina, Tracy Oasis Marina, Lazy M Marina, Discovery Bay Yacht Harbor, Orwood Resort, Cruiser Haven, Whiskey Slough Marina, Louis Park Launch Ramp, Ladd's Stockton Marina, Buckley Cove Launch Ramp, River Point Landing, Five Star Marina, Tiki Laguna Resort & Marina, Turner Cut Resort, Windmill Cove Marina, Stockton Sail Club, Rock Slough Resort, Holland Riverside Marina, Village West Marina, Paradise Point Marina, King Island Resort, Honker Cut Marina, Herman & Helen's Marina, Hennis Marina, Frank's Marina, Sunset Harbor, Lundborg Landing, Marine Emporium, Sugar Barge RV, Seahorse Marina, Russo's Marina, Boyd's Harbor, Beacon Harbor, Bethel Harbor.

[30]The Delta carries 47 percent of all the runoff water in the state. It provides water for residential, industrial, and agricultural uses in both the north and south state areas. The Delta supports approximately 120 fish species, approximately 750 plant and animal species, and is the largest wetland habitat in the western United States (CALFED Bay-Delta Program 2001). The annual survey of the Delta was partially initiated in response to recommendations made by the Scientific Advisory Panel convened in 1988 to consider the hydrilla infestation in Calaveras County (Stocker, R.K. and L.W.J. Anderson *et. al.* 1988).

Aquatic Plants Seen:
Algae, American pondweed, azolla, cabomba, coontail, curly leaf pondweed, duckweed, Egeria, hyacinth, milfoil, parrotfeather, pennywort, primrose, sago pondweed, small leaf pondweed, cattails, tules.

SOUTH AMERICAN SPONGEPLANT (*leads Patrick Akers, Ed Finley and Florence Maly*)

The CDFA occasionally gives the Hydrilla Program responsibility for other newly introduced, invasive aquatic weeds. One recent example is giant salvinia, which has been eradicated from within the state. Similarly, beginning in about 2004, the Hydrilla Program began work on South American spongeplant (*Limnobium laevigatum*). This species behaves much like water hyacinth or giant salvinia except it reproduces heavily from seed, as well as producing new plants by budding. Until 2007 the effort was quite small. Spongeplant was limited to one small pond in the Redding area where it responded well to treatment. Over the last couple of seasons, however, new, separate infestations started appearing in several parts of the Central Valley, particularly the San Joaquin Valley. The increasing problems warrant including the plant in this report.

South American spongeplant presents something of a paradox as far as eradication is concerned. In any one location, even small crews can make significant progress and reduce populations to very low levels, even over long stretches of water. Conversely, the plant seems to be spreading rapidly and appearing in widely separated locations. Spongeplant could very well present a threat to California much like water hyacinth. However, hydrilla is the Program's priority, and the increasing number of infested sites is straining the Program's ability to address this pest.

South American Spongeplant was first confirmed in the San Joaquin Valley in August 2007 in the San Joaquin River in Fresno. Program crews initiated delimitation surveys and found plants in patches of various sizes and stages of development, in ponded and slow moving stretches of the river, starting approximately three miles upstream of Highway 41 and stretching downstream to Highway 145, a distance of around 20 miles. Up to 60 miles of river are usually dry below Highway 145. The infestation may continue beyond that point, but the crew has not been able to survey that far. During the 2007 season, CDFA crews identified the upstream limit of the infestation and hand removed approximately 90 percent of the biomass from there downstream to Highway 99, a distance of about 11 miles. Work continued in 2008 and 2009 with plant removal continuing down to Highway 145, again removing at least 95 percent of the biomass. In October of 2009 water flows increased from Friant Dam into the San Joaquin in the start of an attempt to restore salmon to the river. These releases are sending water beyond Highway 145 and may carry spongeplant along as well.

In the meantime, spongeplant was discovered in January 2008 in a small canal (Cameron Slough) arising from the Kings River east of Sanger in Fresno County. Delimitation surveys discovered the source pond (about 0.1 acres) and determined that the infestation covered only approximately two miles of Cameron and a short distance of an associated canal, Byrd Slough. Six weeks of intensive hand removal reduced the biomass by 90 percent. Throughout 2008 and early 2009, crews continued survey and removal activities on a routine basis and now can find only a few widely scattered plants. Periodic monitoring continues to remove germinated seedlings in the source pond. Spongeplant was never found in the Kings River.

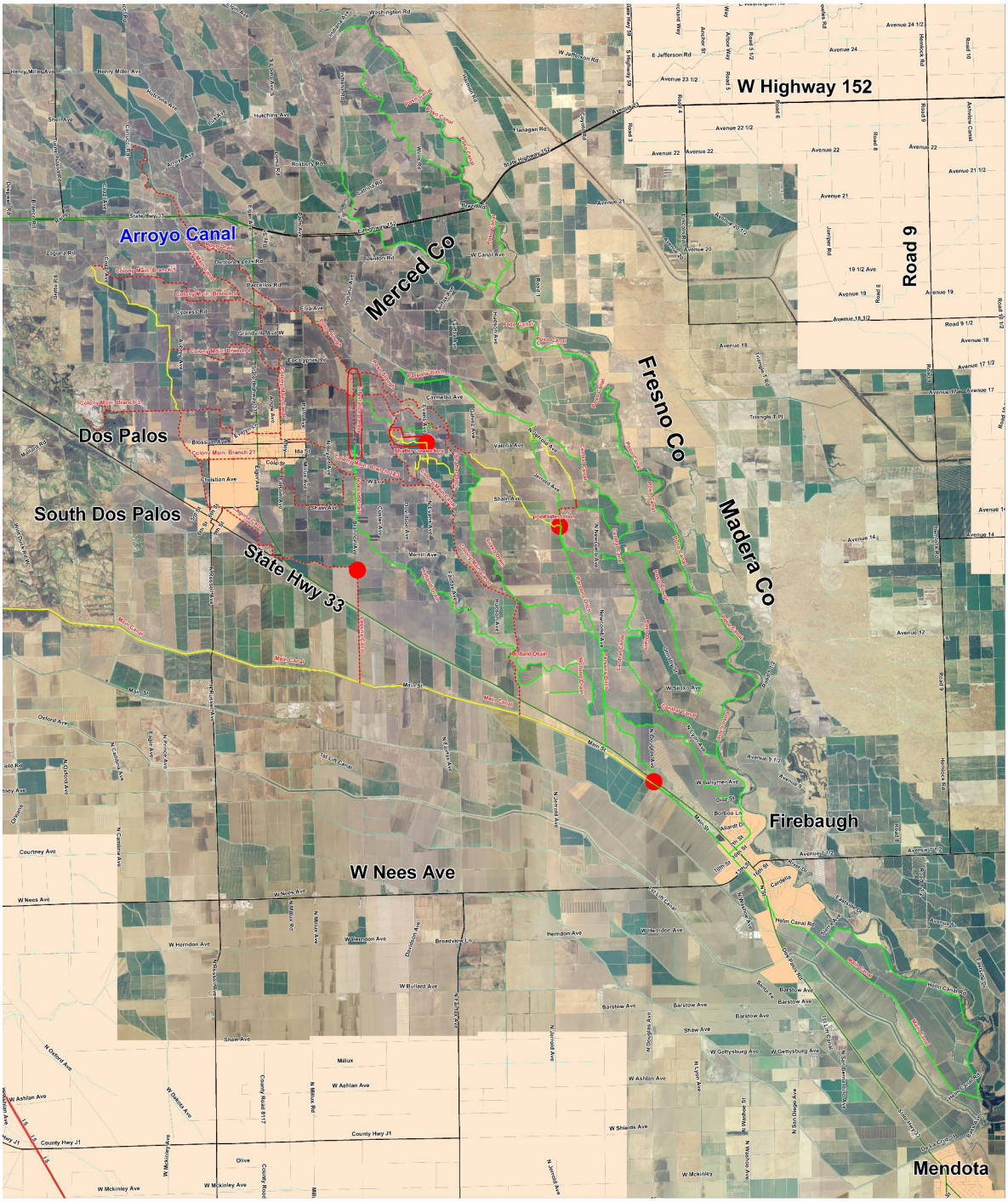
Another infestation was found in an irrigation canal in Merced County on June 25, 2008. The infestation was in the last 100 yards of a dead end canal. Almost all plants were manually or mechanically removed. The few remaining plants were treated with glyphosate. Pumps at the end of this canal pump water into a lateral canal where it is siphoned into fields. Very few plants were in the lateral prior to its going completely dry. No spongeplant was found in the fields or in any other canal in the vicinity. The main canal has been free of spongeplant since late July 2008.

In November 2008, the CDFA was notified of yet another infestation, this time in northwestern Fresno and southwestern Merced Counties. It is possible that this infestation came from plants in the San Joaquin River, as there is a connection between the river and a reservoir (Mendota Pool) that feeds the canals. The majority of plants were located in 0.3 miles of an irrigation canal, where most were trapped by a low bridge. However, some plants escaped, and occurred as widely scattered individuals over approximately five miles downstream. Additional delimitation surveys revealed the plant to be in at least three main delivery canals, two major drains and several smaller ditches, covering many miles of canals (Plate ??). In most areas, the surveys revealed light, scattered plants and small patches, with only a few major mats of mature plants, which were in two of the delivery canals.

The crews eliminated the mats by early 2009, using hand removal and glyphosate treatments. Many of the plants in the third delivery canal died when the canal was dewatered. However, plants reappeared later in the season, either from a seed bank or the few remaining individuals. By late September, large mats reappeared in one large canal and numerous plants were found in two major drains. By the end of the season in late December, hand removal, some glyphosate treatments by the water districts, and dewatering had rid the canals of plants, but scattered plants remained in the drains.

There was also a report of spongeplant along the Sacramento River near Rio Vista. Hydrilla Program personnel confirmed a small infestation exists south of Brannan Island and appears to be spreading slowly. However, no crews are available nearby that can focus on removing it.

Plate 14: Spongeplant in the area of western Fresno County



Infestation Levels

local heavy	(1
no plants	(124
none; downstream of infested	(33
scattered	(151

South American spongeplant survey
in irrigation canals in the west-central section
of the San Joaquin Valley, California

Results of 2008 survey

SUMMARY AND CONCLUSIONS

2009 was another challenging year for the CDFA Hydrilla Eradication Program, mostly due to Clear Lake. Hydrilla continued its push there, and the areas needing treatment continued to expand. However, the Clear Lake Project has possibly broken the momentum of the hydrilla's resurgence. The number of plant finds this year were down by more than 60 percent from 2008; the plants were found in fewer areas and were of much lower vigor and the area needing treatment increased much less than in previous years. Assuming these results were not a fluke due to conditions in the lake this year, there is reason to hope we are beginning to turn the corner on this infestation once more. A great deal of work remains, but the goal seems attainable.

Aside from Clear Lake, hydrilla is in decline in California. Program crews found no hydrilla in eight infestations, continued to reduce the populations at the other known infested sites and found no new infestations this year.

Many of the current infestations are approaching eradication. In Eastman Lake and the Chowchilla River, no plants were detected for the seventh year in a row, and this project had reached eradication. No plants were detected for the last five years in Calaveras County in Bear Creek and the stock pond near Mokelumne Hill, and in the Tulare County fishing ponds. No plants have been found for three years in Shasta County and the Nevada County ponds. In addition, plant populations and tuber counts are decreasing in the Yuba County Water District Canal, although there have been some resurgences in several of the associated ponds. Only two infested drains remain in Imperial County.

While most if not all of the eradication projects made progress this year, the effort to find new hydrilla introductions has suffered some in the past two years, especially north of the Delta. This is due to the demands of Clear Lake, which has led to the loss of the seasonal crew in Redding and the Clear Lake crew focusing all its efforts on the lake, with no time for detection surveys. In the Delta and San Joaquin, survey continues at a good pace, much of it in conjunction with work on spongeplant. CDFA and county biologists continue to survey the critical Sacramento/San Joaquin River Delta. Once again, CDFA survey crews detected no hydrilla plants in the Delta in 2009.

The CDFA Hydrilla Eradication Program has been a cooperative effort since the first discovery of hydrilla in Lake Ellis in Marysville in 1976. The Governor, Legislature and the CDFA recognized the threat hydrilla posed for the State of California and quickly instituted the legal framework needed to eradicate this noxious weed. With the support of many cooperators, the CDFA Hydrilla Eradication Program has been successfully conducting survey, eradication and public education efforts ever since.

In conclusion, the CDFA's Hydrilla Eradication Program is helping to protect California's waterways by keeping them free of an especially invasive, noxious, aquatic weed. Continued diligence in survey and public outreach, and rapid response to any new detection, are keys to the success of this effort. The CDFA Hydrilla Eradication Program would like to thank its supporters and cooperators for aiding in its success.

COOPERATORS

The CDFA Hydrilla Eradication Program would like to thank all of its cooperators and supporters in 2006. The CDFA has received financial support, manpower, regulatory support, and/or technical assistance from the following: the California Department of Boating and Waterways, Center for Spatial Technologies and Remote Sensing, California Department of Water Resources, United States Army Corps of Engineers, United States Department of the Interior-Bureau of Reclamation, United States Department of Agriculture-Agricultural Research Service Exotic and Invasive Weed Research Unit, the Yolo County Flood Control and Water Conservation District, Lake County Department of Public Works, Imperial Irrigation District, Nevada County Transfer Facility, and the Alameda, Calaveras, Contra Costa, Imperial, Lake, Los Angeles, Madera, Mariposa, Nevada, Orange, San Joaquin, Santa Barbara, Shasta, Tulare, Ventura and Yuba County Agricultural Commissioners.

REFERENCES

CALFED Bay-Delta Program, 2001. *Ecosystem Restoration Program, Draft Stage 1 Implementation Plan, August 2001. CalFed Bay-Delta Program*, 1416 "9th" Street, Room 1155, Sacramento, California 95814 www.calfed.water.ca.gov/stage1_2002_psp.htm

Cocks, T. J. Jennsen, A. Stewart, I Wilson, and T. Shields, 1998. *The HyMap Airborne Hyperspectral Sensor: The System, Calibration, and Performance. Proceedings of the 1st EARSEL Workshop on Imaging Spectroscopy*, Zurich, October 1998

DiTomaso, J. M. and E. Healy, 2003. *Aquatic and Riparian Weeds of the West.* University of California Division of Agriculture and Natural Resources publication number 3421. 6701 San Pablo Ave, Oakland, CA94608-1239

Mulitsch, M., E. Underwood, J. Greenberg, S. Ustin, R. Leavitt, L. Anderson, M. Carlock, 2005. *Application Of Hyperspectral Imagery For Detecting Invasive Aquatic And Riparian Species In The Sacramento-San Joaquin Delta*. Proceedings of the California Weed Science Society, 2005

Netherland, M.D., D.R. Honnell, A.G. Staddon, and K.D. Getsinger, 2002. *Comparison of Immunoassay and HPLC for Analyzing Fluridone Concentrations: New Applications for Immunoassay Techniques.* Lake and Reservoir Management 18(1): 75-80 2002

Spencer, Dave and G. Ksander, 2001. *Influence of a Dilute Acetic Acid Solution on Hydrilla and American Pondweed in the Oregon House Canal.* The United States Department of Agriculture, Agriculture Research Service, Exotic and Invasive Weed Unit, One Shields Avenue, Davis, California 95616

Stocker, R.K., L.W.J. Anderson, A. Leon Bates, J.J. Joyce, H.E. Westerdahl, 1986. *Report of the Hydrilla Science Advisory Panel on Hydrilla Infestations in the Sacramento River.* California Department of Food and Agriculture, 1220 "N" Street, Sacramento, California 95814

Stocker, R.K., L.W.J. Anderson, A. Leon Bates, J.J. Joyce, H.E. Westerdahl, 1988. *Report of the Hydrilla Science Advisory Panel on Hydrilla Infestations on Redding and Calaveras Areas.* California Department of Food and Agriculture, 1220 "N" Street, Sacramento, California 95814

Stocker, R.K., L.W.J. Anderson, A. Leon Bates, J.J. Joyce, H.E. Westerdahl, 1989. *Report of the Hydrilla Science Advisory Panel on Hydrilla Infestations in Eastman Lake and Chowchilla River.* California Department of Food and Agriculture, 1220 "N" Street, Sacramento, California 95814

Stocker, R.K., L.W.J. Anderson, A. Leon Bates, K.A. Langeland, 1994. *Report of the Hydrilla Technical Review Committee.* California Department of Food and Agriculture, 1220 "N" Street, Sacramento, California 95814