THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
HYDRILLA ERADICATION PROGRAM
ANNUAL PROGRESS REPORT 2012

PROTECTING CALIFORNIA'S WATERWAYS

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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 2012. 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 most 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. 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 2012 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 the Lake County Department of Public Works, and the Sutter-Yuba Weed Management Area.

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, so eradication efforts cost less and result in less environmental impact than if infestations 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 of 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, by the end of five weeks of growth, a single nine-inch rooted shoot (a stem with growing tip), produces 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 that 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 poisoned prey animals.

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 importantly 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" for 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 below). Of these 29 separate hydrilla introductions, the Hydrilla Eradication Program has eradicated hydrilla from 20 sites in the following 14 counties: Los Angeles, Madera, Mariposa, 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 nine locations in the following seven counties: Calaveras, Imperial, Lake, Nevada, Shasta, Tulare and Yuba. In 2010, with the declaration of eradication of the Chowchilla River / Eastman Lake infestation, Madera and Mariposa Counties move from the "infested" to the "eradicated" category. In 2012, the two infestations in Calaveras County and the infestation in Tulare County also achieved the criteria for eradication, and will be declared eradicated in late 2012 or early 2013.

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 2004, 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

[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.

throwing a small grappling hook (Plate 1), which is dragged 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 Fahrenheit[14]) in the spring and 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 2012, 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 or 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.

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 Advisory 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 should not depend on any fixed time criterion for follow-up treatment. They suggested instead 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

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[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.

presents challenges, both in accurately following tuber depletion and in relating this to the absolute absence of plants. It is not uncommon in tuber surveys to take a large number of random 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 depletion 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 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 results for the NPDES General Permit are 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, 2012

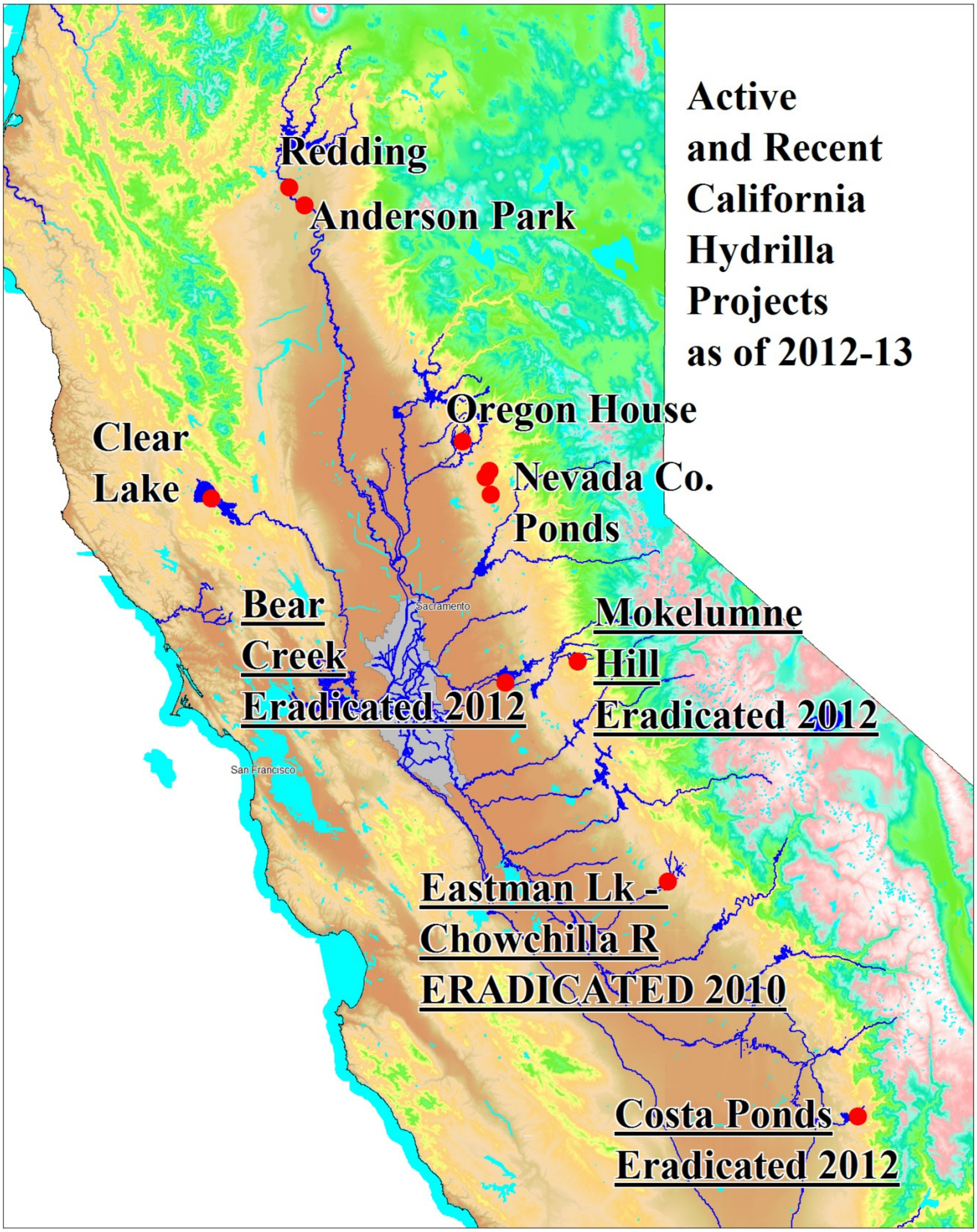


Table 1. Status of Hydrilla in California, by County, 1977 – 2012

COUNTY	YEAR *	DESCRIPTION OF WATERWAY	SIZE	STATUS**
Calaveras	1988	Bear Creek, Units 2 to 11	5 miles	Declare eradication 2012-13
	1988	Stock Pond	0.5 acres	Declare eradication 2012-13
	1996	Bear Creek, Unit 1	0.75 miles	Declare eradication 2012-13
Imperial	1977	Imperial Irrigation System	270 acres of ponds, 600 miles of canals, drains	Survey, Survey, Active
Lake	1994	Clear Lake	739 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	Declare eradication 2012-13
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.

2012 SEASON HIGHLIGHTS AND LESSONS

1) Three more hydrilla projects reached the threshold for eradication. At the end of the 2012 season, eight years have passed with no plants in the Mokelumne Hill and Bear Creek infestations in Calaveras County, and in the Costa Lakes infestation in Tulare County. These infestations will be declared eradicated this winter.

2) As of the end of 2012, six seasons with no plants have passed in Shasta County's Riverview Golf Course and Anderson City River Park infestations. The ponds had been under treatment with herbicide through 2011. 2012 was the first year of the non-treatment confirmation survey phase of the projects.

3) CDFA disbanded its longtime weed programs in 2011 due to declines in the State's General Fund, and with them went the six District Weed Biologists. The Weed Biologist in the Northwest District, Ed Finley, had been taking care of the hydrilla and spongeplant infestations around Redding, but that ended with his retirement as of June 30, 2011. His role has been picked up by Jonathan Heintz and Patrick Akers, working out of Sacramento, with help from the seasonal crews in Clear Lake or Fresno. The change in staffing led to a change in strategy for surveying the ponds. Rather than surveying lightly many times during the season, crews visited the ponds only twice, in the first weeks of July and September. However, they spent several days surveying the ponds each time. No hydrilla was found.

4) Clear Lake hydrilla had a little bounce this year. Three small colonies appeared, with three to 11 plants each, probably due to previously missed plants getting shredded and fragments starting new plants. All told 26 plants were found this year, as compared to six in 2011. However, because the colonies were compact, with the plants within a couple hundred feet of each other, just 26 acres were brought under treatment this year. Had all the 2012 finds represented single isolated plants, as many as 130 acres might have been brought under treatment. The number of new acres brought under treatment each year has been 350, 249, 120, 20, and 10 acres in 2007, 2008, 2009, 2010, and 2011, respectively.

5) After the results of 2011 and in anticipation of starting to dredge in Clear Lake, the Program took some treatment areas out of herbicide treatment in the 2012 season. All the candidate areas had been in treatment for at least consecutive four years and had gone at least four years without plants. About 90 acres were removed from treatment for the 2012 season. More treatment areas will become eligible for removal from treatment in the 2013 season.

6) In Nevada County, the Waste Transfer and Fairgrounds Ponds reached seven and six years, respectively, without plants. 2012 was also the first year without treatment for the two ponds. They will remain under survey for at least another three years before declaring eradication. In Valkenburg Pond, three small plants were found this year, so treatments continued in this pond.

7) Dredging for plants in Clear Lake occurred for the first time in 2012. Dredging is intended for removing occasional straggler plants, as a complement to herbicide treatments and to avoid prolonging them. By 2012, the Hydrilla Program had contracted with a Lake County biologist to put in place all the regulatory and permitting requirements for dredging and identified a contractor to do the dredging. We attempted

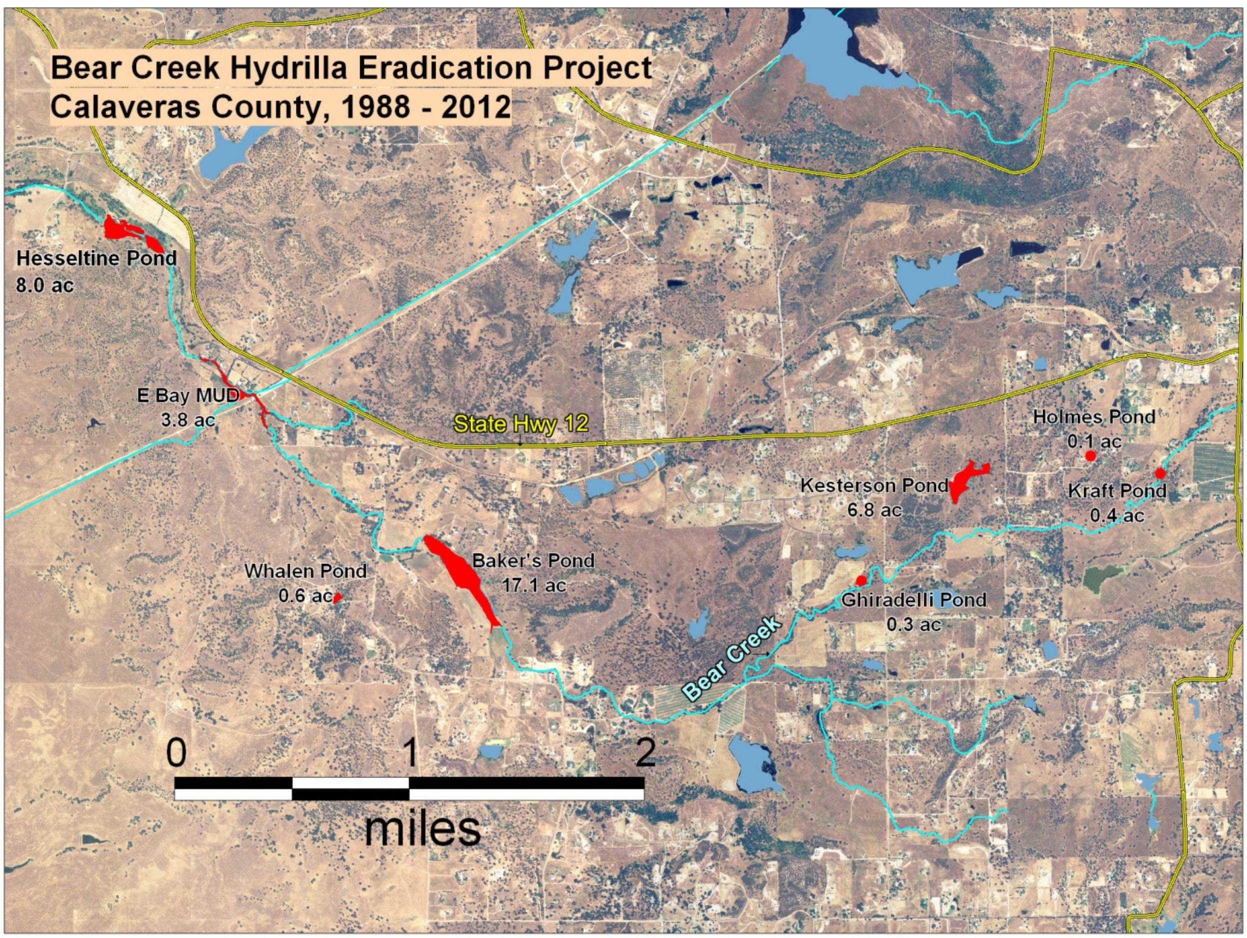
dredging six plants in one small area near shore, in a situation that provided relatively good conditions for dredging. Unfortunately, the contractor had trouble containing the spoils, which is a major requirement of the permits and contract. We will have to ensure better performance on this issue before dredging can proceed further.

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

CALAVERAS COUNTY *(Lead: Florence Maly)*

Both of the active projects in Calaveras County reached eradication this year. CDFA biologists believe that there have been two separate infestations of hydrilla, both dioecious, in Calaveras County, based on the separation by distance and watershed between the two locations. 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 (Plates 3,4). The Calaveras County Hydrilla Eradication Project (Calaveras Project) began soon after the plants were found.

Plate 3: Extent of Bear Creek Infestation when 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.

Later in 1988, a concerned landowner reported a separate infestation in two ponds located near Mokelumne Hill, about 30 miles from the Bear Creek area (Plate 5). 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. Active Bear Creek Hydrilla Infestation Area, near Lake Comanche

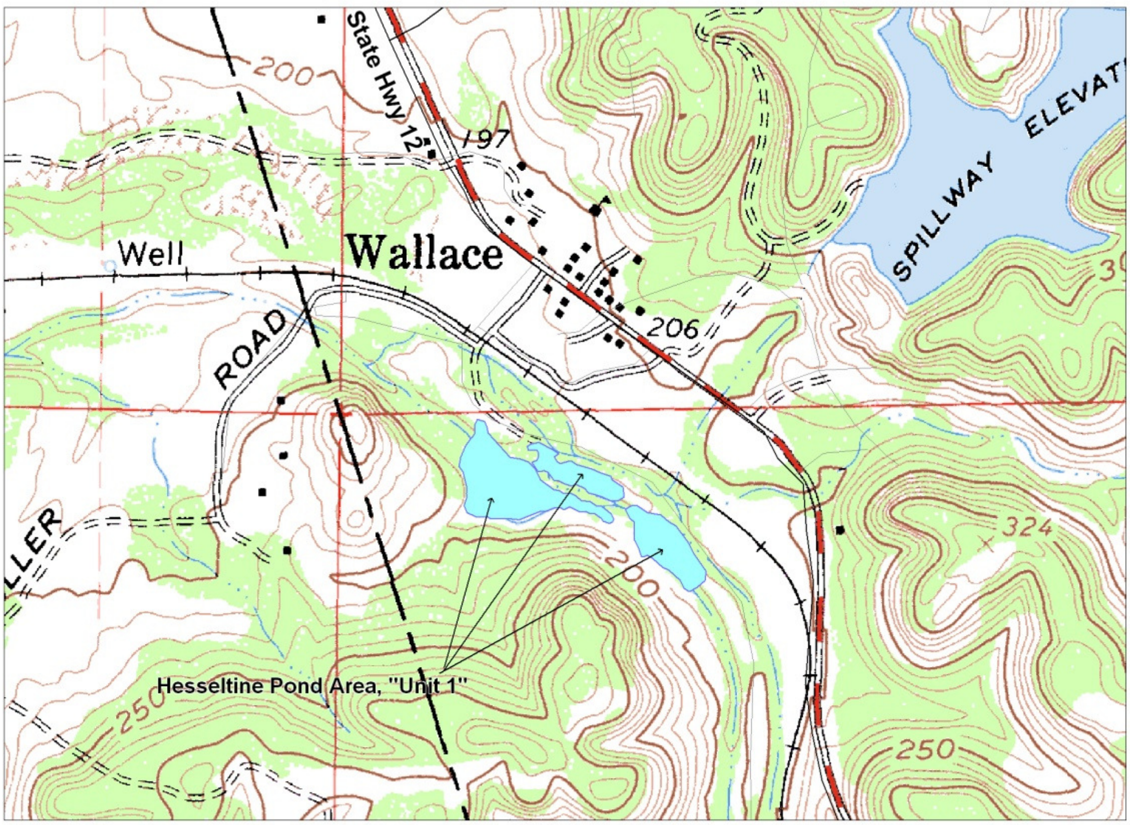
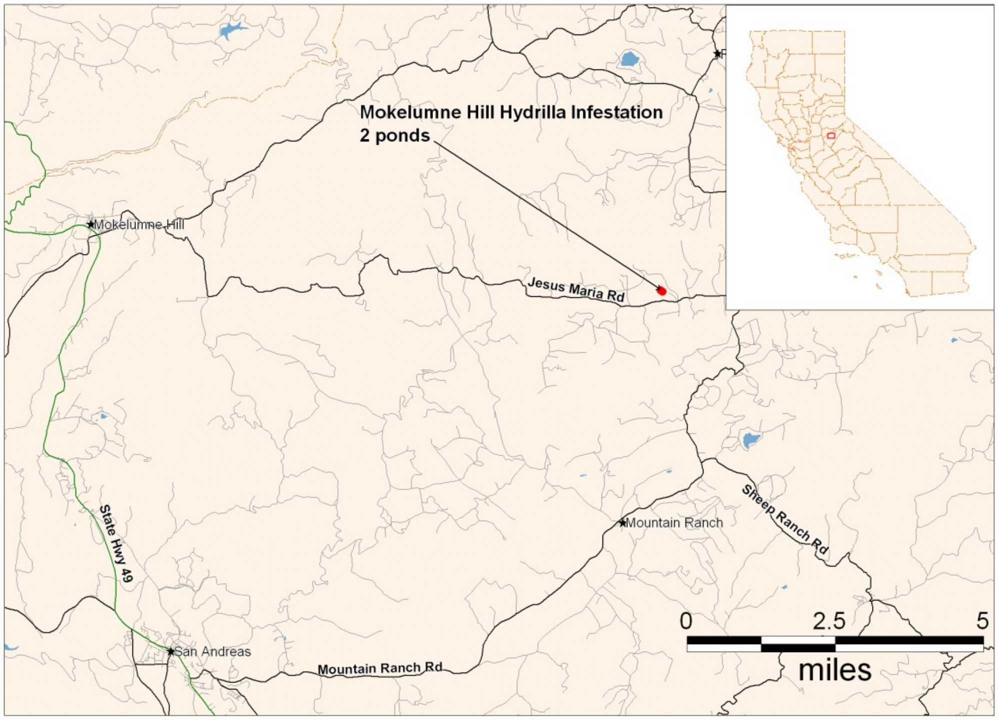


Plate 5. Mokelumne Hill Infestation Site



Bear Creek Project

Survey of Bear Creek

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 ponded areas in the Bear Creek drainage project have been approaching eradication for several years. 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 2011, 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. No surveys were conducted in 2012 as it had been over 10 years since any hydrilla finds in any of the areas.

While upstream management units were approaching eradication, the Hesseltine area (Unit 1) had more recent hydrilla detections. Unit 1 is a series of ponded and swampy areas, totaling approximately 10 acres (Plate 4). The main ponded area (Hesseltine “main pond”) is located about half a mile downstream from Unit 2 and measures approximately 3.6 acres. The pattern of water flow through the area underwent some changes several years ago, 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 and 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, the Program 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 of the "main pond" 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, including the areas of the last hydrilla finds. Even the main pond was much reduced in size and depth.

In contrast, 2011 was a very wet year. By late September only the outlying sections of the Hesseltine Unit were dry or very low. Most swampy areas and stream sections upstream of the main pond were dry or had only a few puddles. The deeper main pond and adjacent swamp 1, however, had fairly high water levels. Water levels in Hesseltine, and Baker Pond in Unit 5, remained static until early December when pond levels started to rise. Previous hydrilla find sites remained wet, unlike the past several years when they dried completely.

2012 returned to very dry conditions. Most of the area was dry and even the main pond dropped markedly by the last survey, to an area of only one-third acre.

In 2004, project crews detected two hydrilla plants in Unit 1 (Table 2). The crews surveyed Unit 1 seven times in 2005, five times in 2006, three times in 2007 and 2008, twice in 2009 and 2010, and three times in 2011, finding no hydrilla. In 2012, pond was surveyed twice. No hydrilla was found. The first survey was conducted on August 6 when the water temperature was 27.8 degrees Celsius (82 degrees Fahrenheit). The last survey was conducted on November 5 when the water temperature was 16.7 degrees Celsius (62 degrees Fahrenheit).

Other aquatic vegetation detected in the Hesseltine ponded area included coontail (*Ceratophyllum demersum*), mosquitofern (*Azolla* species), various pondweeds (*Potomageton* species), duckweed (*Lemna* species), chara, water primrose (*Ludwigia* species), watermilfoil (*Myriophyllum* species), parrotsfeather (*M. aquaticum*) and cattails (*Typha* species).

Table 2. Number of Hydrilla Plants and Tubers Found and Removed from Bear Creek, Calaveras County, 2000 - 2012

Unit 1 – Hesseltine Ponded Area

YEAR	2000	2001	2002	2003	2004	2005-11	2012
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 were 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 year was the eighth without plants, so there was no treatment.

Because there have been some instances in this project of hydrilla disappearing for a couple of years only to return, the Program considered it prudent to take a little more cautious approach to declaring eradication. However, after eight years without plants, under a variety of dry and wet conditions, the Program has decided to declare eradication in this project.

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, ever since it was first found in 1988. No hydrilla plants have been found in the smaller of the infested ponds since 1998, but plants were detected in the larger pond in 2002, 2003 and 2004. In 2004, 10 hydrilla plants were detected in pond three, the main infested pond (Table 3). No plants appeared in either pond in 2005-11 or in 2012, making this the eighth year without plants.

Calaveras Project crews surveyed all ponds on the property at least once in 2012 and most of them twice, including the two hydrilla ponds. The first survey was on September 26, when the water temperature was 18.9 degrees C (66 degrees F). The last survey was on November 5, when the water temperature was 15.6 degrees C (60 degrees F). Other aquatic vegetation detected included chara, naiad, watershield (*Brasenia schreberi*), coontail, American and slender pondweed and cattails.

The infested pond was not treated in 2012.

Because there have been some instances in this project of hydrilla disappearing for a couple of years only to return, the Program considered it prudent to take a more cautious approach to declaring eradication. However, after eight years without plants, the Program has decided to declare eradication in this project.

Table 3. Number of Hydrilla Plants and Tubers Found and Removed from the Stock Pond Near Mokelumne Hill, Calaveras County 2000 - 2012

YEAR	2000	2001	2002	2003	2004	2005-11	2012
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. They also surveyed boat ramp areas at Lake Comanche. No hydrilla was detected.

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

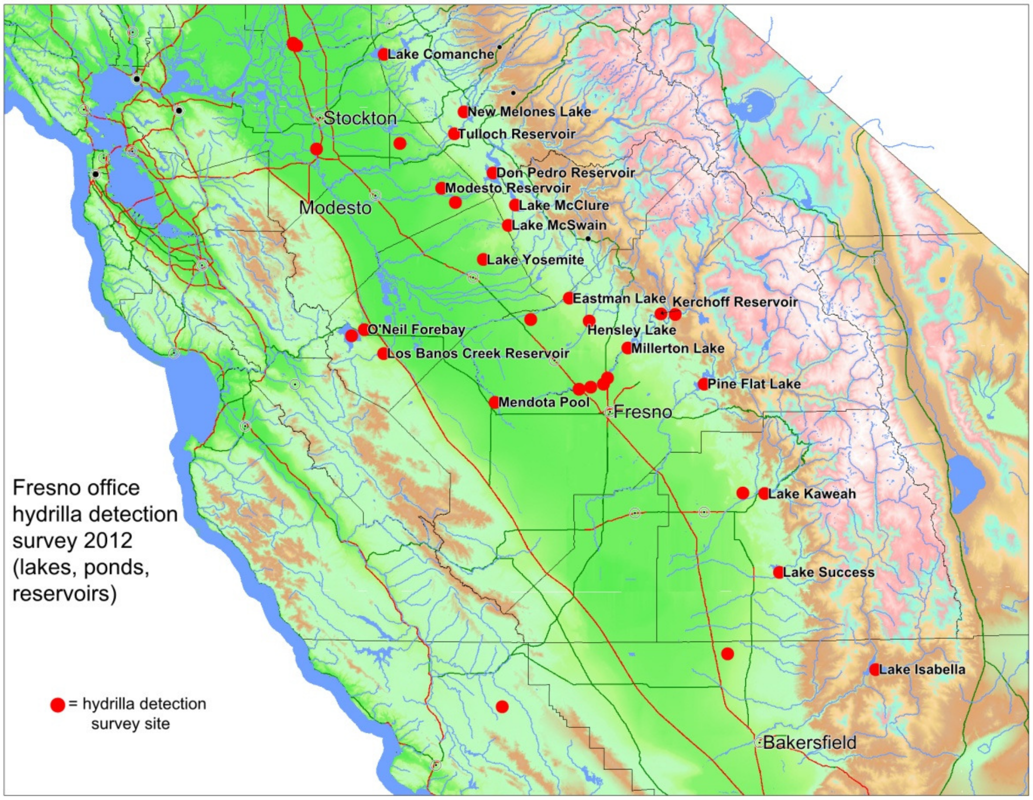
The Hydrilla Program crew in Fresno takes care of the Calaveras and Tulare Springville Projects, as well as working on occasion in Imperial County. With the Chowchilla project beginning to taper off, the crew has had more opportunity to expand its detection efforts. The crew detected no hydrilla in 2012.

A summary of areas visited:

Lakes (Plate 6)
Lake Success, Hensley Lake, Bass Lake, Manzanita Lake, Pine Flat Lake, Lake Woolomes, Millerton Lake, Redinger Lake, San Luis Reservoir, O'Neil Forebay, Kerchoff Reservoir, Eastman Lake, Lake Kaweah, Lake Yosemite, Los Banos Creek Reservoir, Merced River at Merced Falls, Whiskeytown Lake – ramp areas, Lake McSwain, Lake Comanche – ramp areas, Lake Isabella, Lake Turlock, Tullock Reservoir, Woodward Reservoir, Modesto Reservoir, Don Pedro Reservoir, New Melones Lake, Lake McClure, Mendota Pool

Ponds (Plate 6)
Chavez Pond, Bravo Lake (actually a ponding basin), Borba Ponds (San Joaquin River), Milburn Pond (San Joaquin River), Sportsmen's Pond (San Joaquin River)

Plate 6: Locations of lakes and ponds visited by the Fresno office crew on general detection surveys



Canals and streams

Fresno office personnel visited many sites in the canals and stream systems around Fresno. In the Central California Irrigation District area (CCID), the office staff visited 124 sites or stretches. The CCID canals run in a network from the San Joaquin River near Firebaugh northwest for over 70 miles, past Gustine to near Crows Landing. In the Grasslands Water District, the crew visited 41 sites and stretches. Grasslands canals run north of and parallel to the CCID system, ending near Los Banos. Beyond Los Banos, the water courses enter a set of state and federal game preserves. The crew visited 21 sites and stretches in this area. In the Cameron Canal system east and southeast of Fresno, the crew visited 55 sites and stretches. Along the middle San Joaquin River between Friant Dam and where it typically runs dry near Gravelly Ford (about 10 miles west of Hwy 99) the crews visited 105 stretches and sites.

They saw many aquatic plants in these various visits, but 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.

Hand removal activities were resumed in November 2006, with IID crews continuing to survey and pull plants through 2012. Numbers of plants are continuing to drop. In April, 2012, crews from the Fresno office also surveyed all the infested sections by foot, throwing hooks repeatedly where the water was deep or murky, and paying special attention to the old hot spots. They found no hydrilla and very little other aquatic vegetation. The crew also surveyed three IID reservoirs by boat. The reservoirs had once had hydrilla, but they found no hydrilla on this trip and only a little other aquatic vegetation.

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

Hydrilla disappeared for the first time from Clear Lake on June 23, 2003, but plants returned in 2007. After plants disappeared in 2003, treatments had continued in 2003, 2004 and 2005.

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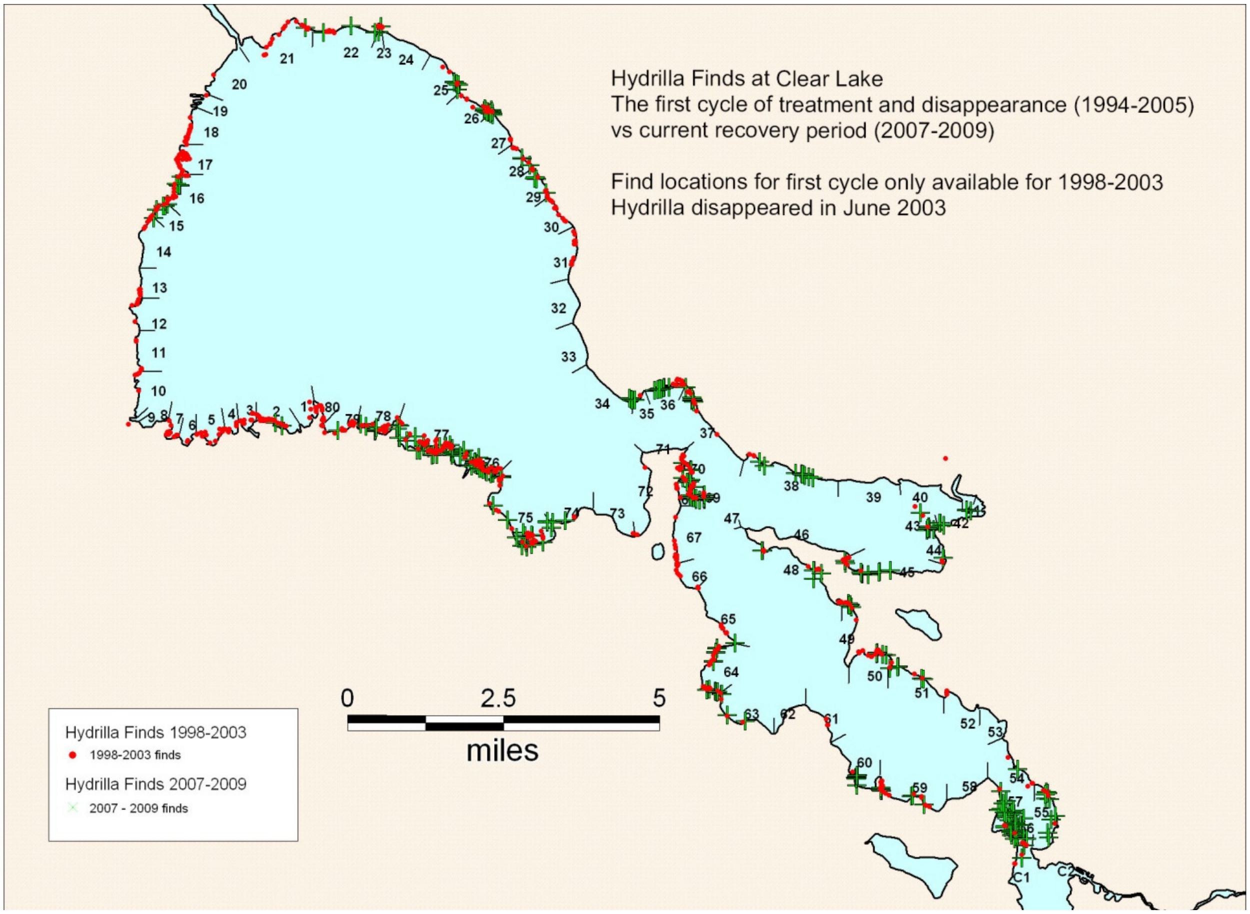
[20] The biological control agent, the triploid grass carp (*Ctenopharyngodon idella*) (TGC) is used to consume hydrilla and other aquatic vegetation. When used in confined areas, and in adequate stocking rates, the TGC can suppress a population nearly to extinction. However, to prevent establishment 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.

Surveys also continued without finding a single plant. The three seasons without plants met the then current criterion to end treatments, and no herbicides were applied in 2006. That 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. With the return of the plants, 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. The number and vigor of plants continued to decline dramatically in 2010 and 2011. In 2012, the number of plants increased some, but they mostly occurred in three clusters, so total acreage did not increase much.

Program managers did not assume that the detection of no plants in Clear Lake in 2003 through 2006 meant 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 number of crews was increased to four in 2008.

The current resurgence of plants clearly comes from tubers that were able to survive the three-year no-plant follow-up treatment after the first disappearance of the plants. 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 7). Further, the 2007-09 plants appeared in many parts of the lake all at once. That is, 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 8). 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.

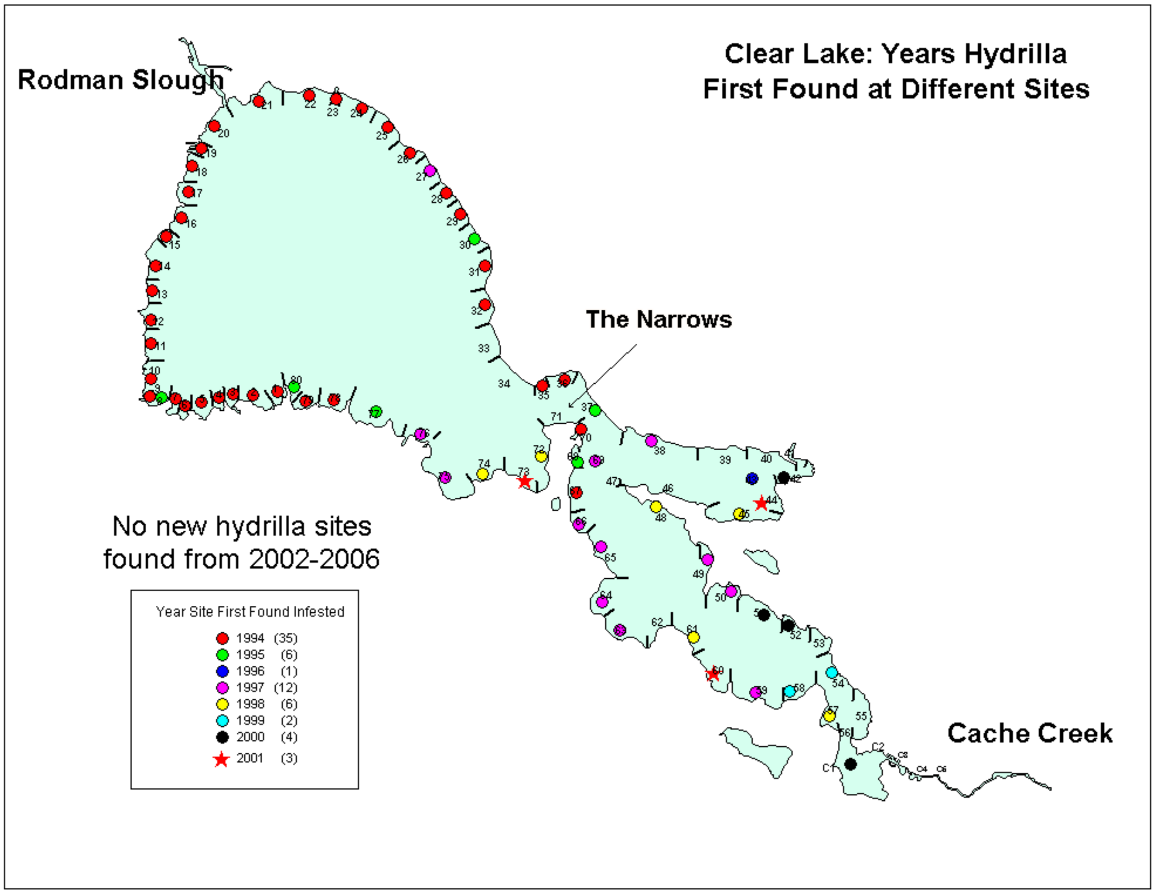
Plate 7: Plant find locations from 2007-2009 compared to finds in 1996-2003



The Clear Lake Project is a cooperative effort between 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 even near the bottom, 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 Fahrenheit) in the summer from 5 to 10 degrees Celsius (40 to 50 degrees Fahrenheit) 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.

[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.

Plate 8. Map of Clear Lake in Lake County Showing Location of Hydrilla Program Management Units and the Year Hydrilla First Detected in Each Unit.



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 (Plates 8, 9). 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 and 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 8, 9). 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.

[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.

Plate 9: Hydrilla in Clear Lake, 1994, in the area of Big Valley, before treatments started.

Clear Lake Project personnel divided the lake's shoreline into 85 (originally 80) management units in order to better organize eradication efforts (Plate 8). These management units were based upon landmarks for ease of navigation; they are not equal in length or area. The management units also varied in width but usually extended about 600 to 800 feet from shore toward the center of the lake where the water is 15 to 20 feet deep.

Survey of Clear Lake

Surveying for hydrilla in Clear Lake is a challenge. Surveys covered from the shoreline out to between 600 to 800 feet from the shore, so the area to be surveyed in one circuit of the lake's 100+ miles of shoreline was nominally about 7,300 acres (about 11 square miles). In addition, hydrilla is actually scarce in Clear Lake now. It takes a great deal of work to find the plants. For instance, the crews found 76 plants in 2009 but that represents a tiny area in a 43,000-acre lake. Square miles of Clear Lake's area are also heavily covered in submerged weeds, which interfere with surveys. Finding each plant took an estimated 95 to 105 person-hours of actual search time on the water in 2009.

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 about 85 percent of the crew's time, or around 8,000 person-hours per season of actual time on the water (not including prep and travel time).

Change in Survey Protocol

The Technical Advisory Panel of 2009 (see below) recommended that the Clear Lake Project try to make its survey methods more systematic. They suggested exploring possibilities such as recording the boat tracks, analyzing search coverage, and/or setting up survey grids to direct each boat's search, all based on an on-board GIS. Unfortunately, the CDFA IT Division refused to allow the purchase of the GPS-enabled ruggedized field computers that would be necessary to carry out such work in the environment of an airboat. In an attempt to make the surveys at least a little more systematic, Clear Lake personnel re-drew the boundaries of the survey areas for 2011 and beyond (Plates 10, 11).

The new survey areas are all close to being equal in area. They are provided to the crews on a consumer-grade boating GPS, so they can track their progress. The old survey areas (= "management units") were never really drawn at all. They had somewhat vague boundaries along the shore that were based on not-necessarily-permanent landmarks, outer boundaries of "around" 600-800 feet, and surveys were not guided by GPS. The management units varied widely in length and in area, from about 35 acres to 409 acres, according to one attempt to draw the units (Plate 9). They totaled 8,460 acres by that same drawing. By contrast, the new survey areas are all very close to 78 acres. They were drawn using the following rules: survey from shore (Zero Rumsey) out a minimum of 100 feet and out to maximum of 1200 feet from shore or to a depth of 20 feet (Zero Rumsey), whichever comes first. This contour was plotted all around the lake excluding the outlet area where it enters Anderson Marsh, and then divided into 80 survey units, each intended to be equal in area. The new survey areas range from 77.4 to 78.9 acres, except for one, which was the last to be drawn at the end of drawing the 79 previous ones. There ended up being only 72 acres left to put into it. The total survey area within the lake is now 6,229 acres.

Plate 10: Comparison of old "management units" with new "survey areas"

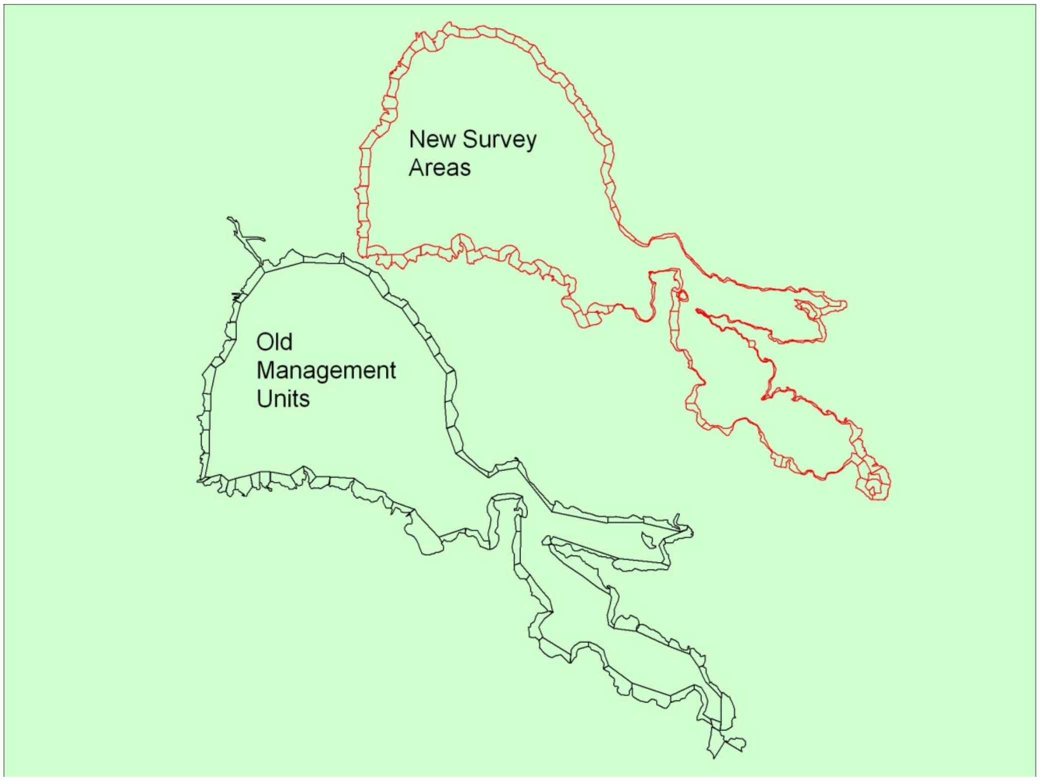
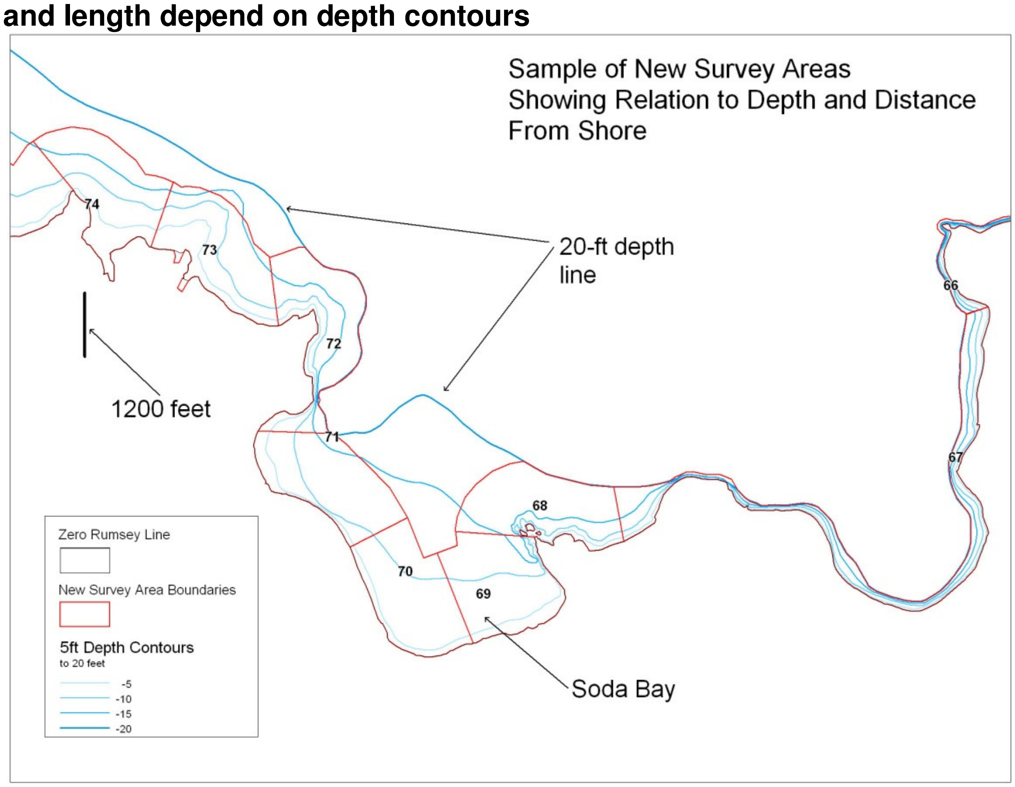


Plate 11: Close-up of a few of the new equal-area survey areas, showing how their width and length depend on depth contours



The new survey areas are short and broad where the water depth falls off very slowly, as in the western basin of the lake, and they are long and skinny where depth falls off quickly (Plate 11). However, they all have close to the same area, so it is more likely that the same intensity of survey effort will be put into each area than with the old areas. The boats each have a consumer-grade GPS with the survey areas marked in them, and the crews can see their tracks so they can see whether they are achieving even coverage.

Results

In 2005, Clear Lake 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, or once every 2.9 weeks. In 2010, the Clear Lake leads decided to focus on spending some extra time during each survey bout in each management unit. In previous years, the crews tried to complete roughly three management units each day. In 2010, the goal was to survey roughly two units each day but put more time in each. This also decreased time moving between units. In 2010, the crews accomplished 566 surveys for an average of 6.9 visits to each management unit or about once every 3.4 weeks. In 2011, the crews performed 510 surveys of survey areas for an average of 6.0 surveys for each area, or an average of about once every 4.4 weeks.

In 2012 the crews performed 520 surveys or about 6.0 surveys for each area. As the survey season ran from May 9 to November 13, this led to survey areas being surveyed on average once every 4.4 weeks, the same as 2011.

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 13). In 2008, another 196 plant locations appeared. Most were single plants but many were large, vigorous clumps up to several yards across and topping out at the water’s surface, especially during September and October. In 2009, counts were down with about 76 plant locations and the plants were, in general, much less vigorous than in 2008. Only a couple plants reached the surface and none were larger than a yard or two in diameter. Most finds were just a few weak stems. In 2010 the decline was even more marked. The crews found only 12 hydrilla plants and most were very sickly. Only five finds were outside established treatment areas, which meant only 20 acres were newly brought under treatment that year. In 2011 only 6 plants were found, all small and mostly sickly.

Table 4. Level of Hydrilla Infestation in Clear Lake, Lake County by Number of Infested Management Units* and Number of Finds, 2000 to 2012

Year	Number of Management Units with "Finds"	Number of Hydrilla "Finds"
2000	31	67
2001	21	41
2002	6	12
2003	1	1
2004-6	0	0
2007	24	72
2008	34	196
2009	24	76
2010	7	12
2011	5	6
2012	5	26

*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.

In 2012, 26 plants were found. This is an increase of several times over 2011. However, most of the finds were in three clusters, in which all the plants were within roughly 250 feet of each other (Plate 12). By comparison, most of the finds in the last few years have been single plants. Because the new finds were clustered, they added only about 26 acres to the area under treatment (Table 6). Apparently surveys missed two or three plants in late 2011 or early 2012 and these were fragmented to produce new small colonies. In fact, in Area 11, a single plant was found in 2011, very late in the season (October 27) (Plate 12). One of the clusters then appeared in that same area in 2012. Quite possibly, that 2011 plant had been shredded by boats or had released turions, and it was the source of the 2012 colony.

The first plant in 2012 was found on July 16 (July 9, June 17, June 9, June 15, and August 10 in 2007 through 2011, respectively) in Unit 11 (old scheme), on the west shore in the western basin, off Lakeport. The last find was on September 13 (November 15, December 9, November 12, August 19, and November 7 in 2007 through 2011), in Unit 71 on the south shore of the Narrows. The first survey in 2012 was on May 9 and the last on November 13. The water temperature at the time of the first survey was 20 degrees Celsius (68 degrees Fahrenheit) and was 14.4 degrees Celsius (58 degrees Fahrenheit) at the last survey.

This year the plants were concentrated on the west end of the lake, mostly in a new area, even though they were limited to a few small clusters (Plates 13a and b, 14), as was also indicated by the plants appearing in five management units (Table 4). That was the same number of management units as in 2011.

Other aquatic plant species detected in Clear Lake in 2012 included coontail, curlyleaf pondweed, American pondweed (*P. nodosus*), Illinois pondweed (*P. illinoensis*), egeria, common elodea, Eurasian watermilfoil (*Myriophyllum spicatum*), sago pondweed (*Stuckenia filiformis*), smartweed (*Polygonum* species), coontail, water primrose, spatterdock (*Nuphar luteum*) and spiny and southern naiad.

Plate 12: Closer view of the three clusters of plants that appeared in 2012.

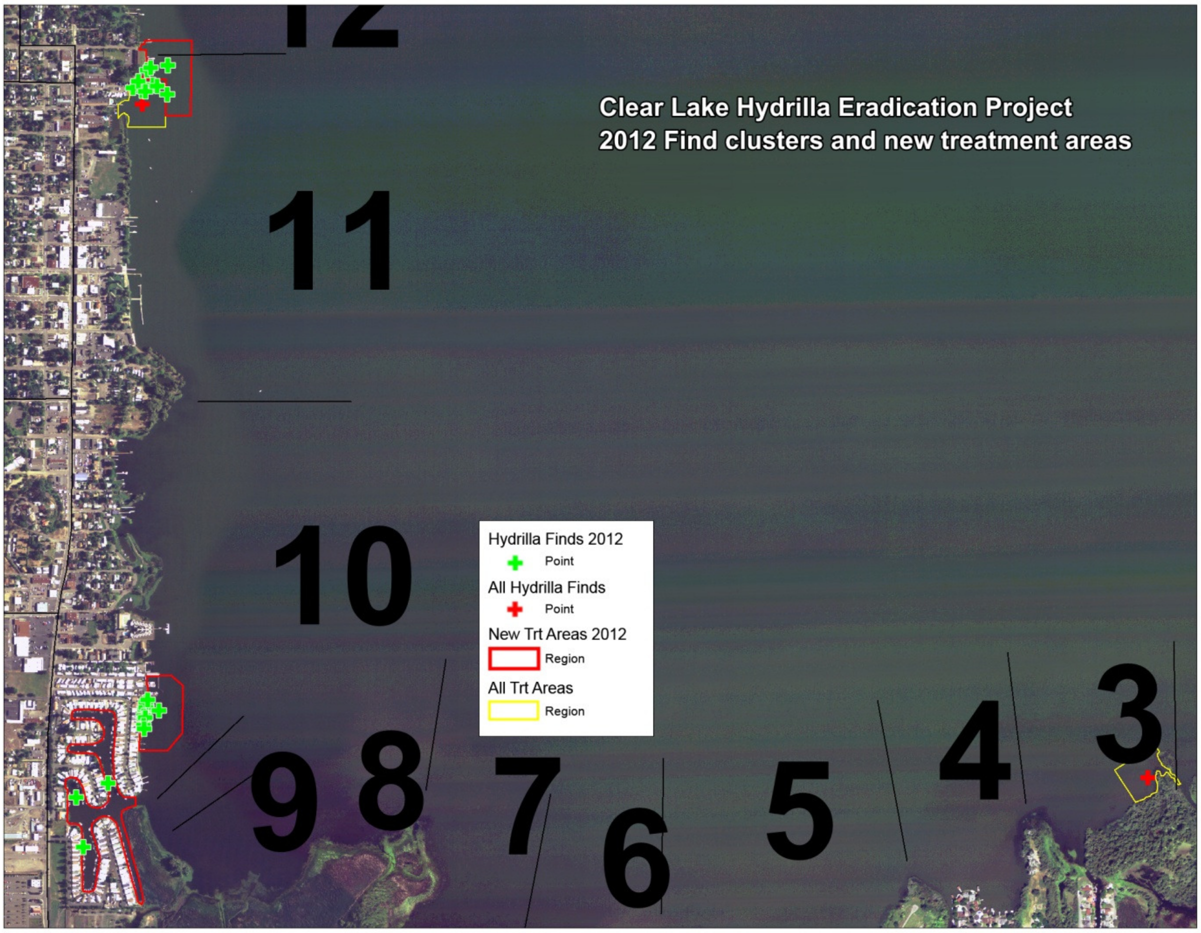


Plate 13a. Hydrilla Finds in Clear Lake, 2007 - 2012: Western section of the lake.

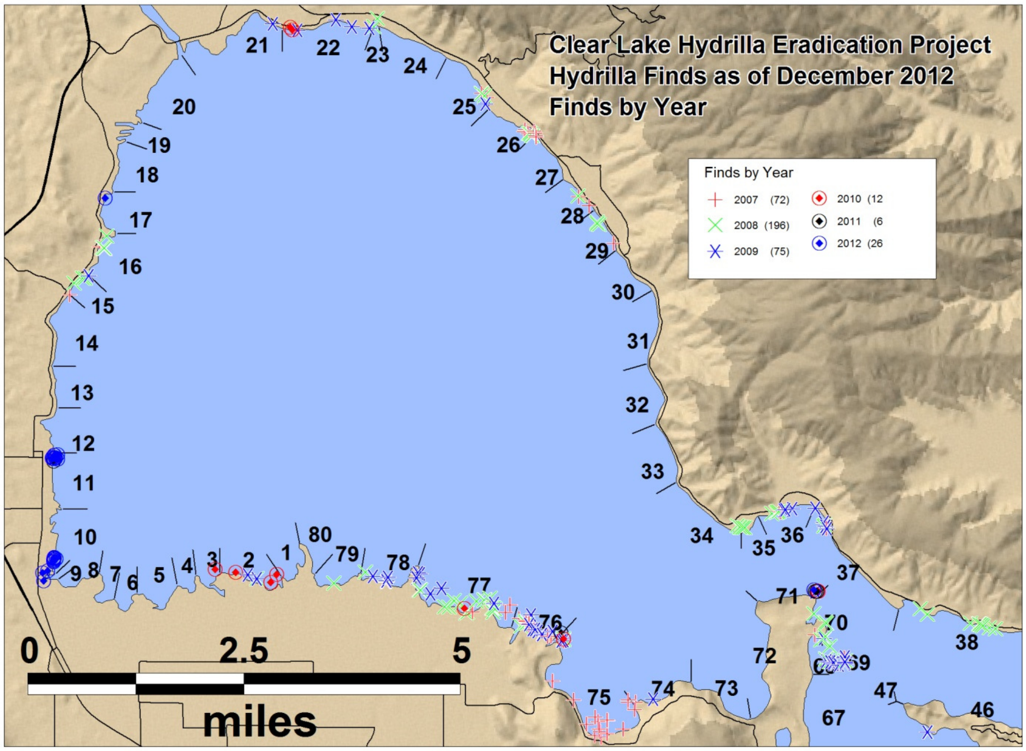


Plate 13b. Hydrilla Finds in Clear Lake, 2007 - 2012: Eastern section of lake.

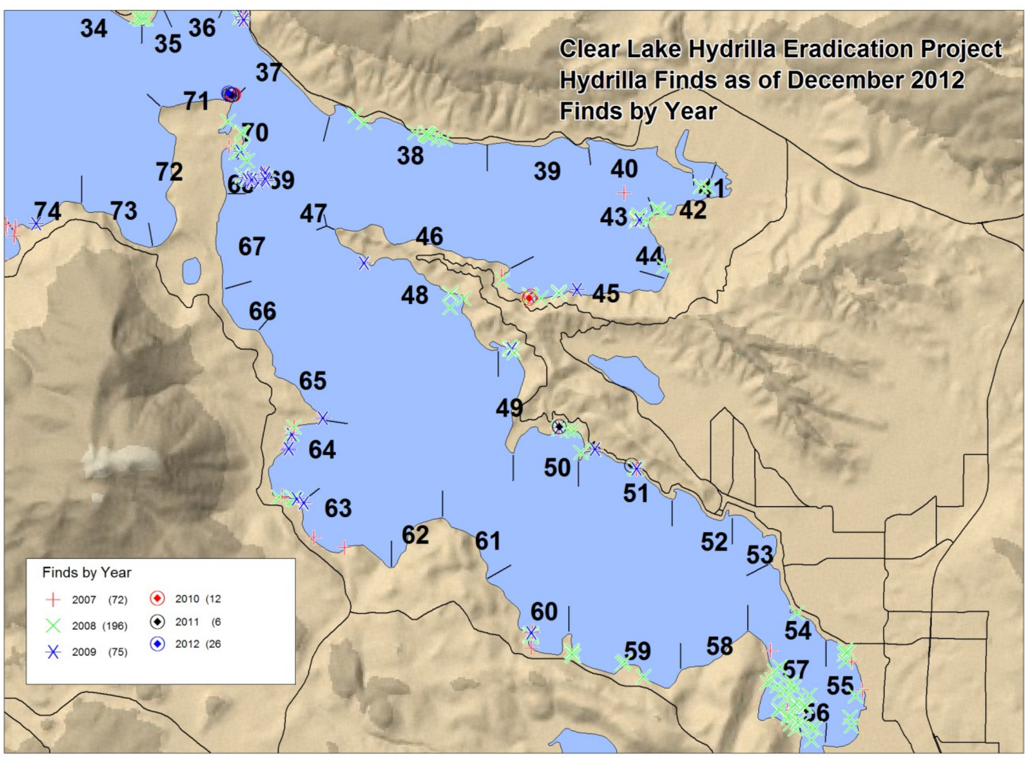


Plate 14. Hydrilla finds in 2012, whole lake

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 2012, project crews made two 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 2012 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 (Table 5), with the return of plants.

The Project used 369 pounds of elemental copper in 2012. This was lower than many of the previous years because there are fewer finds, and fewer finds outside established treatment areas. Each find in a new area 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. Fluridone is used for the remainder of all treatments.

Table 5. Aquatic Herbicide Used by the CDFA in Clear Lake, Lake County 2000 - 2012

year	Copper, pounds of active ingredient	Fluridone, pounds of active ingredient
2000	1,960	2,689
2001	1,112	2,839
2002	282	2,370
2003	12	1,824
2004	0	867
2005	0	219
2006	0	8.2
2007	4,352	570
2008	5,295	912
2009	2,206	1,140
2010	492	1,457
2011	285	1,464
2012	**369**	**1,266**

The Clear Lake Project's use of fluridone had also decreased until 2006 (Table 5) as management units reached the original three-year criterion for the end of treatments. That trend also reversed itself in 2007, because of increasing areas coming under treatment with the new finds. 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 about four to five years. Acreage increased steadily until 2011-12, when areas began reaching a minimum of four full years of treatment with no plants. That criterion, combined with others such as number of nearby plants, location in the lake, and water depth, allowed Project leads to identify about 90 acres to remove from treatment (Table 6). In 2011, less than 10 acres were added and those only late in the season after fluridone treatments had ended, so the 1464 pounds of fluridone used in 2011 is only slightly higher than 2010. In 2012, the amount of fluridone use actually decreased from the previous year for the first time since 2007. Even though 26 acres were added during the season, it was more than offset by the 90 acres taken out of treatment at the start of the season. With a little luck, this trend should continue in the coming years.

The new criteria for taking areas out of treatment will depend not just on their time under treatment with no plants, but on other factors that, at least qualitatively, consider the relative likelihood of plants returning and the danger posed by any such return. The additional criteria include such things as water depth and general weediness (which affect survey effectiveness), number of plant finds that were in the treatment area or areas nearby (which may indicate likelihood of plants returning), length of time in treatment before plants disappeared, and location in the lake (which may indicate dangers due to water movement or routes of escaping the lake). For areas that appear relatively safe (such as areas that only ever had a single isolated plant), four years of treatment with no plants may be deemed adequate. Five years will probably be the accepted criteria for most areas. However, for a few high-risk areas, such as near the lake's outlet or major boat ramps, or perhaps in areas that have had a long history of plant finds nearby, even six years of treatment may be deemed prudent. The fact is, we don't know just how long tubers will survive. We know three years of treatment without plants wasn't enough, but we also know from 2011's tuber survey that tubers appear to be becoming rare in the lake. We have good reason to hope that we are pushing the general population toward extinction, but we have to acknowledge that taking an area out of treatment is merely a requirement to check whether eradication has been reached. It is the follow-up surveys that determine eradication status, and they may instead show that more treatment is necessary.

Table 6: Changes in area under treatment through time in the Clear Lake Hydrilla Project

Season	Acres at start of season	Acres brought into treatment	Acres in treatment, end of season	Acres removed from treatment, between seasons
2007	0	248	248	0
2008	248	325	573	0
2009	599*	120	719	0
2010	719	20	739	0
2011	739	9.6	748.6	89.7
2012	658.9	26	684.9	to be determined
2013	TBD			

* = start of 2009 is higher than end of 2008 because of merging and adjustment of treatment areas between seasons

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 2012, there were 83 permits for treatments.

Surveys Outside of the Quarantine Zone

With the intensive treatments and survey on the lake itself surveys of other water bodies in the area have dropped off. In 2012, no water bodies other than Clear Lake were surveyed.

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, the public needs 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 2012, 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 April. Patrick Akers gave a presentation to the UC Davis Aquatic Weed School in September.

New Initiatives 2012

In October 2009, the Program convened a Technical Advisory Panel (TAP) of four outside experts to review the Clear Lake Project and recommend improvements. 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 report is available on the CDFA's Hydrilla Program web page at: http://www.cdfa.ca.gov/phpps/ipc/hydrilla/hydrilla_hp.htm.

Several of their suggestions have been carried out and reported in earlier reports, including re-drawing the survey boundaries, a tuber survey, and "artificial hydrilla target" survey hooking tests. The tuber survey is complete and was reported last year, the new survey boundaries are now in everyday use, and the survey hooking tests still continue when time permits.

This year the Project had two main special projects: a dredging trial and a small study of the effects of years in treatment on fluridone sediment concentrations. Preliminary results of that work will be reported here.

Dredging Initiative

The Hydrilla Program usually uses a range of methods in a project to eradicate hydrilla. It is unusual for a Project to depend so wholly on herbicides as has been the case in the Clear Lake Project. However, Clear Lake is also the largest, most difficult project the Program has ever faced, and herbicides provide efficient control of large areas. Although it is labor-intensive, the most common and useful of the alternate control methods in other projects has been small-scale dredging, to directly remove the tubers from the sediments. Dredging provides one of the few methods that is at all effective in directly attacking the tuber bank and seems like one method that should be suitable for Clear Lake, especially for attacking the last few "straggler" plants.

Project personnel have wanted to try dredging in Clear Lake for several years, and the TAP also recommended pursuing the strategy. Unfortunately, dredging is itself almost more highly regulated than herbicides, especially in Clear Lake where there are mercury problems. Even though the area that would be dredged for any one plant would be small (10x10 to 15x15 feet) and probably 200 sites would be a very high guess as to the number of plants that would be dredged, it still requires several permits from several different agencies. However, even though there were concerns, the Clear Lake community seemed supportive of the approach in general.

In the fall of 2010, the Hydrilla Program entered into a $45,000 contract with Lake County to support one of their Biologists half-time in the Water Resources Department. Her task was to put the permits in place that would allow dredging. By the fall of 2011, the permits were in hand. The Program then developed a contract that provided for up to $150,000 for small-scale dredging services over 2012-13.

In August, the Project decided to dredge one of the new clusters found in 2012 (in Unit 10). This area provided probably optimal conditions to try dredging. There were several plants very close together, the water was shallow, it was easy to locate and mark the plants, and it was possible to put up one sediment curtain to surround several plants at once. The contractor brought up a crew and attempted to use diver-directed suction dredging with a hose. Unfortunately, the contractor was not able to control the sediment spoils very well, letting substantial amounts escape back into the lake. At the very least, that issue will need serious improvement if dredging is to continue. The work was also quite expensive, costing over $5,000 per plant, even though they were handled with a single mobilization.

Sediment fluridone concentration study

This is a longitudinal study to look at fluridone concentration in sediments of Clear Lake among areas under treatment for different lengths of time. The design was modified to also test contributions of sediment characteristics and situation.

Background and approach

Some citizens in the Clear Lake community expressed a concern about the possibility of build-up of fluridone in the lake's sediments, due to the long-term treatments and fluridone's affinity for sediments. This study's approach was to sample areas that have been under treatment for different periods of time, and to look for trends in increasing fluridone concentration with time.

A preferable approach might have been to follow individual treatment areas through time as the treatments were made, as that would help control for variations in treatment methods and environmental conditions through time. However, that approach was not possible as the study was conceived after treatments had been underway for several years. The current method may have increased variability compared to the method of following single treatment areas through time (because it will include any changes in treatment protocols or environmental conditions between years, which cannot be measured), but if the concentration trend is reasonably strong, it should still be apparent.

Basic sampling design

Table 7 gives the number of treatment areas that had been under treatment for different lengths of time at the time the study was initiated. As can be seen, the number of new treatment areas has fallen precipitously during the last two years, mostly because the number of plant finds has fallen. Because of this limitation, the design was to take five samples (each one from a different treatment area) from each of years 1 through 4. A set of samples was also taken from five untreated areas as well.

Table 7: As of the end of the 2011 treatment season, the number of treatment areas that had been under treatment for the indicated number of full treatment seasons.
"Full Years under Treatment" means that the treatment area received all the possible applications during the season (typically five). The first year a treatment area enters treatment is not a "Full Year under Treatment", as hydrilla finds have always occurred after the first application for a season, so that the area does not receive the full treatment for that year.

Hydrilla fluridone treatments, Clear Lake, 2007-2011.

Full Years under Treatment	Number of Treatment Areas
0	2
1	5
2	33
3	38
4	34

Sampling design, modified to include sediment characteristics

The sampling design was modified to try to obtain clearer information on possible effects of sediment characteristics, which are known to have a strong effect on fluridone distribution. In two treatment areas for each year class, two samples were taken instead of one. One of the samples was taken near shore. The second sample was taken farther from shore, near the middle of the treatment area, the same as for the samples from the treatment areas with only a single sample. Sediments in a water body usually sort themselves by density and grain size by distance from the source of sediment (the shore or stream inlet), so this was an attempt to emphasize such a possible difference.

The samples were taken in early May, shortly before the start of the treatments for the year. This time was chosen to minimize the effects of in-season treatments on the sediment concentrations. The time was determined by considering the signal we were trying to measure and whether other signals might interfere with it. At least two possible signals are apparent. One signal is the increase in fluridone levels through the treatment season due to the standard treatment schedule. The second signal is the postulated "background increase" in fluridone levels due to carryover from ongoing multi-year applications. This second signal is what we hope to measure. The in-season treatments clearly add on top of the background level. The relative size of the two signals is not known, but the in-season signal might possibly be much larger than the background signal. Any variability in the in-season signal will also add to any variability in the overall signal and possibly obscure the signal from the background increase. The most desirable time to take the sample would appear to be when the in-season signal is at a minimum. That minimum should occur in the spring just before the first application, as this is the maximum period for fluridone concentration to decline, between the last treatment of the previous year and the first treatment of the current year. The background level may well be changing during the course of a year and using just one sample period meant that change cannot be followed. However, at any other time, the signal is a combination of the background and in-season signals, with no way to partition them out.

The samples were gathered with a 6x6-inch Eckhardt clamshell dredge sampler. At least eight scoops were taken over an area of at least six by 10 feet, to gather a minimum of a gallon of material. The different subsamples were pooled and thoroughly mixed. Two separate samples of approximately one pint each were taken, one to be analyzed for fluridone, and one for physical characteristics such as percent sand, clay, and organic material.

The reason for pooling subsamples was that fluridone concentrations across the surface of the sediment can be extremely variable over very short distances (a few inches). This is a result of applying the fluridone in a concentrated pellet. According to data from Sepro, our typical applications provide enough pellets to place about one pellet for each square foot of bottom, if they were placed uniformly. Since a pellet contains a concentration of 50 million ppb (five percent), it's clear that any small sample that happened to scoop up a pellet would register a huge fluridone concentration, while others nearby could contain little or none. This issue has been observed already in Clear Lake in preliminary data using diffusion chambers to measure the fluridone in the sediment water. Such samplers measure concentration from a very small area. Sample concentrations have varied 30 to 100 times or more within a single treatment area. The mixing of subsamples was intended to help overcome this variability.

Samples were analyzed for fluridone by the CDFA Chemistry laboratory using methods previously developed for water samples and an earlier study of fluridone in and near tules. The samples for the physical characteristics still await analysis, as the Chemistry lab was not equipped for such analyses, and finding a laboratory that can provide the service for a state agency has encountered difficulties.

Results

Table 8 gives a basic summary of the data showing the effects of time in treatment on the chemical analyses made on the samples. Even though there is an apparent increase in fluridone concentration when measured on both a wet and dry basis, an ANOVA indicates that, for a simple comparison between the means, the differences between them are not statistically significant at the five percent ($\alpha = 0.05$) critical level (wet basis P-value = 0.251, dry basis P-value = 0.103). This is due to the high level of variation in the data, which appears to increase markedly with time in treatment. Pooling subsamples reduced the variation from the studies with diffusion chambers, but it was still high.

Table 8: Fluridone concentration vs. number of years under treatment

Years in Trt	fluridione, ppb wet*	fluridione, ppb dry*	% water*
0	10.49 ± 5.5	36.24 ± 18.8	61.31 ± 22.4
1	171.80 ± 130.5	376.11 ± 329.3	47.36 ± 17.1
2	128.70 ± 182.4	282.63 ± 324.5	42.81 ± 24.7
3	173.93 ± 271.4	736.66 ± 1138.4	55.80 ± 31.6
4	268.04 ± 244.6	1416.77 ± 1596.4	66.99 ± 21.7

* = mean ± 95% confidence interval of the mean

Prior to the experiment, we had postulated that fluridone concentration would increase in some fashion with time. This seems to be the case on visual inspection of the means, especially for the data for dry weight basis. The appropriate test for such a relationship is a regression. Linear regressions showed (Table 9) that there was a significant effect of time for both a wet and dry basis ($P(m \neq 0) < 0.05$ for both measures). However, the confidence intervals for the means indicate that there is a high level of variation in the data, and the regression coefficients

(R-square measures) indicate that the regression slope (ie, the effect of time) does not explain very much of the differences (variation) found in the data. If they had, the R-square measures would have been much closer to 1.0.

Table 9: linear regression analysis results, time vs fluridone concentration

Coefficient	Dry wgt basis	Wet wgt basis
R Square	0.187	0.122
Adjusted R Square	0.162	0.095
intercept value (= b)	-54.637	47.145
P(b ≠ 0)	0.845	0.431
slope value (= m, years in trt)	312.160	51.724
P(m ≠ 0)	0.00952	0.03964

These points also become clear when plotting the data (Plate 15a and b). In fact, in the dry basis data, most of the effect of time seems to be due to an increase in variation of fluridone concentration, and most of the effect seems to be driven by just two to four outlier points. Something appears to be going on besides just a simple relationship between time and fluridone concentration in the sediments. One possibility involves organic matter in the sediment. Fluridone is known to bind to organic matter better than other substrates (e.g., sand). It might be that organic matter builds up more in some treated areas, due to continued mortality of plants there. The amount of build-up would also be influenced by tendency of plants to grow in the area, which varies strongly from place to place in the lake and with no regard to the treatments with fluridone. That is, we treat in some places that are generally very weedy, and in other places that generally are fairly free of weeds. Difference in water movements from place to place could also play a large role.

Further explorations of this possibility will have to await the analyses of physical characteristics of the sediments.

Plate 15a: Fluridone concentration in sediments of treatment areas on a dry weight basis, as compared to the number of years the areas have been in treatment.

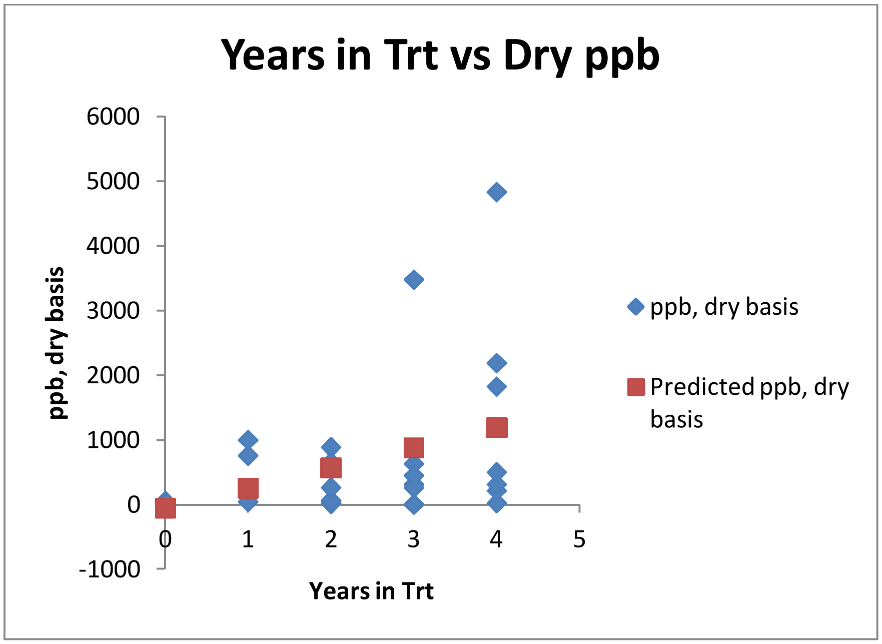
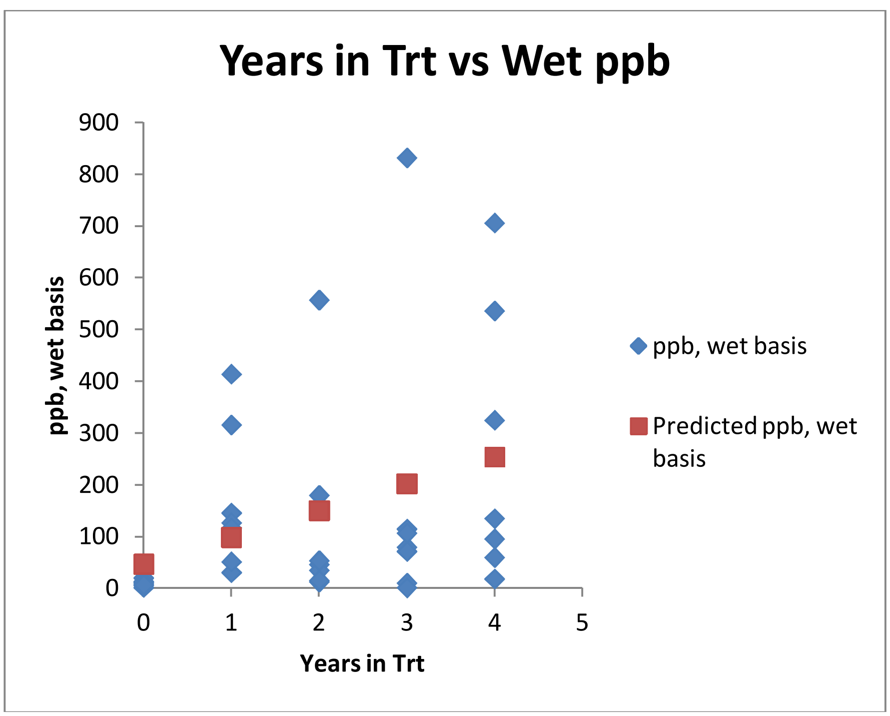


Plate 15b: Fluridone concentration in sediments of treatment areas on a wet weight basis, as compared to the number of years the areas have been in treatment.



We tried to create conditions that would emphasize differences in physical characteristics by taking samples both near and farther from shore, but the data provides no insights. While visual inspection of the data suggested there could be differences between near and far, at least for the data on a dry weight basis, t-tests showed any such differences were not statistically different at $\alpha = 0.05$ (five percent critical level for P(means are not equal)) (Table 10). These results held whether we used all the sample results or just compared the paired results for each treatment area where two samples (near shore and middle of the treatment area) were taken. Again, this lack of differences was due to the large variability among the samples, as shown by the large confidence intervals.

Table 10: Results of statistical tests (t-test) that the means of fluridone concentration are not different between samples taken close to shore and samples taken in the middle of the treatment area

	ppb, fluridone, dry wgt basis				ppb, fluridone, wet wgt basis			
	all data		matched pairs		all data		matched pairs	
Coefficient	**mid**	**near**	**mid**	**near**	**mid**	**near**	**mid**	**near**
mean ± 95% confidence interval for mean	693.4 ± 491.1	260.22 ± 262.0	696.8 ± 1047.7	260.22 ± 262.0	170.2 ± 96.3	101.5 ± 104.8	129.2 ± 148.0	101.5 ± 104.8
count	25	10	10	10	25	10	10	10
t Statistic	1.121		0.968		0.198		0.337	
P(means ≠) one-tail	0.135		0.179		1.692		0.372	

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 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 16) within two weeks. 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.

Several hydrilla mats were clearly visible in the northeastern third of the pond, including one that was fairly large. 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. Dr. Lars Anderson of the USDA-Agricultural Research Service 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. 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 pond was treated once in 2011 with fluridone to reach a concentration of 90 ppb. 2011 was the sixth year without plants, while still under treatment (Table 11). As such, treatments were suspended in 2012, to determine whether the population had been fully eradicated. The Project Biologist surveyed the pond thoroughly one time, in July. He found no hydrilla.

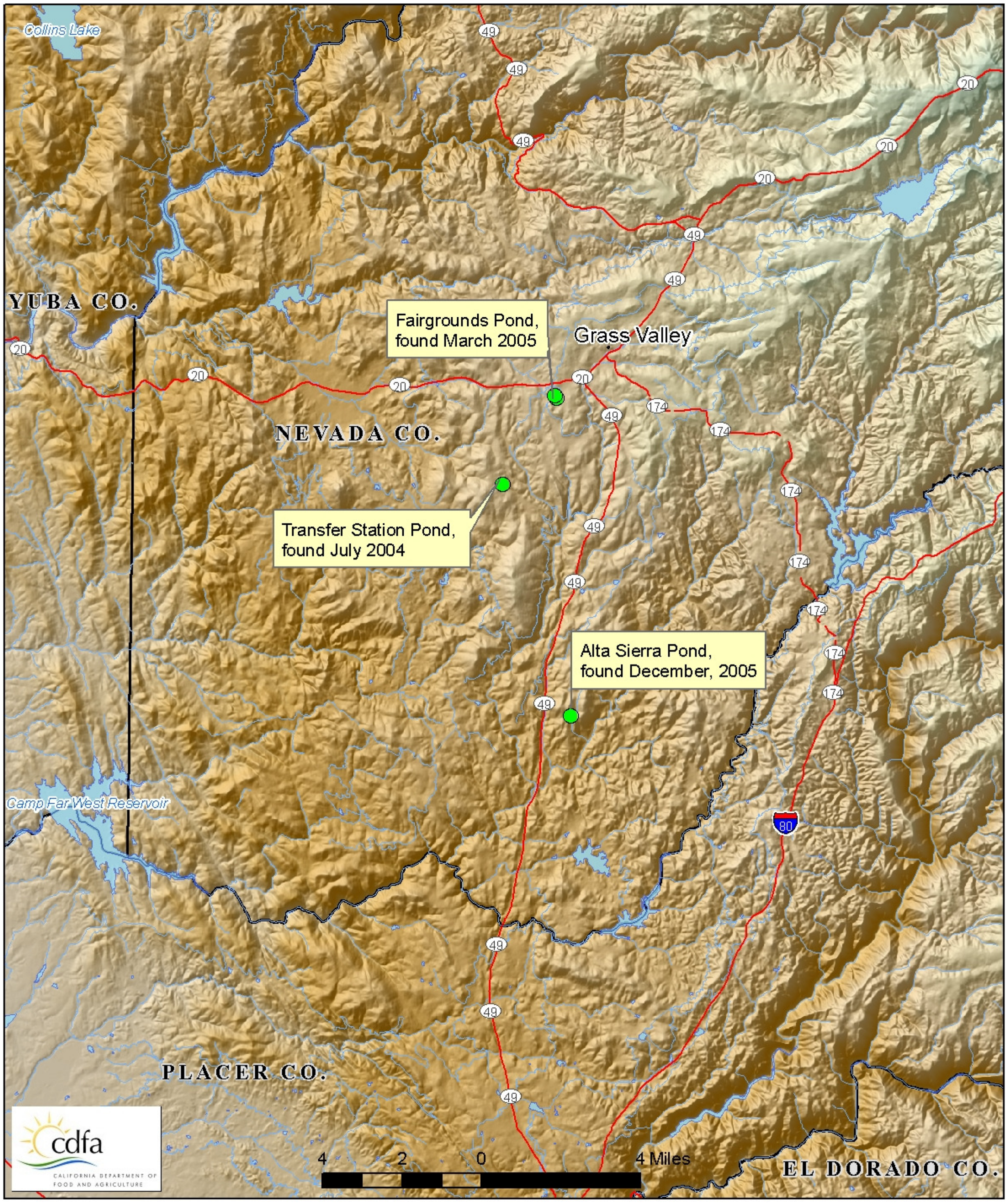
Nevada County Fairgrounds Pond

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 to the County Agricultural Commissioner's Office and John Mills, the Deputy Commissioner, sent a sample to the CDFA Botany Lab, which confirmed the plant as hydrilla. On February 24, the CDFA biologists made the first assessment of the pond. Raking and visual surveys indicated that the pond was nearly 70 percent covered with hydrilla but later soil core sampling, taking a four-inch diameter core at 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 as 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. GPS measurements 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, 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 half a mile downstream from the pond. The plants do not reside directly in the stream but do grow in

Plate 16. Map of Ponds currently known to be infested in Nevada County

California Department of Food and Agriculture
Recent Hydrilla Detections in Nevada County, 2005



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 it still controls the hydrilla.

Survey and Treatment of the Fairgrounds Pond

The Project biologist surveyed the pond twice in 2012 in July and August. No hydrilla was found. This represents the sixth year without plants (Table 11).

2011 was the fifth year without plants so the pond was not treated in 2012, in order to determine whether the eradication has been successful. 2012 represents the first year with no treatment and no plants. The pond will be followed at least three more years before considering whether eradication has been reached.

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 and Brian Steger from the office took a sample and sent it to the CDFA Botany 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 5 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 other infested water bodies. 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 2007. Treatments continued through 2011. The Project biologist surveyed the pond four times in 2012 at monthly intervals, in June, July, and August. He found hydrilla during the visit in mid-July, with three small, well-separated plants. Prior to this find, the pond had been free of hydrilla for five years, discounting one unverified suspect in 2010. We had started the season intending to suspend the treatments this year, but after the find, the pond was again treated to 30 ppb late in the season. Next year we will probably make two treatments at 30 ppb.

Table 11: hydrilla finds in Nevada County ponds by year

			Year				
Pond	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Transfer	N	N	N	N	N	N	N
Fairgrounds	Y (3 plants)	N	N	N	N	N	N
Valkenburg	Y (15% cover)	N	N	N	1?*	N	Y

* = suspicious plant spotted on visual survey but could not be recovered to confirm

SHASTA COUNTY *(Lead: Ed Finley, now Jonathan Heintz, Patrick Akers)*

2011 saw a major change in the Shasta Eradication Project. For the previous eight years or so Ed Finley took care of the hydrilla and spongeplant eradication projects around Redding. In 2011, however, the CDFA ended all General Fund resources for the weed programs, effectively eliminating them. Most of Ed's support came from the weed programs. He had been planning retirement during the last couple of years and did so on June 30. However, with the funding cuts his vacant position in Redding was eliminated. For the foreseeable future biologists from Sacramento will attend the projects, with the help of seasonal crews from Clear Lake or Fresno. Fortunately, the Shasta Projects are well advanced in their progress and with luck should need just a few thorough surveys each year.

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 4 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, a new infestation was detected in two interconnected ponds in River Park in Anderson, about eight miles south of Redding, and in 1996 hydrilla was detected in a pond system at the Riverview Golf Course in Redding (Plate 17). 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, to improve visibility and access. The last survey was very intense, and employed a crew in a canoe and the 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, the 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. On August 23, prior to the first fluridone treatment, the crew treated the part of the pond that had plants with 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.

No hydrilla appeared in the Anderson Ponds during 2007 through 2010, and none appeared in 2011. The crews surveyed the ponds 13 times in 2007, nine times in 2008, three times in 2009, twice in 2010, and two times in 2011.

By the end of 2011, the Anderson Park ponds had gone five years in treatment with no plants (2007-11). This is a long time in treatment with no plants, but with the ponds' history of hydrilla reappearing, a little paranoia seemed warranted. Nonetheless, by 2012 we had crossed into the timeframe of the new estimate for tuber longevity (four to seven years) and it seemed time to check whether we had finally killed out all the plants. Accordingly, no treatments were made in 2012.

In addition, the survey protocol was changed. While in the past, the ponds had been surveyed often, they were usually surveyed quickly. In 2012, the ponds were only surveyed twice, but intensively each time. For each survey, five to seven people were involved, coming from the Sacramento, Fresno, and Clear Lake offices. They surveyed in two-person canoes or one-person kayaks and spent a full day surveying the 13 acres covered by the ponds. The surveys were also timed to match the best opportunities for finding the hydrilla. The first was in early

July, when the hydrilla is entering its phase of maximal growth rate. The second was in the first week of September, when hydrilla plants should be reaching their maximum size.
No hydrilla was found in either survey.

Plate 17. Map of Infestation at Riverview Golf Course, Redding.

Survey of Riverview Golf Course Ponds

The Riverview Golf Course infestation consists of four interconnected ponds (Plate 17). 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, 2009 or 2010 (Table 12). There were 11 surveys of Rother's Pond in 2009. In 2010, the crew inspected Rother's Pond 10 times and twice in 2011.

The crew surveyed the ponds twice in 2012. The surveys this year were fairly intense, spending a full day each time surveying the ponds. As in Anderson Pond, for each survey, five to seven people were involved, coming from the Sacramento, Fresno, and Clear Lake offices. They surveyed in two-person canoes or one-person kayaks and spent a full day surveying the 39 acres covered by the ponds. The surveys were also timed to match the best opportunities for finding the hydrilla. The first was in early July, when the hydrilla is entering its phase of maximal growth rate. The second was in the first week of September, when hydrilla plants should be reaching their maximum size.

No hydrilla was found in either survey.

The first survey in 2012 was on July 12 when the water temperature was 18.9 degrees C (66 degrees F) and the last survey was on September 10 when the water temperature was 21.1 degrees C 70 degrees F). Other aquatic plants noted were egeria, coontail, water primrose, parrotsfeather, and curlyleaf pondweed.

No plants have been found in the lower three ponds since 2002.

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

Table 12. Number of Hydrilla Plants and Tubers Found and Removed from Redding Golf Course Ponds, Shasta County 2000 - 2012

	YEAR	2000	2001	2002	2003	2004	2005	2006	2007-2011	2012
Rother's Pond	Plants	1	9	18*	1	0	12	3	0	0
	Tubers	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
	Tubers	0	0	75**	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

As of 2011, the golf course ponds had gone five years under treatment with no plants. The Project leads decided to not treat in 2012 and to begin the follow-up confirmation phase of surveys.

Survey Inside and Outside the Quarantine Zone[23]

Because of budget constraints, the seasonal crew was eliminated at the Redding office in 2009. 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.

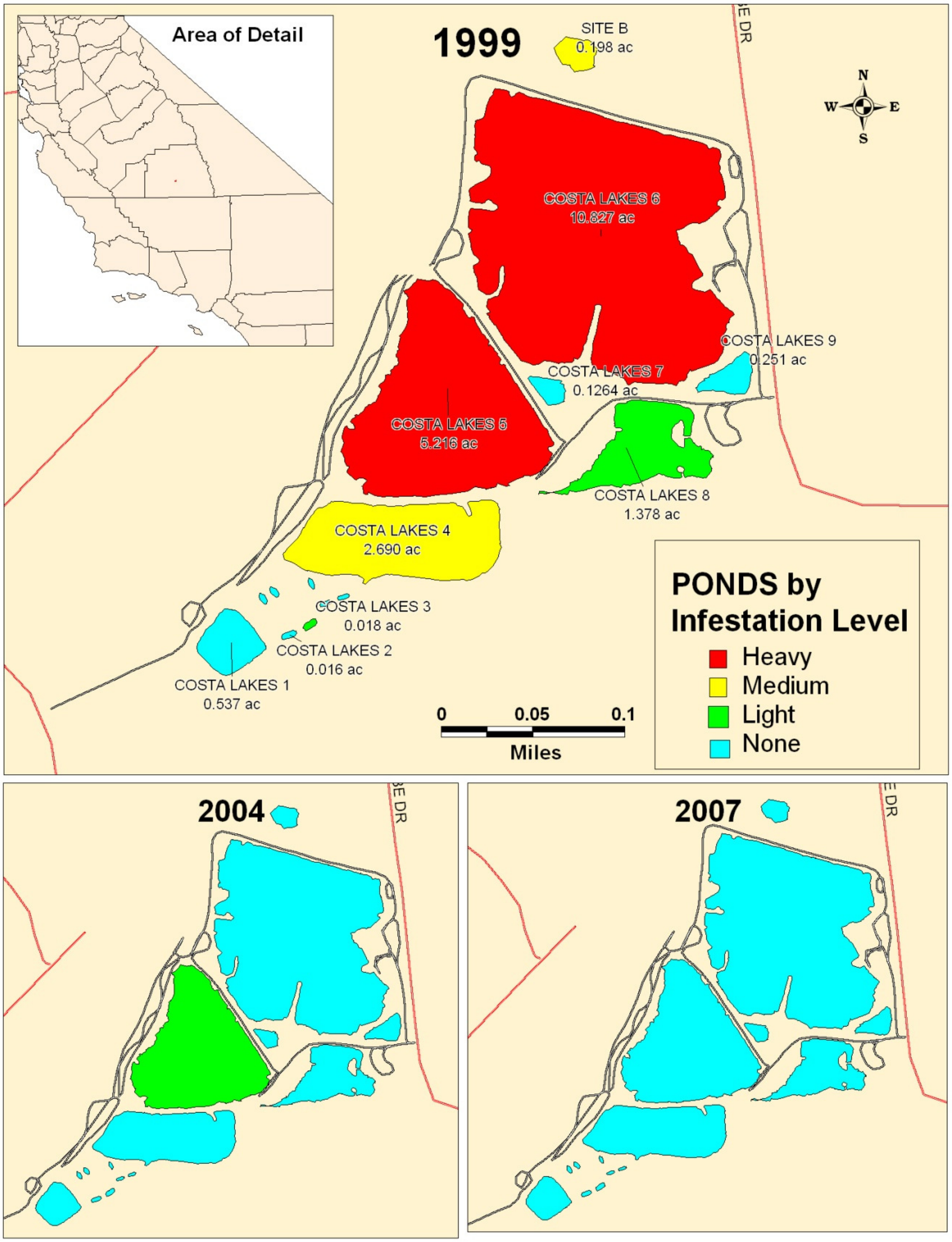
On October 7, 1996, a second infestation appeared in a fishing resort southwest of Springville and east of Porterville. The Tulare County Hydrilla Eradication Project (Tulare Project), which is a cooperative effort between the CDFA and the Tulare County Department of Agriculture, began soon thereafter. This resort is adjacent to the Tule River and is approximately two miles upstream from Lake Success[24]. 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 18). The infestations in the ponds ranged from very dense to just a few scattered plants. 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.

[23] 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.

[24] 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 18. Map Showing Change in Hydrilla Infestation at the Springville Ponds from the Year of First Detection, 1996, to Current Year, 2012



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, four to five times in 2009, three to four times in 2010, and three to five times in 2011. In 2012, they surveyed the ponds two to three times. The first survey was May 15, when the water temperature was about 26.7 degrees Celsius (80 degrees Fahrenheit). The last survey was on October 18, when the water temperature was about 20 degrees Celsius (68 degrees Fahrenheit). 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 18, Table 13). In 2005, nine surveys in that pond detected no hydrilla, and neither did eight surveys in 2006, six in 2007, five in 2008 and 2009, four in 2010, five in 2011, or three in 2012. Because of high turbidity and algal blooms in the ponds, the water visibility is often poor. Crew members have developed a technique of cruising the ponds 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 ponds, they can often bring up a plant with its root crown intact. Other aquatic vegetation detected in these ponds included elodea, curly leaf and small leaf pondweeds, chara, azolla, water primrose, duckweed, naiads, nitella, cattails and algae.

Table 13. Number of Rooted Hydrilla Plants and Tubers Found and Removed from the Springville Ponds, Tulare County 2000 – 2012

YEAR	2000	2001	2002	2003	2004	2005-11	2012
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. That was the last treatment in the project. Since 2012 was the eigth year with no plants, no herbicide was applied this year.

The Project is now reaching eradication. It had an instance of hydrilla reappearing after an absence of two years, and some scientific studies suggest that hydrilla tubers may lay dormant longer than the four to five years originally thought. An extra two years of survey was deemed prudent, past the original criterion of six years without plants. The Program is now satisfied that it is time to declare eradication.

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 ever found 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 19), 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, different from the infestations in Lake Ellis and Shakey's Pond.

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[25] (Plate 21). 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 21). 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 21). 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. In 2012, a newly dug pond was found infested on the winery property.

Although hydrilla was first found in a pond, all the ponds 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 suppressed and under surveillance, but to not push all out for eradication, until the infestation in the canal has been destroyed.

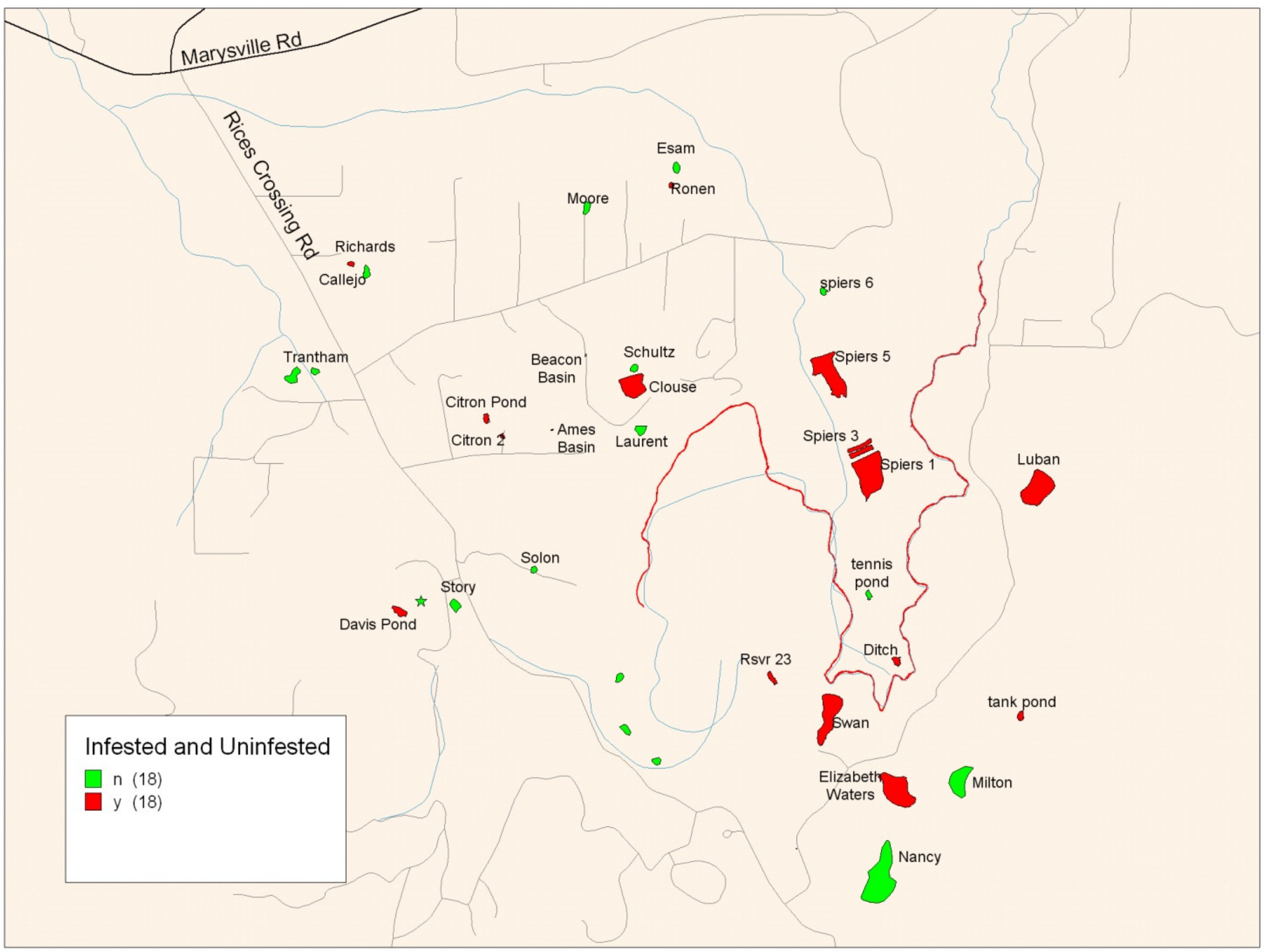
[25] The infested water lilies in the ornamental fountain were removed, the hydrilla plants and tubers destroyed, and the water lilies repotted and returned.

2012 Surveys of Ponds under Eradication

Project staff visited most ponds two or three times in 2012, focusing on ponds that have had hydrilla in recent years. Visits were made at intervals in June, July, August and September. A few ponds received only one visit, as problems arose this year with ownership or property changes that affected access.

Of the three ponds used for irrigation, Ditch and Reservoir 23 had no hydrilla this year. Hydrilla was found in Tank Pond in August. 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 19. Hydrilla Infested Ponds near Oregon House, and Hydrilla Infested Portion of Yuba County Water District Canal



Of the 11 ponds not used for irrigation, hydrilla was detected in four of them in 2012 as opposed to none in 2011 (Table 14). Each pond has its own hydrilla history. In 2006, Citron Pond was heavily infested by mid season, and produced plants in each of the following year. However, the pond was lined in 2010 and has produced no plants since then. Clouse Pond, which had over 50 plants in 2006, has been free of hydrilla for the last five years. Davis Pond has been clear after producing a few plants in 2006. Two ponds, Elizabeth and Swan, had not produced any plants for at least six years (Table 14) as of 2007. Intensive surveys in 2008 turned up a single plant in Swan but found none in Elizabeth. No plants have been found in either pond since 2008, including 2012. The four Spiers Ponds have been free of hydrilla for the last six years, including 2012, 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, in 2010 only a handful of plants were found, and no plants were found in 2011.

A newly dug pond was discovered on the winery property in October, 2012, which proved to be infested. It is about 0.15 acres and five to six feet deep. We are dubbing the pond “Blacktop”.

Table 14. Presence (+) or Absence (-) of Hydrilla Plants or Tubers in the Yuba Ponds Near Oregon House, Yuba County 2000 – 2010

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	2010	2011	2012
Irrigation	Ditch	0.2	+	+	+	+	+	+	+	-	+	+	-	-	-
	Reservoir 23	0.3	+	+	+	+	-	-	+	-	-	+	-	-	-
	Tank	0.2	+	+	+	+	+	+	-	-	-	-	-	+	+
Non-Irrigation	Citron	0.2	+	+	+	+	-	+	+ extremely heavy	+ many	+ many, small	+ many, small	- lined	-	-
	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	-	-	-	-	-	-	-	-	+	-	-	-	+
	Blacktop (new 2012)	0.16													+

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

Treatment of Ponds within the Quarantine Zone

Water bodies are treated according to the conditions observed in the ponds and management goals. The three irrigation ponds (Reservoir 23, Tank, and Ditch) are only treated with copper, to avoid damage to irrigated plants. Tank Pond was the only one with plants in 2012, and it was treated at about three week intervals with copper at 1 ppm in between early June and early September (Table 15). None of the non-irrigation ponds were treated in 2011 because they had not produced any hydrilla for four to five years. All of the ponds that showed hydrilla this year were treated with fluridone, or are scheduled for treatment next year if the find was late in the season. This included Luban Pond. We had been minimizing treatment in Luban for a few years because the pond is one of the few places left in California that has had significant densities of hydrilla within the last few years. There had been interest in trying some new herbicides in it that are candidates for being registered in California. However, with the lining of the canal now being so far advanced and the number of plants there so low, we are moving Luban towards an eradication footing and will be putting in full treatments. We will be moving all the ponds to full eradication. The new "Blacktop" Pond was treated with fluridone at 60 ppb.

Table 15. Treatments to Water Bodies in the Oregon House Eradication Project, Yuba County, 2011

Water Body	Date Treated	Product	Active Ingredient	Target Concen-tration in Water	Concen-tration Unit	Notes
Citron		na	na			Pond lined 2010
Luban	Aug., Sept.	Sonar AS and SRP	Fluridone	60, 30	ppb	
Spiers 1-5						No treatment
Elizabeth						No treatment
Res 23						No treatment
Tank		Komeen	Copper	1	Ppm	3 week intervals
Ditch						No treatment
Swan	July, Sept.	Sonar AS and SRP	Fluridone	30, 30	ppb	
Cornejo						treatment 2013
Davis	July	Soand SRP	Fluridone	90	ppb	
Ronen						No treatment
Clouse						No treatment
Shakeys	July	Sonar SRP	Fluridone	30	ppb	

Several ponds have received special treatments in recent years. The big change in 2010 was in Citron Pond. Project biologists, working with the land owner, decided to line the pond. The Project biologist devoted a large portion of his time that season to lining the pond with a heavy synthetic rubber bottom liner. The liner completely seals the bottom of the pond. No plants were found in the pond in 2011, though Project staff plan to watch it carefully for the next few years. It is possible some hydrilla might emerge at the water's edge or if a tear develops in the liner. However, this action should put an end to the major persistent site of infestation in Oregon House, other than the canal itself.

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 21), 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 a requisite for eradication of the hydrilla in the ponds.

Survey and Treatment of the Yuba Water District Canal

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[26] 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.

In 2012, the Project biologist began tests treatments with endothall, which has a new formulation with no restrictions on irrigation. Endothall is as effective as copper for hydrilla, and in addition seems to be much more effective on some of the other plants such as elodea and pondweeds, which on occasion become so dense they interfere with survey.

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 in 2009. All plants were dug out in 2009, so no copper treatments were made that year.

Visits to the canal suffered through the middle part of 2010 because of the effort put into lining Citron pond, so the canal went six to eight weeks without a visit. Visits began September and continued monthly through November, turning up about 20 plants again in 2010. All plants were dug out, with an effort made to find the tubers. In 2011 and 2012, the canal was surveyed every few weeks from June through September. One small patch was found this year, and dug out. The concrete lining of the canal also again made progress this year.

[26] 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.

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 2009, and all were dredged out to remove any tubers. A few plants appeared again in 2010. In 2011 two or three square yards of the basin were found covered with plants and the biologist took care while removing them to not send fragments of hydrilla downstream.

In 2012, a few plants once again appeared in the basin. During the year, the Project biologist and the canal company decided to replace the basin with a set of pipes and manifolds. The biologist obtained the parts for the system during the season and the canal company will be constructing and installing them during the winter and early spring when the canal is dewatered.

The 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 found 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 developed 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 (WMA) 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 to line another 1500 feet in April of 2009, with the help of a $20,000 contribution from the Hydrilla Program.

Since then the Agricultural Commissioner's Office and the WMA have continued organizing funds, including contributions from the Hydrilla Program. In 2011 all the different logistic and contract complications were overcome and the group lined 3,665 feet In October. With this effort, all but about 540 feet of the upper infested section of the canal will have been lined, and most of the the most heavily infested sections have been covered. Another 930 feet were lined in October 2012. With this effort the heavily infested sections have been lined, and only a few plants are appearing each year in the canal. For at least a couple years, the Program will try to finish the rest of the eradication using survey and digging of plants and tubers.

Three years after lining the canal in 2008, some stretches of the lined section are developing deposits of soil and organic matter. A few hydrilla plants were noted growing in the deposits, but they were easily removed. Project personnel are working on cleaning the sediments from the lined section.

Shakey's Pond, Survey and Treatment

Dr. Lars Anderson (USDA-Agricultural Research Service) 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 can cause oxygen depletion and lead to a fish kill. To minimize that possibility, the biologist treated one-third of the pond at a time at a concentration of 1 ppm of copper in each treated area. No fish mortality was noted. The copper treatments cleaned up the pond very thoroughly, and the biologist applied two treatments of fluridone at 45 ppb during October 2007.

Water samples taken early in the 2009 treatment season revealed that the pond holds fluridone concentrations well. One treatment of fluridone at 45 ppb was applied in June, 2010, and water tests in spring of 2011 showed there were still effective levels in the pond. No fluridone was added to the pond that year. The pond was surveyed three times in 2011 in July, August, and September and twice in 2012, in August and September. No plants were found in 2011 but one sickly plant was found in September 2012 and removed by hand. The pond was then treated with fluridone at 45 ppb. Prior to this year, the last plants appeared 2009, when three plants were found. 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[27]. The annual survey is conducted when hydrilla plants would have reached the surface and formed dense mats. The crews also note the presence of other aquatic weeds.

Staff from the Fresno and Sacramento offices conducted the 2012 Delta Survey at various times during July and August. Surveys of larger waterways, such as Old River, Middle River, major canals and many of the major sloughs, were conducted from motorboats. Marinas, launch ramps, and some of the smaller channels and sloughs were surveyed by canoe, kayak or airboats. Smaller watercraft allowed the crews to get closer to shore and boat slips, resulting in a more thorough survey. No hydrilla was found.

[27]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).

Waterways:

Bishop Cut, White Slough (east end to Honker Cut), Disappointment Slough, Pixley Slough, Fourteen Mile Slough, Deep Water Channel, The Barges, Hog Is, Spud Is, Windmill Cove, Hogreach Cut-off, Acker Is, Tinsley Is, Smith Canal, Calaveras River, Fourteen Mile Slough.

Marinas:
Paradise Point, Herman and Helen's, Honker Cut, King Island, Village West, Buckey Cove, 5 Star, River Point Landing, Whiskey Slough, Tracy Oasis, Tower Park, New Hope Landing, Whimpy's, Walnut Grove, Guisties, Cosumnes River at Cosumnes River Preserve.

Aquatic Plants Seen:
Algae, American pondweed, azolla, cabomba, coontail, curly leaf pondweed, duckweed, egeria, water hyacinth, watermilfoil, parrotfeather, water pennywort, water primrose, sago pondweed, small leaf pondweed, South American spongeplant, cattails, tules.

SOUTH AMERICAN SPONGEPLANT (***leads: Patrick Akers 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 four seasons, however, new, separate infestations started appearing in waterways and spreading in several parts of the Central Valley, particularly the San Joaquin Valley. The increasing problems warrant including the plant in this report.

Spongeplant could very well present a threat to California much like water hyacinth. However, it seems to spread much more easily in canals and other water infrastructure than hyacinth, so it may become a more widespread and persistent problem. Nonetheless, hydrilla is the Program's priority, and the increasing number of infested sites is straining the Program's ability to address the new pest.

South American spongeplant presents something of a paradox as far as eradication is concerned. On the one hand, in any one location, even small crews can make significant progress and reduce populations to very low levels, even over long stretches of water. If an infestation is caught early, before the plants set many seeds, often plants never come back after an area is thoroughly cleaned. On the other hand, the plant seems to be leapfrogging about, appearing in locations that have apparently minor connections. Its small, abundant seedlings seem to move much more easily than water hyacinth. Also, once a location has been heavily infested and the plants have set seeds, infestations take a long time to kill out, as the seed bank appears to last at least four years. As a result, sometimes the situation looks very hopeful, other times it looks fairly hopeless, and the outlook can change in a few days' time.

Infestations by water system name and detection year:

2007 San Joaquin River
2007 Salt Slough
2008 Cameron Slough/Byrd Slough
2008 San Luis Canal Company/Henry Miller Reclamation District
2008 Central California Irrigation District
2010 North Grasslands Water District
2010 Grasslands Water District
2010 Patterson Irrigation District
2011 San Luis National Wildlife Refuge
2012 Two new infestation sites, both associated with CCID Main Canal.
Cameron Slough extended approximately 1.5 miles.
Grasslands San Luis Canal extended a couple miles.

San Joaquin River:
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. During the 2007 season, the 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, 2009, and 2010, with plant removal continuing down to Highway 145, again removing at least 95 percent of the biomass. In summer of 2009 water flows increased from Friant Dam into the San Joaquin, marking the start of an attempt to restore salmon to the river. The first releases for the restoration project pushed the flow up to a high of 2000 cfs for a brief time. Previously, releases ranged between less than 100 cfs to approximately 350 cfs. The increased flows perhaps pushed spongeplant further downstream, but it also left plants high and dry when the water receded, effectively killing them.

In January 2011, there was a large release of water (over 6,000 cfs for a couple of days) which caused major flooding of previously dry areas. The river flow did not decrease to a safe level for survey activities until August. We feared finding large numbers of plants, both in the original channels and in newly created channels as well. This was not the case. While the main river channel had changed in some places, there were no new large ponded areas. Further, there were no large mats of plants. In the river channel proper, plant numbers were so low they could be counted individually. The crew removed approximately 3,900 plants from the channel. Five isolated ponds accounted for approximately 15,000 plants. Numbers above about 100 are visual estimates, but the crew members are now highly experienced with different densities of plants. No plants were found downstream of Hwy. 99 to Modoc Ave. This was the farthest downstream point we could survey because in early November the water release from Friant Dam was greatly reduced and the river went dry somewhere west of Modoc Ave. The crew checked the river bed from San Mateo Ave. up to the Chowchilla Bypass, where the water was in small pools; no spongeplant was seen.

Access to the river was limited by high water flows in 2012. During these periods crews worked every stretch between the infestation source down to just below Hwy 145. The majority of plants removed were from the three mile section starting below Hwy 41 in Fresno. This area had the heaviest concentrations of plants at the start of the infestation, so it is not surprising to see the higher numbers here. Of the 26,500 plants removed from the river this year, approximately 95 percent were from three isolated ponds and a side channel. No spongeplant was found in Mendota Pool, which is the main water source for many of the canal west of the river, or in the river downstream of the Pool.

Kings River area east of Fresno:
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. The source pond was also cleaned out in February 2008. Since that time, seedlings have been removed shortly after germination, stopping any new seed formation. Very few seedlings are being found as of February 2011. The pond outflow is also screened, which catches most seedlings before they can enter the canal. In the canal, six weeks of intensive hand removal in winter 2008 reduced the biomass by 90 percent, and by 98 percent by the end of the year. Eradication efforts continued through 2009 and 2010. Very few plants were detected in the last survey of 2010. Spongeplant was never found in the Kings River itself.

Hydrilla Program personnel pumped mud out of the bottom of the source pond in October, 2011. The pumping probably removed thousands of seeds and seedlings. Its effectiveness was demonstrated by the decrease in the appearance of seedlings. After the pumping less than 100 seedlings were removed before the end of the year. Prior to the pumping we were removing about 500 seedlings every three weeks.

The source pond for the Cameron infestation continued to produce seedlings throughout 2012. Approximately 2700 seedlings were removed. No plants were allowed to mature and produce seeds.

The Cameron Slough infestation increased another 1.5 miles with the discovery of two large patches and some scattered plants downstream of the lowest previously recorded plant site. Crews removed 7500 plants from Cameron, with the two patches accounting for approximately 85 percent of that total. Control structures were installed in key points along the slough to prohibit further downstream movement.

No spongeplant was found in Byrd Slough.

San Luis Canal Company/Henry Miller Reclamation District:
An infestation covering a few hundred feet was discovered in a small end canal in June 2008. By the end of July this infestation was eradicated, with no return of plants. In 2010 additional infestations were found in other canals and drains in the system. An infestation found in Salt Slough in 2007 may have come from the SLCC/HMRD system, which is upstream of the Slough.

Extensive survey and mapping of the district occurred in 2011. A few relatively small infestations were found. The district did not allow the Program crew to remove the plants, for fear of liability. However, the district did increase their spraying and dredging activities and were able to reduce these infestations.

In 2012, there was one thorough survey of the entire district, and it revealed revealed zero spongeplant. The District personnel dredged many of the waterways, including most of the prior plant sites.

Central California Irrigation District and related waterways:
In November 2008, the CDFA was notified of yet another infestation, this time in northwestern Fresno and southwestern Merced Counties between Mendota and Dos Palos, in canals and drains of the Central California Irrigation District (CCID). This large water system extends over three counties (Fresno, Merced and Stanislaus) and its Main Canal runs for approximately 76 miles between Mendota Pool and Crows Landing. Many scattered plants and limited spot infestations were eliminated in a number of these canals, usually within two to three months of the find. Major portions of Main Canal have been dredged by the CCID, removing plants and, hopefully, seeds.

Infestation levels in 2011 were less than 30 percent of that seen in 2010. The Irrigation district dredged more canals and drains, and sprayed plants where the CDFA crews could not hand remove them.

The CCID canals are the likely source of infestations discovered in 2010 in the Grasslands Water District and the North Grasslands Wildlife Area canals. With these discoveries, spongeplant has now been found well north of Los Banos.

In 2012 fewer miles of canal, and fewer overall sites had continuing infestations. However, two new sites adjacent to the CCID Main Canal were discovered. These sites, a small isolated pond and a small feeder canal, plus the Cebro farmer side drain found in 2011, accounted for the majority of the 29,000 plants and additional 5 cubic yards of material removed from the CCID system this year.

Patterson Irrigation District:
In October 2010, a small infestation was discovered in the central canal of the Patterson Irrigation District system. PID personnel reported that they eliminated all the plants by the end of 2010.

A quick survey of the infested area in March 2012 did not find any plants.

San Luis National Wildlife Refuge:
This infestation was discovered in July 2011. Two canals and a large marsh were heavily infested. By year’s end, all plants had been removed by the CDFA crew and Refuge personnel. Plants were too numerous to count but the estimates are that several tons of biomass were removed.

The two canals and the marsh were de-watered, dredged and burned in mid 2012. Water was placed back in the waterways in early November. No spongeplant was detected in 2012.

Grasslands Water District:
The Irrigation District attempted to bring this infestation under control on their own, but the spongeplant grew so fast that their spray program could not keep up with it. The Hydrilla crew removed square yards of plants to bring the infestation to a point where the district could manage it.

The waterways in this district require consistent attention to maintain control. The 2,500 plants removed were scattered throughout the various canals. Unfortunately, plants did appear to move farther downstream, albeit in very small numbers.

Cebro Drain:
The drain is a farmer's small side channel located adjacent to the CCID Main Canal. The owner committed to spraying every two weeks and the Program crew placed some booms to keep plants out of the Main Canal. However, at year's end there were still many small plants. The crew will have to look at hand removal this spring.

This waterway required consistent attention in 2012 to keep it under control. It was infested for some time before it was discovered so there is undoubtedly a large seed bank.

Sacramento Delta:
No work was done by Program personnel on spongeplant in the Delta in 2012, except for a couple short surveys to check the population status around Decker Island. Encouragingly, that population remained small, at least by the time of the survey in early August. Less encouraging, reports from other agencies working in the Delta indicated the spongeplant was spreading farther in Frank's Tract, especially in the southwest corner.

SUMMARY AND CONCLUSIONS

In 2012 the CDFA Hydrilla Eradication Program continued its momentum towards achieving eradication of hydrilla across California. Since 2010, we have reached eradication in four separate projects (Chowchilla/Eastman, Bear Creek, Mokelumne Hill, Springville Ponds). In three other projects, there have been no plants for five to six years and we have moved to the post-treatment confirmation survey phase (Redding golf course, Anderson Park, two of the three ponds in Nevada County). Even the irrigation drains in Imperial County appeared to be free of hydrilla this year. Hydrilla was found in only three projects (Clear Lake, Oregon House, one small pond in Nevada County).

Clear Lake took a bounce along the bottom this year. More plants were found this year than last (26 vs six), but only in five spots. If the source plants for the three colonies had been found before they were fragmented, there might have been only five plants this year instead of 26. But detection of individual plants in Clear Lake will continue to present major challenges and there will almost certainly be some misses that take some time to discover. Since there is no high-tech, high-speed way to pinpoint single hydrilla plants, the only method to improve survey results is to increase survey effort, and resources are constrained for that. Despite the survey challenge, overall infestation levels in the lake are trending towards extinction. Further, with the leveling off in treatment area, there is reason to hope that the project will remain within the budget available to the Hydrilla Program.

With the lining of 3,700 feet of the Oregon House canal in 2011 and 930 feet in 2012, that infestation is starting a clear trend towards eradication. Less than 20 to 30 plants have been found in the canal in each of the last few years, and all the ponds are being put on a treatment regime to move them to eradication. With the piping of Ames Basin in the winter of 2012-13, another stubborn little source of infestation will be removed, which otherwise could have reinfested all the downstream ponds.

While the eradication projects made progress this year, the effort to survey for new hydrilla introductions has suffered some in the past four years, especially north of the Delta. This is due to the demands of Clear Lake and recent cuts to the weed programs in the CDFA. These factors led first to the loss of the seasonal crew in Redding, then to the Clear Lake crew focusing all its efforts on the lake with no time for detection surveys, and finally to the loss of the weed biologist in Redding. Many resources for detection were lost with these changes. In the Delta and San Joaquin Valley, survey continues at a good pace, which also provides us some opportunity to survey for and work on spongeplant. The CDFA and county biologists continue to survey the critical Sacramento / San Joaquin River Delta. Once again, survey crews detected no hydrilla plants in the Delta in 2012.

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.

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