CDFA Hydrilla Program: Annual Progress Report for 1999 and 2000

Protecting California's Waterways

INTRODUCTION

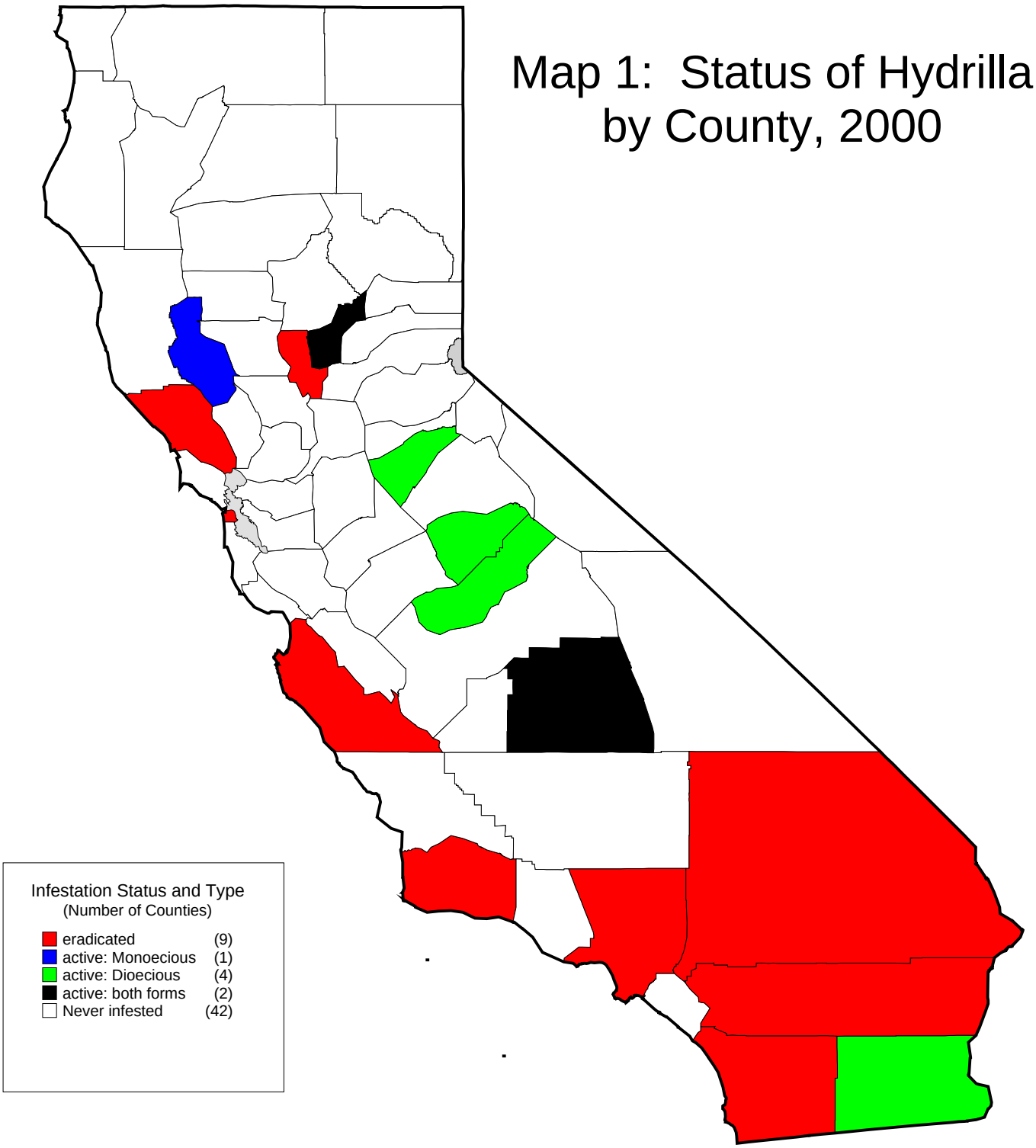
Hydrilla (*Hydrilla verticillata* Royal L.F.) is a noxious submersed non-native aquatic weed. Two different forms of this weed have been found in the United States, indicating at least two separate introductions of this plant. The dioecious form of hydrilla was first identified in Florida in the 1960's, where it was believed to have been introduced in the 1950's. This infestation has since spread throughout the southeastern United States and into Texas and California. The monoecious form was first detected in the Potomac River, near Washington, D.C. in the 1980's. It has since spread south into a number of the southern states and has also been found in Washington State and California. Hydrilla can form dense mats on the water surface and can fill the entire water column with plants, impeding water deliveries in irrigation systems, adversely affecting recreational uses, and displacing native vegetation.

Dioecious hydrilla was first found in 1976 in California, in a 31-acre lake in Marysville, Yuba County. Since then, hydrilla has been found in 17 counties in California. Monoecious hydrilla was found for the first time in California in 1993 at an aquatic nursery in Visalia, Tulare County. A second infestation was found in 1994 in Clear Lake, Lake County, and a third infestation in 1997 in Yuba County. Of the 17 counties in California that have had infestations of hydrilla, eradication has been achieved from various water bodies in 13 of the counties: Calaveras, Los Angeles, Monterey, Riverside, San Bernardino, San Francisco, Santa Barbara, Shasta, Sonoma, Sutter, San Diego, Tulare and Yuba (Table 1, Map 1). Infestations in an area are generally considered as separate introductions when they appear more than two or three years apart. By these criteria, California has suffered approximately 33 separate infestations. Of these, 20 have been fully eradicated and only eight still require treatments. Hydrilla has not returned to any of the infested sites where eradication has been declared, although routine monitoring of these sites continues.

Various federal, state and local agencies recognize the existing and potential negative impacts of hydrilla and contribute funds, manpower or other support to the eradication program. State agencies that contribute include the Department of Boating and Waterways, Department of Water Resources, and the Department of Fish and Game. Federal agencies include the Bureau of Reclamation, Bureau of Land Management (BLM), United States Army Corps of Engineers, and two services from the United States Department of Agriculture: the Animal and Plant Health Inspection Service (USDA-APHIS) and the Agricultural Research Service (USDA-ARS). Numerous local and county agencies are also involved with the project, including the Yolo County Flood Control and Water Conservation District, Yuba County Water District, Imperial Irrigation District, Big Valley Rancheria, and Department of Lake County Public Works. When an infestation of hydrilla is detected, the local, lead agency is the County Agricultural Commissioner's Office. The California Department of Food and Agriculture (CDFA), Integrated Pest Control Branch, is responsible for administering and conducting the statewide survey and eradication program.

The eradication program uses an integrated, adaptive management approach to achieve its objectives. The program may employ biological, physical, cultural, or chemical controls, and often employs combinations of several methods. Treatment selections are based upon hydrologic, climatic, biologic, chemical, end use, and other environmental and resource factors that may affect the feasibility of the treatment or the management of the water resource. Herbicides play an important role in many projects. Following the recommendations of a scientific advisory panel on the science and management of hydrilla, the standard herbicide protocol is to treat for at least three years once hydrilla is found. After the initial three-year

Map 1: Status of Hydrilla by County, 2000



Weed Information Project, CDFA Integrated Pest Control Branch, May 2001
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treatment period, treatments continue until surveys show hydrilla is absent for at least one full growing season. Treatments generally cease then, but surveys continue. Eradication may be declared after two more years of surveys with no finds of hydrilla. If hydrilla re-appears, the area will once again receive treatments until no hydrilla is found for at least one growing season, and, again, it will require at least three full years of negative surveys before eradication may be declared. In practice, an area may receive regular surveys for many years following the removal of an infestation.

Some aspects of hydrilla's biology, especially its reproductive biology, are of central importance to its control. Hydrilla has multiple means to reproduce, most of which are vegetative. If the plant is broken, fragments having as few as two whorls of leaves (about one inch) can root and form new plants. The plant generally produces a mat of creeping stolons above and below ground, and it can re-grow from these stolons if the stems and leaves are destroyed. The plants also produce two types of a vegetative resting stage, both of which are modified buds. One type is produced along the stem and is generally called a turion. The other type develops on the stolons and is also a turion, but is more commonly referred to as a tuber. Stem turions separate from the parent stem in late fall or at maturity. The tubers remain attached until the parent stolon decomposes. A period of low temperatures often stimulates turion and tuber germination, especially in the monoecious biotype. Turions and tubers typically germinate in spring when conditions become favorable, or they may remain dormant. Under field conditions, monoecious tubers survive for up to five years. Dioecious tubers are usually larger than monoecious tubers and can survive longer, for up to 10 years. Stem turions mostly develop in late summer through fall as day length shortens. Tubers typically develop in mid-summer through winter, but monoecious plants may also form them in the spring.

Table 1: STATUS OF HYDRILLA IN CALIFORNIA (2000)

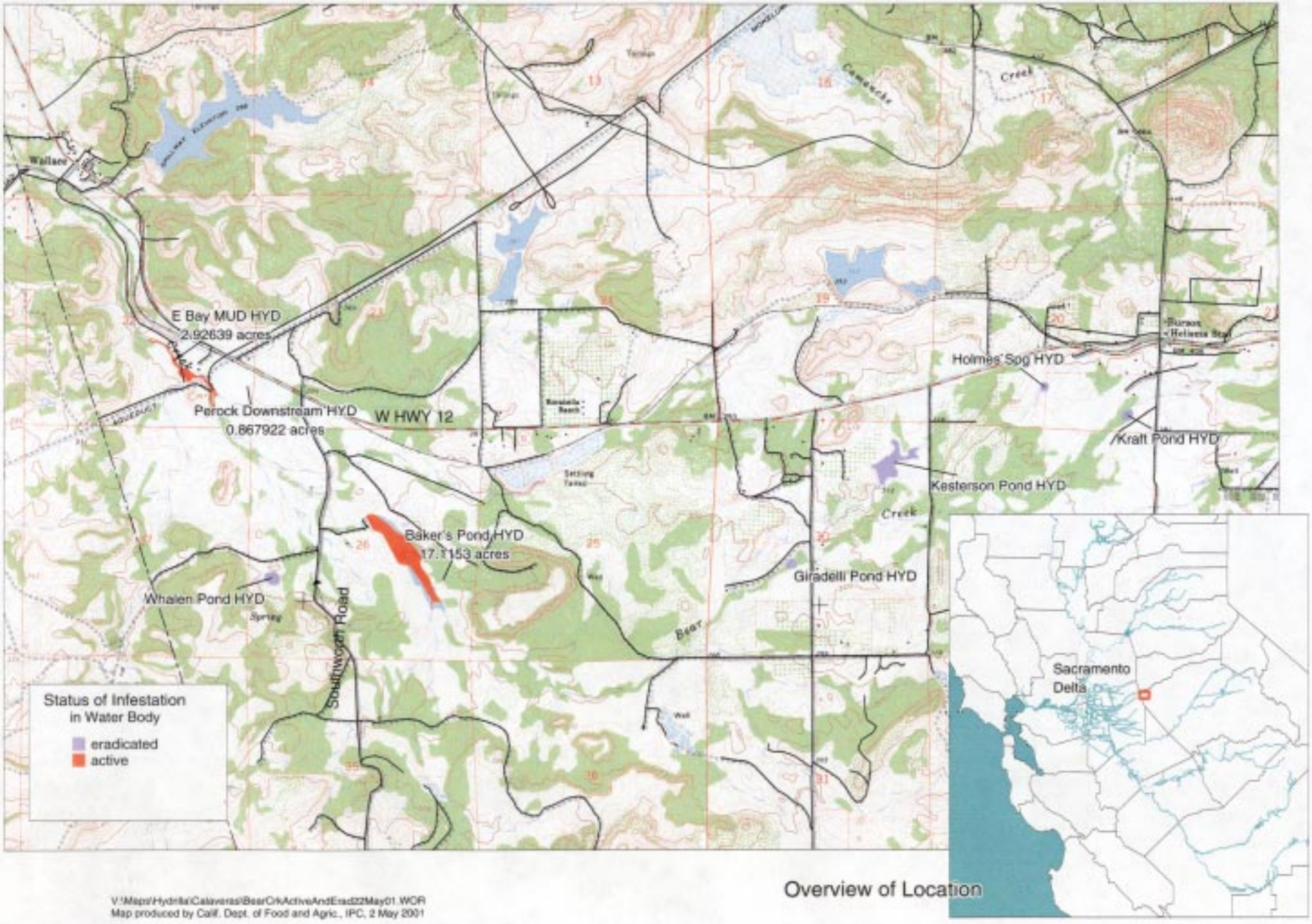
COUNTY	YEAR	WATER BODY	SIZE	STATUS
YUBA	1976 1990 1997	Lake Ellis One pond 13 ponds and two spill basins	30.8 acres 6.0 acres 20 acres and 3.1 miles of canal	Eradicated *Survey Active
SAN DIEGO	1977 1977	Lake Murray One pond	160 acres <1 acre	Eradicated Eradicated
IMPERIAL	1977	45 pond/reservoirs Imperial Irrigation System	270 acres 600 miles of canals, ditches	Survey
SANTA BARBARA	1977 1993	One pond One pond	12 acre <.01 acre	Eradicated Eradicated
RIVERSIDE	1977 1984 1985	One pond One pond Three ponds	<1 acre <1 acre <1 acre	Eradicated Eradicated Eradicated
MONTEREY	1978	Private pond	0.01 acre	Eradicated
LOS ANGELES	1980 1983 1985	Eight ponds One pond One pond	2 acres <1 acre <1 acre	Eradicated Eradicated Eradicated
SONOMA	1984	Spring Lake	72 acres	Eradicated
SUTTER	1985 1990	One pond One pond	<.01 acre <.01 acre	Eradicated Eradicated
SHASTA	1985 1986 1994 1996	Seven ponds Four ponds Two ponds Three ponds	133 acres 23.5 acres 13 acres 37 acres	Eradicated Survey Survey Active
CALAVERAS	1988 1988 1996	Seven ponds Two ponds One pond	23 acres 0.6 acre 4 acre	Survey Eradicated Active
SAN BERNARDINO	1988	One pond	<.01 acre	Eradicated
SAN FRANCISCO	1988	One pond	2 acres	Eradicated
MADERA/ MARIPOSA	1989	Eastman Lake Chowchilla River	100/1,800 acres 26 miles	Active Active
TULARE	1993 1996	Three ponds Six ponds	0.6 acre 20 acres	Eradicated Active
LAKE	1994	Clear Lake	1,153 acres/ 43,000 acres	Active

*Survey = No further treatment required; three year negative survey required for declaration of eradication.

CALAVERAS COUNTY

Two separate infestations of hydrilla exist in this county. The first infestation was detected in May 1988, consisting of seven farm ponds along the Bear Creek drainage between the towns of Burson and Wallace (Map 2). The other infestation in this county consists of two ponds located near Mountain Ranch, also discovered in 1988 (Map 3).

Map 2: Bear Creek Drainage Hydrilla Eradication Project, Calaveras County



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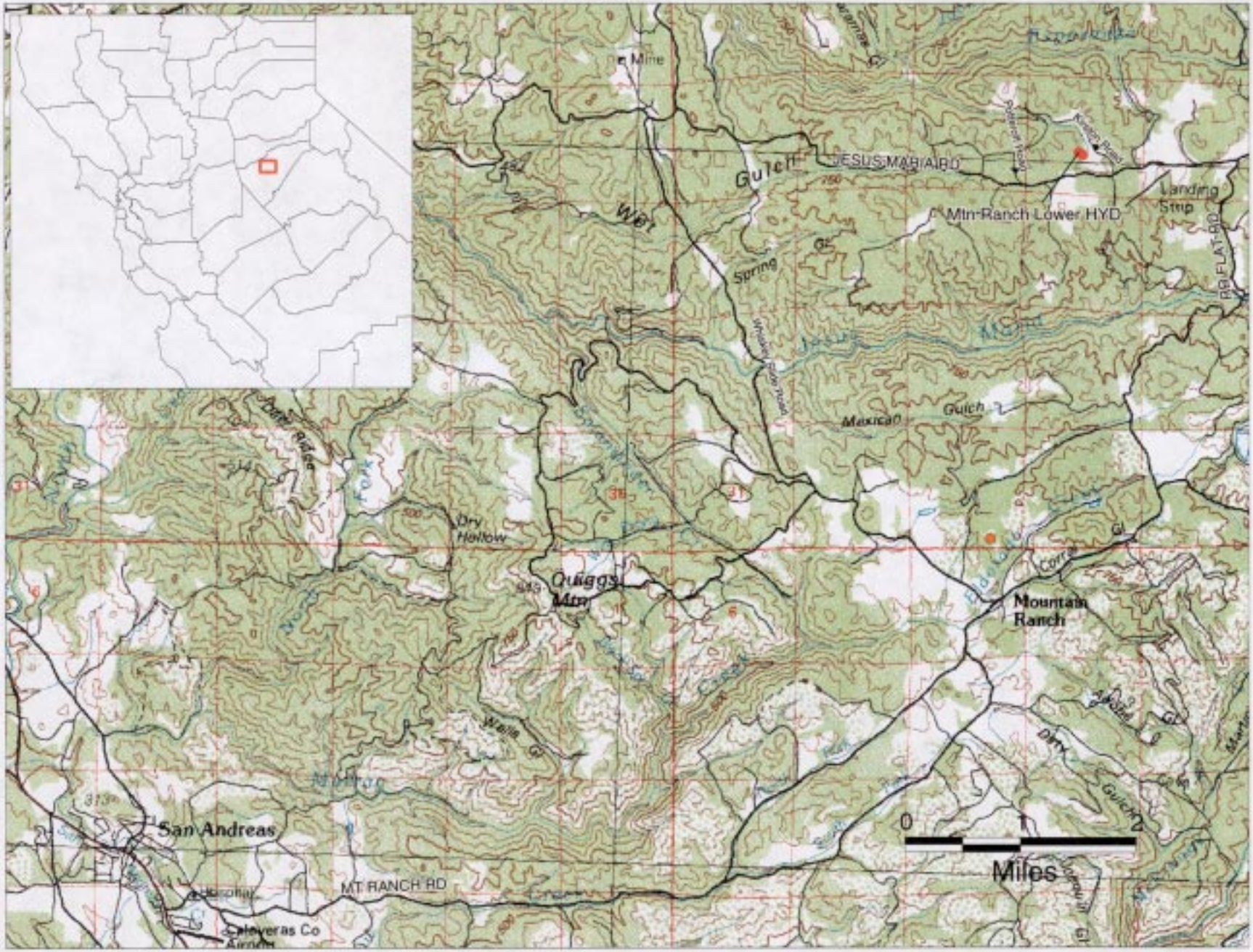
Map produced by Calif. Dept. of Food and Agric., IPC, 2 May 2001

Map 3: Mountain Ranch Hydrilla Eradication Project, Calaveras County

Ponds digitized from existing maps

● = Infested ponds



Map by CDFA, Integrated Pest Control Branch, Noxious Weed Information Project, 20 May 2001
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Bear Creek enters the Sacramento/San Joaquin Delta at Disappointment Slough approximately 26 miles downstream from the lowest infested pond on the creek (Overview, Map 2). By 1996, chemical applications, physical excavations of bottom soils, and soil fumigation of some of the ponds had reduced this infestation to only three ponds that had only a few plants (Map 4). However, in June 1996, a new four-acre pond, approximately one mile downstream from the lowest known infested pond, was found to have hydrilla. Plants were scattered, but in very low densities, leading to the assumption that the infestation was probably no more than two years old. The infestation may have started when high water flows in early 1995 flushed plant material from the upstream infestation into the pond. A few plants were also found in the creek between the ponds. Most plants in the pond and creek areas were physically removed and treated with Komeen™, followed by applications of Sonar™. Excellent control was achieved. In 1997, two infested ponds in the Bear Creek drainage had a few plants; these were removed and the ponds were treated with Sonar™. For the first time, no plants were detected in the 17-acre Baker Pond, the largest impoundment on the project. In 1998, all infested ponds were surveyed and treated with multiple treatments of Sonar™ at 25 to 30 parts per billion (ppb) each to achieve a total concentration of about 50 to 60 ppb. In 1998, no plants were found in seven of the eight ponds previously infested. In 1999, no hydrilla was found in the ponds, but 11 plants were found all within a few feet of one another in a slow-moving section of the stream connecting the ponds. The soil surrounding them was dredged to remove any hydrilla tubers, and that section was treated with Sonar™ at 90 ppb. A few other ponds received a treatment at 30 ppb to prevent any possible formation of tubers. In 2000, no plants were found in any of the ponds or in Bear Creek. Several ponds received a late treatment with Sonar™ at 30 ppb since they had hydrilla during the previous three years. No treatments are planned for 2001 because of the very low amounts of hydrilla found in previous years, but treatments will occur if hydrilla is found during the season.

The Mountain Ranch ponds are located about 30 miles from the Bear Creek area (Map 3). These ponds were excavated and fumigated, one in 1991, the other in 1992. A few plants reappeared in 1993, and all plants were removed manually or with a suction dredge. No plants were found during surveys in 1994 and 1995. In 1996, approximately 12 plants reappeared in the larger pond, and it was treated with Sonar™. These two ponds have not had hydrilla since 1996 and the hydrilla can be considered eradicated, though the ponds continue to receive periodic checks.

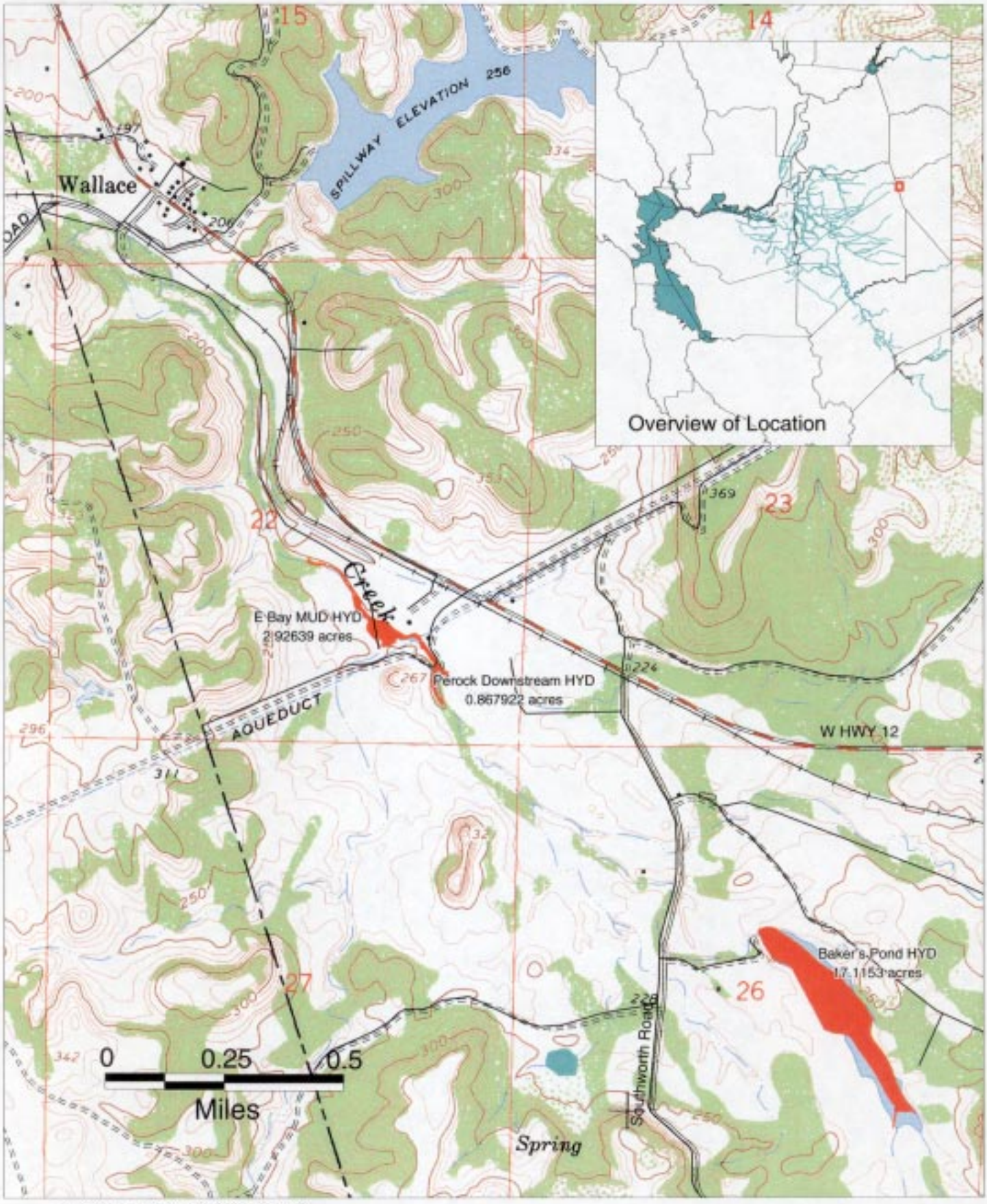
MADERA AND MARIPOSA COUNTIES

In June 1989, biologists with CDFA and the Madera County Agricultural Commissioner's Office conducted a routine detection survey of aquatic sites in the area and detected hydrilla in Eastman Lake, a 1,780-acre water body used for flood control, irrigation, recreation and wildlife. Scattered patches of hydrilla were found in the northern section of the lake and along the eastern and southeastern shoreline, amounting to 100 infested acres. An extensive delimiting survey of all known water bodies in the area determined that hydrilla was established in the Chowchilla River and in its West Fork, as well as Eastman Lake. Approximately 26 miles of river were infested with amounts varying from single plants to dense patches, although most had dense patches.

The intensive eradication program, initiated in 1989, has drastically reduced the hydrilla infestation (Map 5, Table 2). When the infestation was found, Eastman Lake was closed to all

Map 4: Bear Creek Drainage Hydrilla Eradication Project, Calaveras County

= Infested Areas



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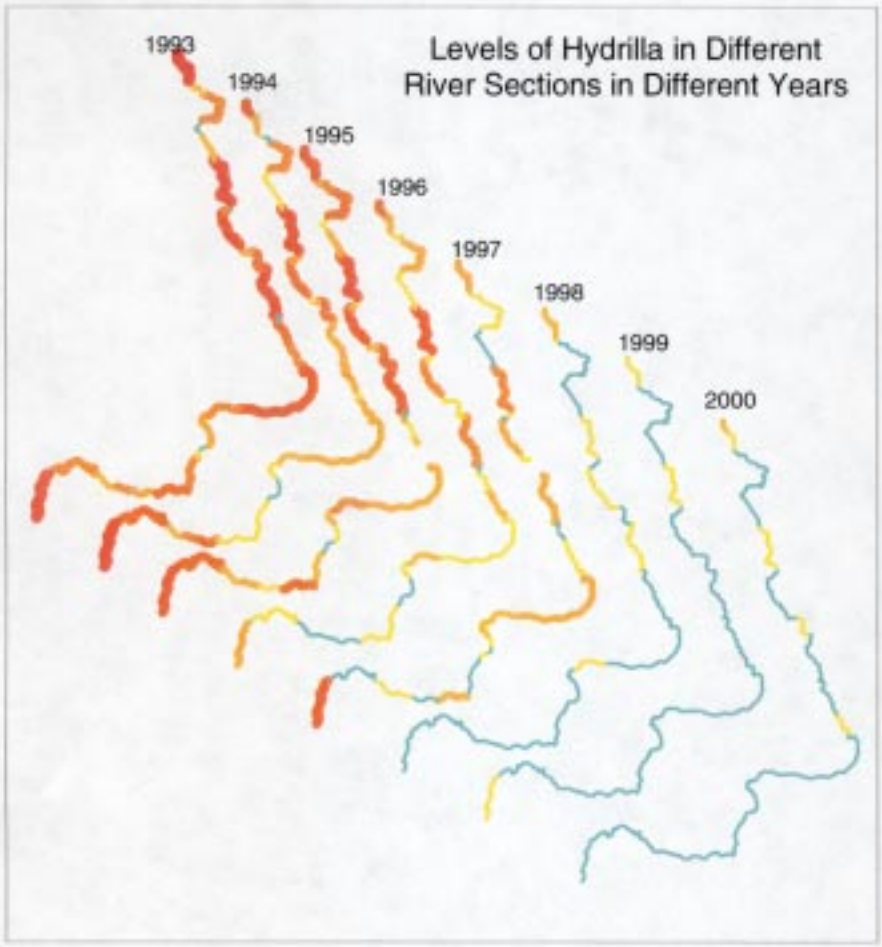
Map produced by Calif. Dept. of Food and Agric., IPC, 2 May 2001

Map 5: History of Hydrilla Infestation in the Chowchilla River, Madera/Mariposa County



Plants Removed in River Section (No. of Sections): 2000

11 to 20 (1)
1 to 10 (4)
0 to 0 (32)

1999

1 to 10 (4)
0 to 0 (33)

1998

11 to 20 (2)
1 to 10 (6)
0 to 0 (29)

1997

161 to 320 (1)
41 to 80 (1)
21 to 40 (6)
11 to 20 (2)
1 to 10 (13)
0 to 0 (12)
all others (2)

1996

161 to 320 (1)
81 to 160 (1)
41 to 80 (2)
21 to 40 (4)
11 to 20 (3)
1 to 10 (17)
0 to 0 (9)

1995

321 to 640 (1)
161 to 320 (5)
81 to 160 (4)
41 to 80 (3)
21 to 40 (6)
11 to 20 (6)
1 to 10 (8)
0 to 0 (3)
all others (1)

1994

641 to 1,280 (1)
321 to 640 (1)
161 to 320 (1)
81 to 160 (4)
41 to 80 (3)
21 to 40 (9)
11 to 20 (2)
1 to 10 (10)
0 to 0 (6)

1993

1,281 to 2,560 (1)
641 to 1,280 (3)
321 to 640 (2)
161 to 320 (1)
81 to 160 (5)
41 to 80 (8)
21 to 40 (6)
11 to 20 (3)
1 to 10 (4)
0 to 0 (4)

Topo Map Showing the Infested Part of the River

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recreational use. Its level was reduced to minimum pool, exposing approximately 10 acres of infested hydrosoil. Once the area became dry, the soil was fumigated with metam-sodium (Vapam™). Regularly scheduled Komeen™ applications over the next three years resulted in no plants being detected after 1993. The quarantine of the lake has been lifted to allow nearly unrestricted recreational use, except for a small area where the river enters the lake. Water levels and water delivery are now unrestricted. A further lifting of fishing restrictions has been approved to allow night fishing in areas that are open to daylight fishing. Further, since the lifting of the quarantine, the Department of Fish and Game has designated Eastman Lake as a trophy bass fishery.

Treatments and dredging activities in the river reduced plant numbers to low enough numbers that physical removal of plants has been the predominant control method since 1993, although Komeen™ and Sonar™ applications are still made to areas where plants might be missed. In 1993, plant densities reached low enough levels that counting plants became practical (Table 2).

By 1997, only 562 plants were found in the river, which were physically removed by digging and dredging. Sonar™ was applied to infested sections of the river where water-flows are minimal. Dredging operations, which are carried out using a mining dredge under a special permit from the Department of Fish and Game, resulted in the recovery of 1,898 tubers from some areas. No tubers were dredged from a number of other areas that had a history of hydrilla, indicating complete removal of hydrilla. In 1999, only 32 plants were found in the river and 19 in 2000. This represents a 99.7 percent decrease in the plant population from the 1993 level. In addition, the number of river units with zero plants found increased from 11 out of 38 in 1997, to 29 in 1998, 33 in 1999, and 32 in 2000. The river units are based on ownership and are not equal in length. Numerous plants are still in the river, however, as indicated by dredging results. Dredging recovered 1,083 tubers in 1999 and 1,789 tubers in 2000. Nearly all tubers came from the farthest upstream sections of the river. In many other previously infested locations that were dredged, no tubers were recovered.

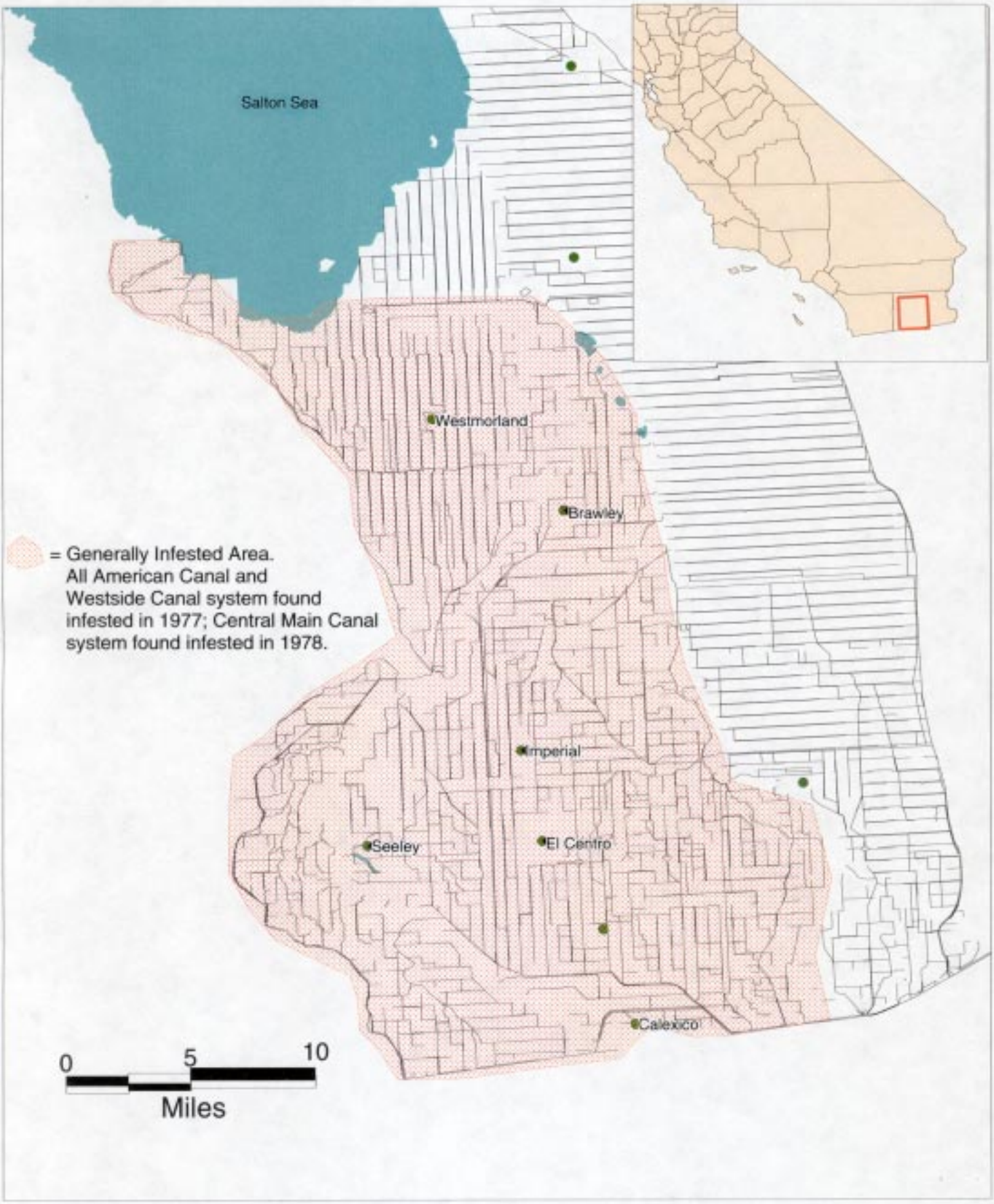
Table 2: HYDRILLA PROJECT - PLANTS REMOVED IN THE CHOWCHILLA RIVER

Year	1993	1994	1995	1996	1997	1998	1999	2000
Plants	6,484	2,088	2,343	637	562	49	32	19

IMPERIAL COUNTY

Hydrilla was first detected in June 1977, in the All American Canal, a part of the Imperial Irrigation District (IID) irrigation system. The irrigation system is network where water flows by gravity through supply (delivery) canals to lateral delivery canals, ponds, and other reservoirs, then to farmers' ditches where the water is delivered to the fields. Drainage canals (drains) then carry away runoff, ultimately to the New and Alamo Rivers. By 1988, approximately 600 miles of canals, 32 ponds (161 acres), and 79 privately owned delivery ditches were infested, despite intense local control efforts (Map 6). A cooperative program began in 1981 to research and develop control methods. Cooperators in the program included IID, USDA-APHIS, USDA-ARS,

Map 6: Imperial Irrigation District Hydrilla Eradication Project, Imperial County



Map by CDFA, Integrated Pest Control Branch, Noxious Weed Information Project, 30 May 2001
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the California Department of Fish and Game, and the Imperial County Agricultural Commissioner's Office, as well as CDFA. One of the methods that was investigated was the use of Triploid Grass Carp (TGC), which feed heavily on aquatic vegetation and especially hydrilla. TGC stocking has made the difference in making progress on the infestation.

The Hydrilla Eradication Project itself was initiated in 1988. Its activities consist of hydrilla survey and treatment, and stocking of TGC in infested canals, ponds, reservoirs, and some drains in the Imperial Valley. TGC have been produced, raised, and distributed by IID since 1988, when their fish hatchery was completed. TGC are generally stocked on a yearly basis to maintain a rate of 100 fish per mile for flowing systems, and 100 fish per acre for ponds. In conjunction with the TGC stocking, the program employs extensive survey, heavy dependence on mechanical removal (mudpumps, draglines, and backhoes), physical removal by hand and shovels, cultural methods such as drawdowns, and some herbicides.

By 1998, hydrilla was not detected in the delivery system. It was detected in four IID drains, one farmer's side canal, and one pond. The total infestation in 1998 consisted of a few plants scattered over about two miles of canal, as compared to the 600 miles in over 320 canals in 1988.

In 1999, IID staff, under contract with the CDFA, continued to carry out hydrilla surveys. Surveys occurred from June through mid December. Canals within the original infestation boundary were surveyed one to four times. More intensive surveys were focused on areas where hydrilla had been found in the last three years. Twenty-six canals, 11 drains, 46 farmers' ditches, and seven ponds were each surveyed six to 12 times. Hydrilla was found in one canal (Thorn 1), two drains (Wildcat and Wisteria 7), one pond (Wormwood 46), and one farmer's ditch (Spruce Lateral 4). Where hydrilla was found, it was removed by hand and by mudpump. TGC stocking was initiated for the pond.

The IID staff surveyed from May through mid December in 2000. Canals within the original infestation boundary were surveyed one to four times. More intensive surveys were focused on areas where hydrilla had been found in the last three years. Twenty-seven canals, 12 drains, 54 farmers' ditches, and seven ponds were each surveyed six to 12 times. Hydrilla was found in one canal (Filaree Spill), two drains, and none in the ponds or farmers' ditches. Where hydrilla was found, it was removed by hand and by mudpump. Sonar™ and Nautique™ treatments are also planned for the drains, and TGC stocking has been initiated for the Filaree Spill. In this instance, a screen is being erected to keep the fish from moving downstream and out of the infested area.

A total of 18,482 TGC were stocked in the Imperial Valley in 2000. In the infested area, the IID Biocontrol Section stocked 2,218 TGC in canals and laterals, and 214 fish in ponds and reservoirs. In the non-infested area, the IID Biocontrol Section stocked 9,381 TGC in canals and laterals for aquatic weed control and to prevent the establishment of hydrilla and a new threat, giant salvinia (*Salvinia molesta)*. The salvinia infestation originates in a drain in the Blythe area. The plants move down into the Colorado River, and they sometimes enter the IID system where water is taken from the river. Also, 4,721 mostly small fish were provided to the program in Mexicali. Mexico's program grows the fish to a larger size in a protected setting and then releases them into infested water bodies on the Mexico side of the border.

LAKE COUNTY

Clear Lake is California's largest natural lake, with approximately 43,000 surface acres. The lake is almost 20 miles long, eight miles wide and has approximately 100 miles of shoreline. It is located approximately 90 miles north of San Francisco. Clear Lake is relatively shallow, with an average depth of approximately 20 feet. Water temperatures range from mid to high 70°F in the summer to 40°F in the winter. These conditions are ideal for hydrilla, especially the monoecious form that is found in Clear Lake.

Fishing is the most popular year-round activity in Clear Lake, and 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 and bluegill in the lake. Because of the heavy traffic of boats into and out of the lake, the probability is extremely high that hydrilla would have spread out of the lake to other bodies of water within and outside of California, had the infestation not been found and treated. Hydrilla was first found in Clear Lake on August 1, 1994 during a routine detection survey conducted by personnel from the CDFA and the Lake County Agricultural Commissioner's Office. Treatments began within days of its detection.

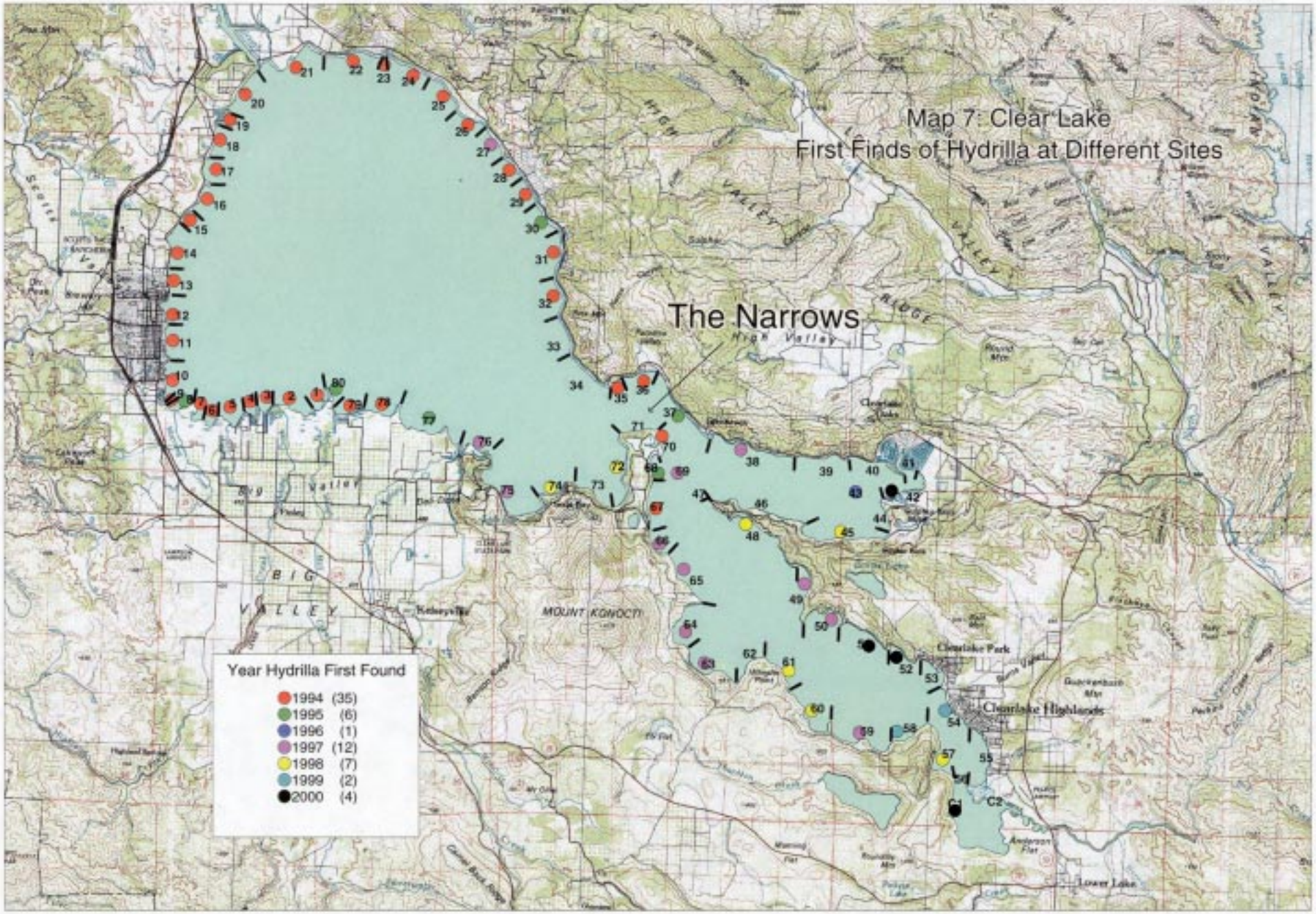
The result of the initial delimiting survey indicated 175 to 200 surface acres of infestation along the shoreline of the upper arm of the lake. Since then, other areas and new infestations have been detected. As of January 1, 2001, approximately 1,150 acres of Clear Lake are presumed infested with hydrilla. The current infestation includes two new locations found in 1999, and four new locations in 2000, totaling 35 acres (Map 7). These sites contain single or scattered plants. A substantial portion of the infestation is still located in the upper arm of the lake, although surveys are beginning to detect no hydrilla in a number of areas that have been under treatment for several years. Twenty-six infested areas are located in the lower arm of the lake, southeast of the Narrows; this is an increase of six sites over 1998. Several of the new sites are scattered along the northeast shore of the lower arm of the lake (areas 48 through 52), along a relatively even, open part of the shoreline. In anticipation that hydrilla may move or has moved to fill in the areas between the current detections, the treatment areas along that part of the lake are being expanded to cover a more extensive part of the shore. This change will increase the area treated in that part of the lake from about 35 acres to about 130 acres. Finally, hydrilla appeared in the forebay above the outlet creek of the lake (Cache Creek) in 2000. This area is now under intensive survey and treatment. Intensive detection surveys in high-risk areas of Cache Creek will be conducted in 2001.

Project Components

Survey and detection, treatment, public information and awareness, and monitoring are the major components of the eradication project. The following summarizes the efforts and results associated with these component activities over the past year.

Survey and Detection

Detection surveys outside the hydrilla eradication area are conducted each year by the CDFA's Associate Agricultural Biologist for the district that includes Clear Lake. Surveys are conducted in cooperation with County Agricultural Commissioners' and other cooperating agencies' staff. In Lake County, Indian Valley Reservoir (4,000 acres), Highland Spring Reservoir (80 acres), Lake Pillsbury (1,980 acres), Blue Lakes (150 acres), and Thurston Lake (300 acres) are



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surveyed each year. In addition, major reservoirs and lakes in Colusa, Mendocino, Napa, Sonoma and Yolo Counties are surveyed since movements of boats from Clear Lake to these bodies of water are a relatively common occurrence. No hydrilla has been found during these detection surveys.

Surveys within Clear Lake constitute a major portion (approximately 50 percent) of the project crew's field activities. For example, in 1999, the different management units (numbered in Map 7) designated around Clear Lake each received an average of 10.95 survey visits, for a total of 931 visits. There are two major objectives associated with survey operations within the eradication area. The first objective is to ascertain and evaluate the status of hydrilla growth in the infested areas. This includes determining when plants start to emerge from vegetative propagules in the hydrosoil and monitoring the plant populations prior to and after treatment. The second objective involves surveillance of non-infested areas of Clear Lake. These surveys are essential to ensure timely detection of new incipient infestations, which permits them to be treated while the propagule bank is still small.

Surface and subsurface surveys are the primary methods for hydrilla detection. Project personnel conduct these surveys from boats and the shoreline. Surveys are conducted through visual inspection of the water to identify rooted plants or plant fragments floating on the surface. In addition, project staff uses a multi-pronged grappling hook to retrieve plants rooted in waters where depth and turbidity preclude visual inspections. Scuba divers conduct underwater surveys on a limited basis. Diving surveys are conducted to establish more accurate information on plant density within a given area. As progress toward eradication continues, underwater surveillance activities will increase to quantify reduction in plant population.

The early surveys each year concentrate on the known infested areas. These areas are all fairly near the shoreline, out to about 500 feet from the shore (Map 8). The first plant for 1999 was found on May 20 in the location designated Area #41, but hydrilla did not begin to appear routinely until the third week of June. The first plant for 2000 was found on June 5 in the location designated Area #49, and hydrilla did not begin to appear routinely until towards the end of June. The initial finds of hydrilla for 1998, 1997, 1996, and 1995, respectively, were on May 18, April 28, May 1, and May 8.

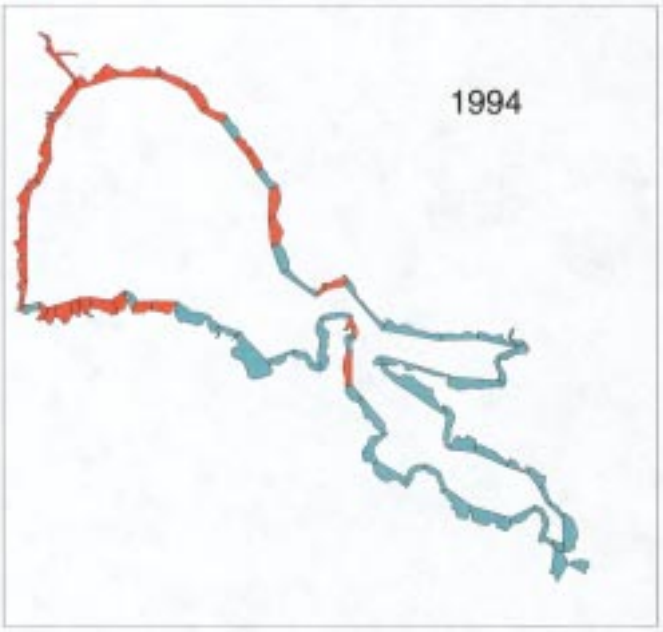
The near-shore areas in both the infested and non-infested areas around the entire lake were surveyed on a two to three week interval through November. Detection surveys outside the near-shore areas, in the deep-water sections of the lake, were initiated in September and continued on a monthly basis until the end of November. No hydrilla has been detected in deep-water areas.

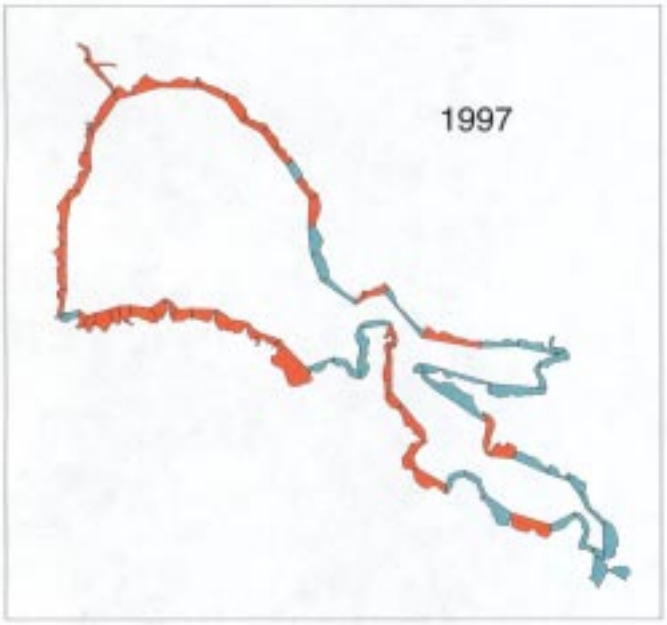
Significantly, after several years of treatment and despite the intensive nature of the surveys, project staff are beginning to find no hydrilla in many areas that once routinely produced plants (Map 8). In 1999, there were 13 areas, all previously infested, where, for the first time, hydrilla could not be found. There were an additional 16 such areas in 2000, although hydrilla was found again in 2000 in three of the 13 areas where it had not been found in 1999. Such re-appearances underscore the need to keep heavy pressure on an infestation, given the tenacious qualities of this plant and the difficulties of finding and killing every last individual in the murky waters of Clear Lake. All infested areas have had very low plant densities in 1999 and 2000. In most cases, only plant fragments or a few scattered plants were found in any area, where any hydrilla was found at all. While newly infested areas continue to be found due to the ease of movement of the plant, the overall level of suppression is very high.

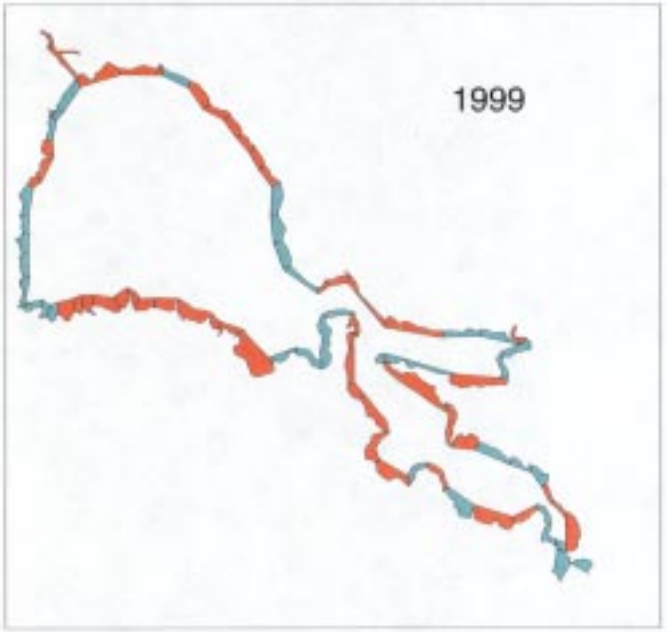
Map 8:
Yearly Survey Results, Clear Lake Hydrilla Infestation, 1994-2000

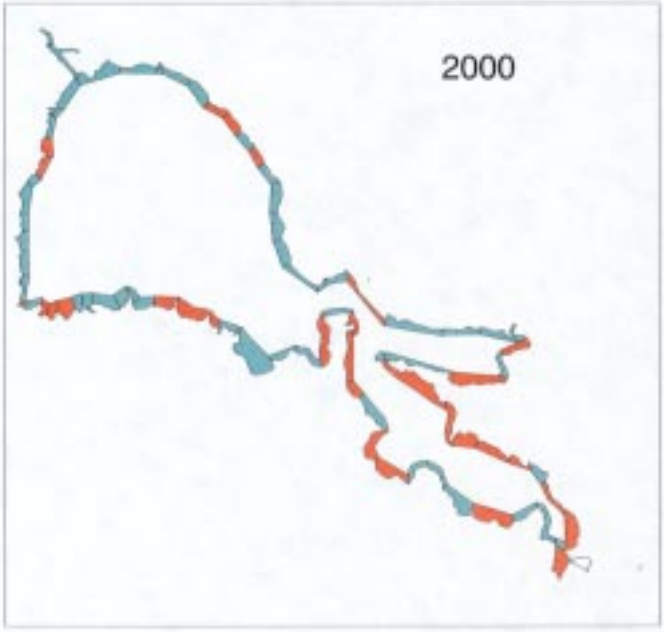
= Found during Year

= Surveyed, but None Found









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In May and October, project personnel conducted detection surveys at various high-risk areas and at access points along Cache Creek. Personnel from the BLM conduct surveys of Cache Creek from the dam at Clear Lake to the Bear Creek-Cache Creek confluence. No hydrilla has been found in Cache Creek. These surveys will continue in 2001 and 2002.

Treatment

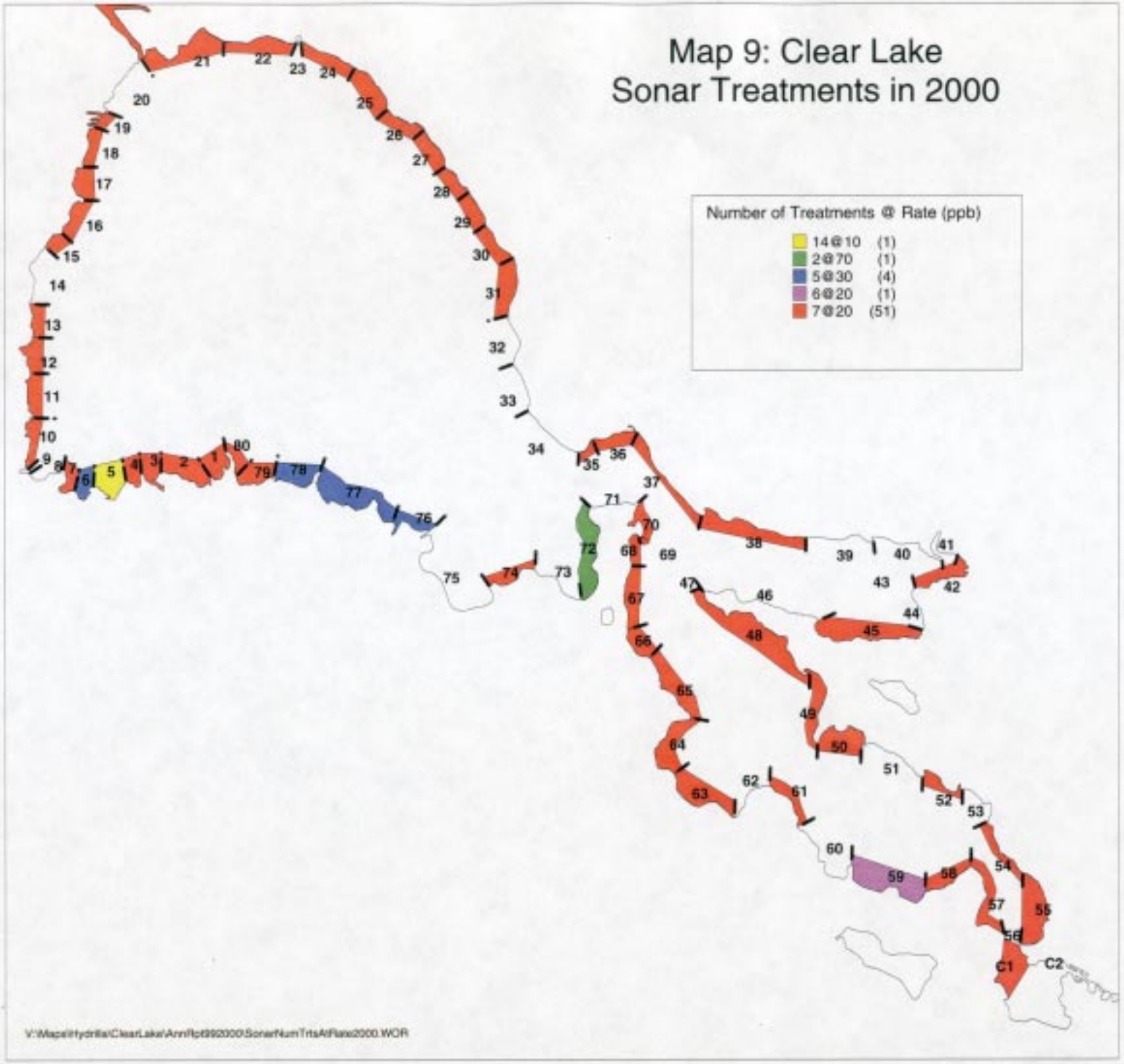
As recommended by the scientific advisory panel, copper-based Komeen™ and the organic compound Sonar™ were again the major treatment options used in the lake. Sonar™ is by far the most used. For example, in 2000, Komeen™ was used to make 49 treatments to 26 different areas, over a total of 116.6 acres. In 1999, it was used to treat 161.8 acres. By comparison, the granular Sonar™ SRP was used to make 443 treatments to 60 different areas, over a total of 1,148.6 acres. In 1999, it was used to treat 856.6 acres. The liquid Sonar™ AS is used much less. In 2000, Sonar™ AS was used in only one area (Nice Harbor) to make seven treatments to two acres.

The use of Sonar™ in Clear Lake has largely replaced the use of Komeen™ in Clear Lake. In 1995, 47,580 gallons of Komeen™ were applied, 20,126 gallons were applied in 1996, 12,205 gallons in 1997, 4,430 gallons in 1998, 3,100 gallons in 1999, and 2,450 gallons in 2000, a 94.8 percent reduction in use since 1995. While Sonar™ has proved to be the most effective herbicide for most of the Clear Lake infestation, Komeen™ can still be the material of choice in other situations, such as where water might be used for irrigation or the long contact time required by Sonar™ is not possible.

Komeen™ is applied on an as-needed basis to achieve rapid destruction of biomass in areas where new infestations or sizable plant densities are found. It is applied at a rate of 16 gallons per acre or 1 parts per million (ppm) of copper. The first Komeen™ treatment in 1999 was made on August 3, and the last treatment on November 24. The first Komeen™ treatment in 2000 was on June 8, but most of the treatments were made in August, September, and October, with the last treatment being made on November 6, 2000.

Sonar™ is used for the long-term suppression of growth and reproduction of hydrilla in infested areas. It is applied on a scheduled basis once treatments begin. Schedules may vary from one area to the next as the local conditions warrant (Map 9). The most common schedule is seven treatments, each at a concentration of 20 ppb, applied either weekly or at two-week intervals. This was particularly true in 2000 (Map 9). Another common schedule is 14 treatments at 10 ppb each, applied either once or twice a week. This 14-treatment schedule was more common in 1999 than in 2000. The first Sonar™ treatment in 1999 was on June 8, and the last was on August 17, 1999. The first Sonar™ treatment in 2000 was on May 22, and the last was on October 10, 2000. Complete control of all submersed aquatic weeds was obtained in all areas treated with Sonar™.

The applications of Sonar™ later in the season are made to stop production of the vegetative propagules known as tubers and turions. Halting their production is a major requirement for hydrilla eradication. Tuber and turion production in hydrilla is a response to the changing photoperiod. As daylight hours decrease, generally starting around August 1 through 15, the production of vegetative propagules increases significantly. From September through November, plant growth slows down and hydrilla transfers its resources and energy into tubers.


Map 9: Clear Lake
Sonar Treatments in 2000
Number of Treatments @ Rate (ppb)
14@10 (1)
2@70 (1)
5@30 (4)
6@20 (1)
7@20 (51)
C1
C2
V:\Maps\Hydrilla\ClearLake\AnnRpt992000\SonarNumTrtsAtRate2000.WOR

Sonar™ effectively interrupts this process and stops production of propagules. No regrowth occurred in any Sonar™ treated area after the last application.

Monitoring for Sonar

In 2000, water samples were taken in Areas 2, 7, 15 (Randy's Dock), 36 (Paradise Cove), 42 (Elam Colony), 52 (Clear Lake Park), 66 (Buckingham area), and 77, at various depths in relation to the surface and bottom. Concentrations ranged from less than one to 9.3 ppb, with most (86 percent) being less than five ppb. These areas all received seven applications of Sonar™ at 20 ppb each. All the samples were taken after July 13, well after treatments had started. Areas 36 and 66 had potable water intakes. In these areas, concentrations again ranged from less than one to 9.3 ppb, with an average of 4.1 ppb. Similar to the results this year, monitoring studies over the past four years indicate fluridone concentrations are substantially below label limits.

Dr. Lars Anderson, of the USDA-ARS, and his laboratory staff at University of California, Davis, initiated a monitoring study in 2000. This study evaluated the amount of Sonar™ in the water just above the bottom sediments compared to the water in pore spaces in the top few inches of the bottom sediments. These samples focused on areas that had been treated with the slow-release SRP formulation of Sonar™. The samples showed that the concentrations above and below the bottom surface were of a similar magnitude (just above bottom = 38.7 ppb; just below bottom = 28.3 ppb). These concentrations were higher than samples higher in the water column, which, even in treated areas, rarely exceed 10 ppb. These results imply there is a boundary zone of relatively still water in the few inches near the bottom of the lake, where the concentration of Sonar™ can build-up. This result is intriguing, as earlier work on water currents in the lake had shown a fairly high amount of water movement, with a mean of about two centimeters per second (cm/sec) (0.045 miles per hour) and often reaching a maximum of six to eight cm/sec (0.134 to 0.178 mph) for a period each day. The water movement measurements were taken at various depths, but always at least one meter above the bottom. This work indicates that the effective zone of the pesticide is restricted to a layer within a few inches above and below the bottom, while the rest of the lake's water, even in the treated areas, is exposed to much lower levels of the herbicide. This study will be repeated and expanded in 2001.

Public Information and Awareness

Public information and awareness is an essential component of the project. The public needs information on the identification of hydrilla and boaters need to know how to prevent its spread in Clear Lake and to other bodies of water. Since public access to the lake is not being restricted, this aspect of the project must be maintained throughout the duration of the project.

Informational signs have been established at 28 public boat-launching facilities to warn the public about hydrilla and remind them to clean their boats and trailers before leaving the lake. In addition, the three major highways (20, 29, and 175) to the Clear Lake area are posted with prominent signs.

Informational pamphlets, produced by the California Department of Boating and Waterways and the CDFA, are distributed by project personnel to businesses around Clear Lake. Between 2,000 and 2,500 pamphlets were distributed each year in 1999 and 2000, to all motels, sporting goods stores, and gas stations as well as many other retail establishments. Additionally, about 1,100 homeowners in 1999 and 2000, with lakefront property in Sonar™

treated areas, received a letter that explained the program and treatment schedules. These letters were sent prior to initiation of project activities, including chemical applications. The number of notifications has increased over previous years. For example, there were 681 notifications in 1998.

Progress and Plans for 2001

The intensive treatment program has continued to significantly reduce the level of hydrilla in Clear Lake and prevented the spread to other bodies of water. Intensive surveys indicate that plant populations are extremely low and scattered in the infested area, even in those areas where hydrilla is still found (Map 8). In addition, some previously infested areas are beginning to have no detectable levels of hydrilla, despite numerous surveys. Two new locations of hydrilla were detected in 1999 and four in 2000. Although finding additional new sites is disappointing, it is to be expected, given the ease of movement of the plant. Early detection was achieved and enabled project staff to respond quickly and effectively to prevent further spread within the infested area.

Applications of Sonar™ and Komeen™ will continue in 2001. The use of Sonar™ will continue to be the primary method of suppression. In previously infested areas where no hydrilla is being detected, the total amount of Sonar™ used will be reduced on a trial basis. The current plan is to reduce the amount applied from its current 140 ppb total to 100 or 120 ppb.

SHASTA COUNTY

The Shasta County eradication projects (Map 10) began in 1985, when hydrilla was detected in seven ponds located next to the Sacramento River. Due to the close proximity to the river and the potential threat to California water systems, the Governor of California issued a Proclamation of Emergency to facilitate eradication efforts. An additional four infested ponds were found in 1986. Four of these 11 ponds were chemically treated and filled in with soil. The remaining seven ponds received herbicide treatments. By 1994, only one (Swimming Pond at Shea's) of the original 11 ponds contained hydrilla, where a few scattered plants remained. No plants were found in this pond in 1996 when the last treatments were made. Those treatments were two applications of Sonar™. No plants were found in this pond from 1997 through 2000, and the hydrilla could be considered eradicated.

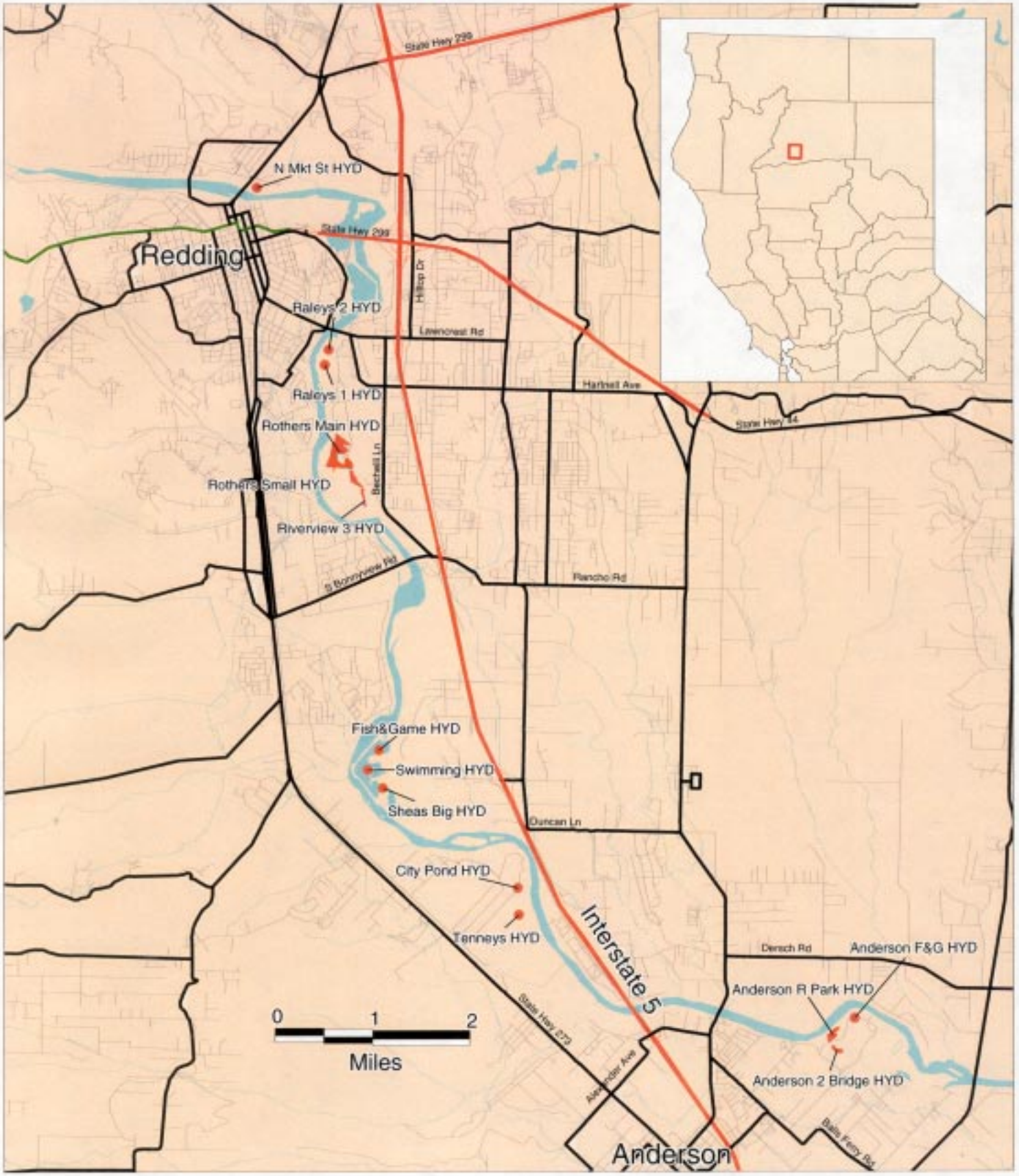
In October 1994, two new ponds (three and 10 acres) were found infested with hydrilla at Anderson River Park, near the City of Anderson (Map 11). Both ponds were treated in 1994 and 1995 with Komeen™. In 1996, both ponds were treated with Sonar™. Plants have not been found in the three-acre pond since 1994, and it could be considered eradicated. A few scattered plants were found in the 10-acre pond in 1996, and again in 1999. In 1999, the plants were hiding under a heavy cover of water primrose at the edge of the pond, and only the use of scuba divers led to their discovery. No plants were found in 2000, but divers were not available. This pond was treated in both 1999 and 2000 with three applications of Sonar™ SRP at 50 ppb each.

In July 1996, a new infestation was found at the Riverview Golf Course in Redding (Map 12). This infestation consists of three ponds, all connected by water flow. The lowest golf course pond actually consists of two small ponds connected by a short channel, with a total area of approximately three acres. Upstream from the small ponds is a six-acre pond, and up stream

Map 10: Active and Historic Hydrilla Sites in the Redding Area, Shasta County

Active sites mapped by 3 m GPS; historic sites digitized by hand from previous maps

● = Hydrilla site, active or inactive



Map by CDFA, Integrated Pest Control Branch, Noxious Weed Information Project, 22 May 2001
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Map 11: Anderson River Park Hydrilla Eradication Project, Anderson
3 meter GPS Data

= Infested Ponds

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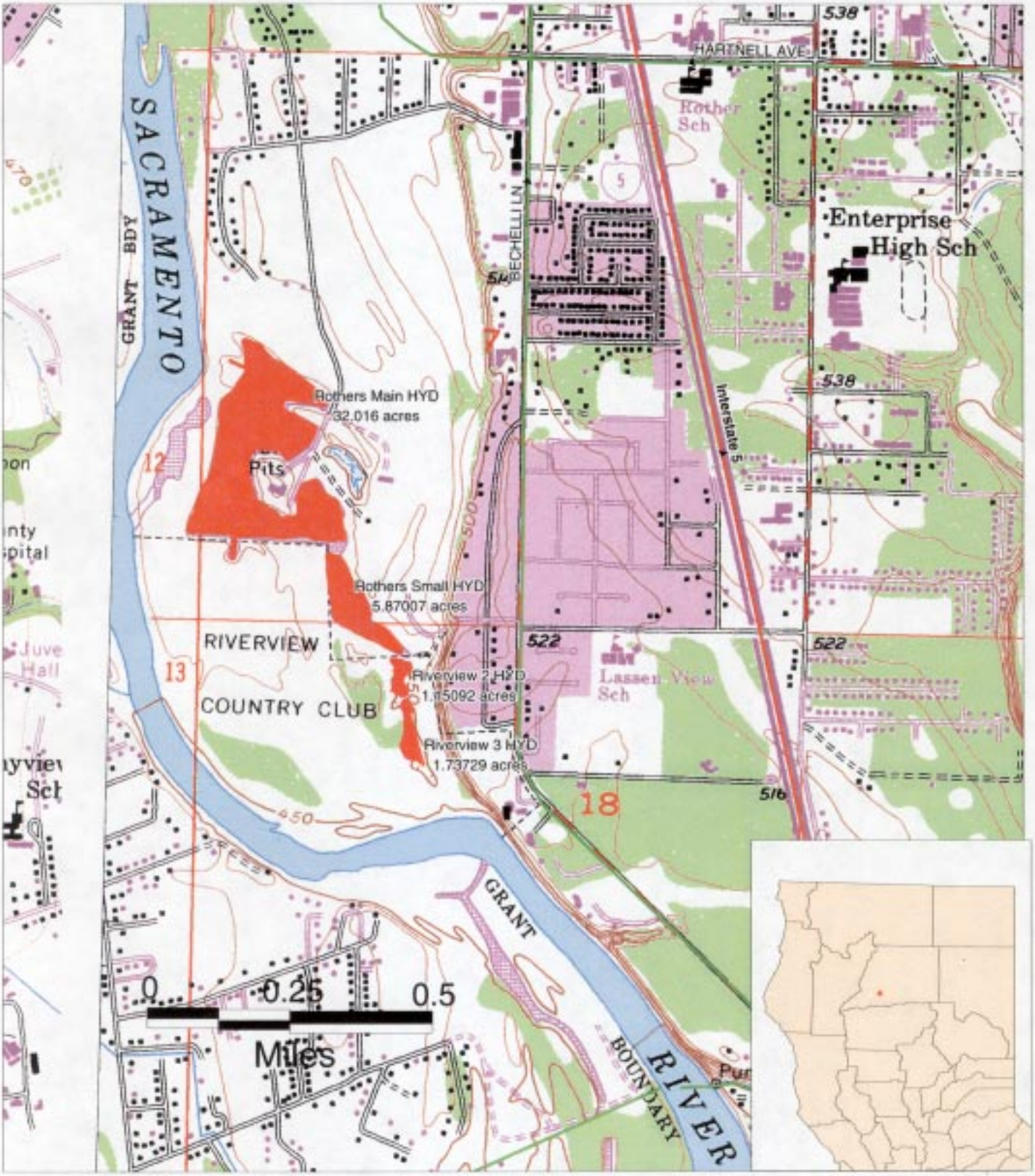
Map by Calif. Dept. of Food and Agric., IPC, 2 May 2001

Map 12: Riverview Golf Course Hydrilla Eradication Project, Redding
3 meter GPS Data

= Infested Ponds



V:\Maps\Hydrilla\Redding\REDD-RiverviewGolf-SWRCBNotice2May01.WOR
Map by Calif. Dept. of Food and Agric., IPC, 2 May 2001

from that is a 30-acre pond, which is not actually on the golf course property. The 30-acre pond contained hydrilla 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 throughout, and the small ponds were heavily infested.

All the Riverview ponds were initially treated with Komeen™, beginning in 1996. The six-acre pond and the small ponds were subsequently treated with Sonar™. In 1999 and 2000, the small ponds were treated weekly with five ppb from late June through mid October. The six-acre pond was treated twice in 1999, with 40 ppb and three times in 2000 with 50 ppb. The pond also received a mid-season treatment of Komeen™ each year, as the early treatments of Sonar™ left the plants chlorotic but still upright. In the 30-acre pond, divers used a suction dredge to remove most of the plants in 1996, but several areas had large cobbles that made the suction equipment ineffective. Since the 30-acre pond was used to water greens on the golf course, Sonar™ was not applied in 1996, to avoid possible damage. At CDFA's request, the golf club developed an alternate water source in 1997, and Sonar™ was applied to the pond beginning in 1997. In 1999, divers found no hydrilla in this pond, and no treatments were made. A single plant was found by surface survey in 2000, and that area was treated with Komeen™ and Sonar™ SRP.

Intensive survey is an important part of the eradication program. Over the past 15 years, 17 ponds in the Redding/Anderson area have had hydrilla. Four of the ponds were buried and no longer exist (Dog Pond, two at North Market Street, and a small pond at Anderson River Park). All 13 remaining ponds were inspected on a roughly monthly basis from April through November in both 1999 and 2000. Scuba divers made surveys in the ponds in 1999, but none were available in 2000. As previously noted, none of the ponds infested in 1985 through 1986 were found to have hydrilla. In 1999, the only ponds that had hydrilla were the large pond in Anderson Park, and the small ponds and the six-acre pond on the golf course. In 2000, the only ponds that had hydrilla were the small ponds and the six-acre pond on the golf course, and the 30-acre pond above the course.

Because hydrilla has appeared in the Redding area on possibly three separate occasions (1985 to 1986, 1994, 1996), project staff are concerned that it might appear elsewhere in the area. Accordingly, the project maintains an intensive program of detection in addition to the surveys of infested ponds. A corridor one mile wide on either side of the river is considered the eradication zone, and ponds and creeks both within and outside this area have been identified and surveyed. Thirteen ponds were inspected inside the eradication zone in 1999 and 12 were inspected in 2000; most received two or more inspections each year. Seven creeks were also inspected in 2000. Outside the eradication zone, 36 ponds and 26 creeks were inspected in 1999, and 36 ponds, 12 lakes, and 45 creeks were inspected in 2000. All the creeks were surveyed for one-half mile above and below road crossings. No hydrilla was found in any of these inspections.

The Sacramento River also received numerous inspections. In 1999, the river was surveyed from the Redding Civic Center to the Red Bluff Diversion Dam once, and from Riverview Golf Course to Deschutes Road an additional two times. In 2000, the river received 29 inspections at nine different locations from the Civic Center to Deschutes Road, and was inspected 10 times at the Red Bluff Diversion Dam and Reading Island. No hydrilla was found. There were no inspections below Red Bluff in 1999 and 2000.

YUBA COUNTY

Yuba County has had three distinct infestations: Lake Ellis, Shakey's Pond, and Oregon House. The first two infestations have been eradicated.

Lake Ellis is a 31-acre ornamental lake in the center of Marysville (Map 13). The infestation there was found in 1976, the first occurrence of hydrilla found in California. By 1979, the lake had been drawn down, the hydrosoil removed, and the infested areas treated with Vapam™. Six plants re-appeared in 1980 in one small location. The entire lake was re-treated with Endothall™ and Komeen™ with special attention paid to the infested location. By 1981, the lake was free of hydrilla and eradication was declared in 1984.

Shakey's Pond (Map 14) may have become infested as a result of carrying aquatic plant material to it from Lake Ellis, although hydrilla was not reported in the pond until 1990. Because the pond is isolated and has no public access, the USDA-ARS and the CDFA made experimental treatments of Mariner™ to the pond in 1990 and 1991. Mariner™ was an herbicide registered for control of weeds in rice that was under consideration for registration for aquatic weed control in ponds at the time. Mariner™ was the only herbicide employed, and it provided excellent control. By 1992, only small numbers of plants were found in the pond, and it received multiple applications of Komeen™. In 1994, divers found 17 plants, which they removed with a suction dredge, and Komeen™ was again applied periodically throughout that season. Divers found about 50 plants in 1995, and again the pond received periodic Komeen™ treatments. In 1996, only one plant was found, and the pond received three treatments of Sonar™. No plants have been found in the pond since 1997 and the infestation there can be considered eradicated, although periodic checks of the pond continue.

Oregon House: The On-going Eradication Project

On August 7, 1997, a new infestation of hydrilla was detected near Oregon House, in Yuba County (Map 15). This infestation was detected by personnel from the Yuba County Agricultural Commissioner's Office, following a call from an individual that suspected hydrilla was infesting a pond at a winery.

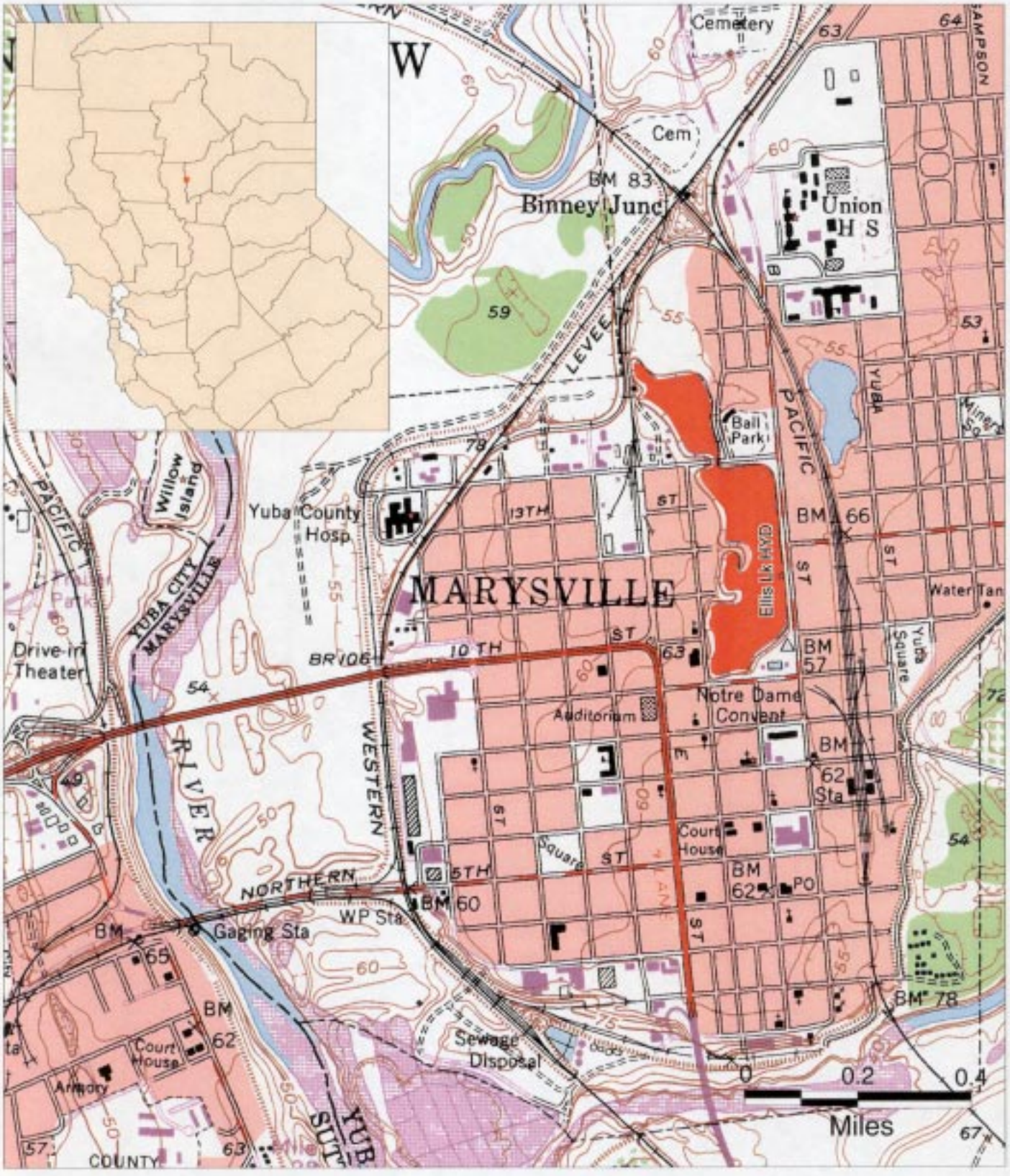
The CDFA's Plant Pest Diagnostics Lab confirmed the specimen to be hydrilla. The USDA-ARS at the University of California, Davis confirmed it as the monoecious form, which had only been found in California two other times. The first monoecious hydrilla infestation was found in 1993 at an aquatic nursery near Visalia, Tulare County, and was introduced via water lilies shipped from a producer in Maryland. The other monoecious hydrilla infestation was found in Clear Lake, Lake County. The source of the Clear Lake introduction is yet to be determined. The new infestation in Yuba County was most likely introduced with water lilies purchased from Maryland, apparently from the same nursery that was the source for the infestation in the nursery in Visalia, Tulare County. The two previous hydrilla infestations in Yuba County were of the dioecious form.

Delimitation surveys conducted by the CDFA and Yuba County biologists found five ponds at the winery infested with hydrilla. Three of these ponds were relatively small and deep, with surface areas of 3.1, 3.1, and 2.7 acres and average depths ranging from nine to 13 feet. Two small ponds of 0.2 and 0.1 acres were also infested. These two ponds were used for irrigating the vineyard. In addition, a few plants were found infesting an ornamental fountain containing water lilies and in a greenhouse where water lilies were stored in small containers. A 17-mile irrigation ditch, owned by the Yuba County Water District (YCWD), was found to have the lowest 3.1 miles

Map 13: Lake Ellis Hydrilla Eradication Project, Marysville, Yuba County

Lake outline digitized by hand from topographic map

= Infested Water Body



Map by CDFA, Integrated Pest Control Branch, Noxious Weed Information Project, 22 May 2001
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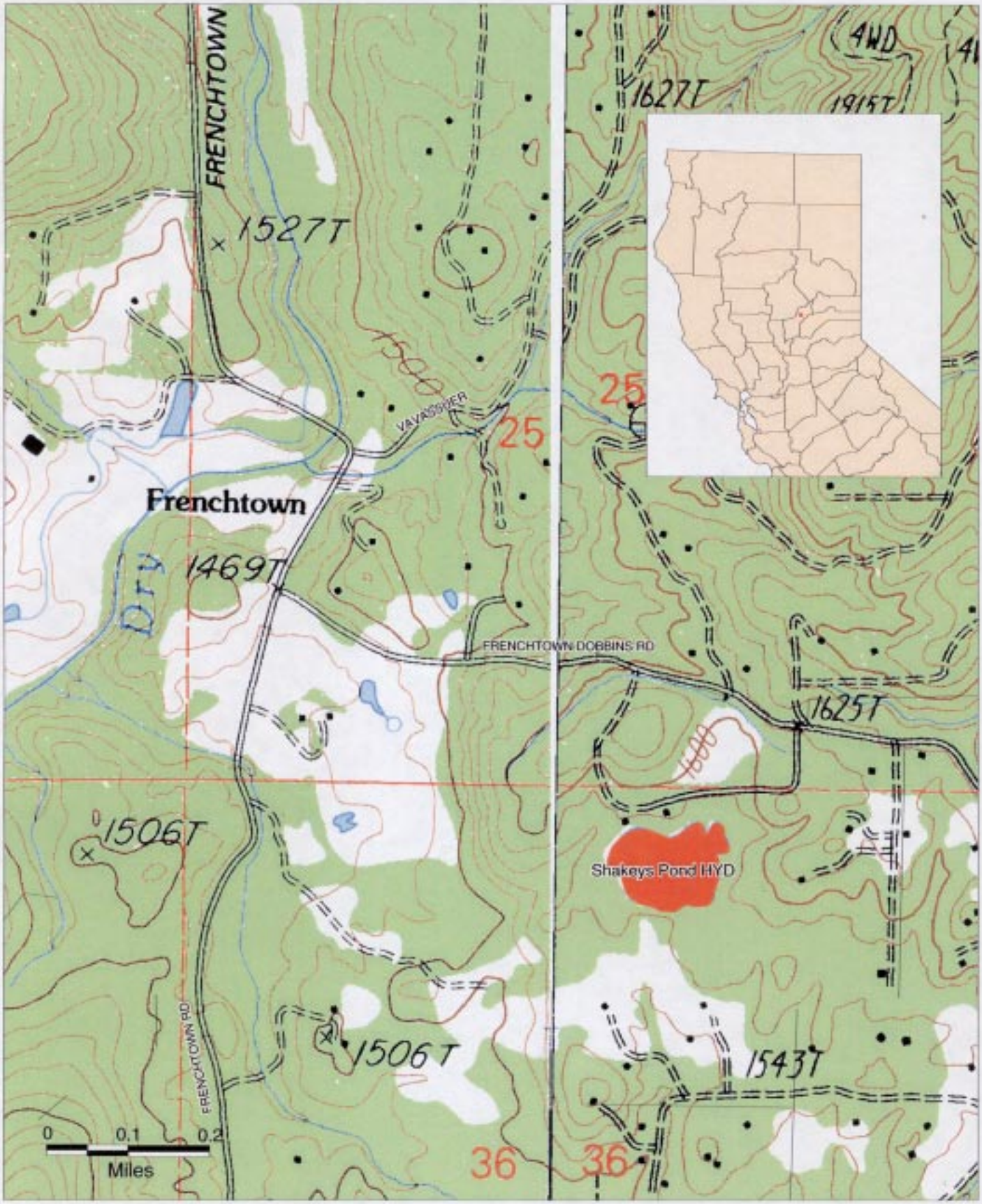
Map 14: Shakeys Pond Hydrilla Eradication Project, Yuba County

Pond outline digitized by hand from a topographic map

= infested pond



Map by CDFA, Integrated Pest Control, Noxious Weed Information Project. 22 May 2001
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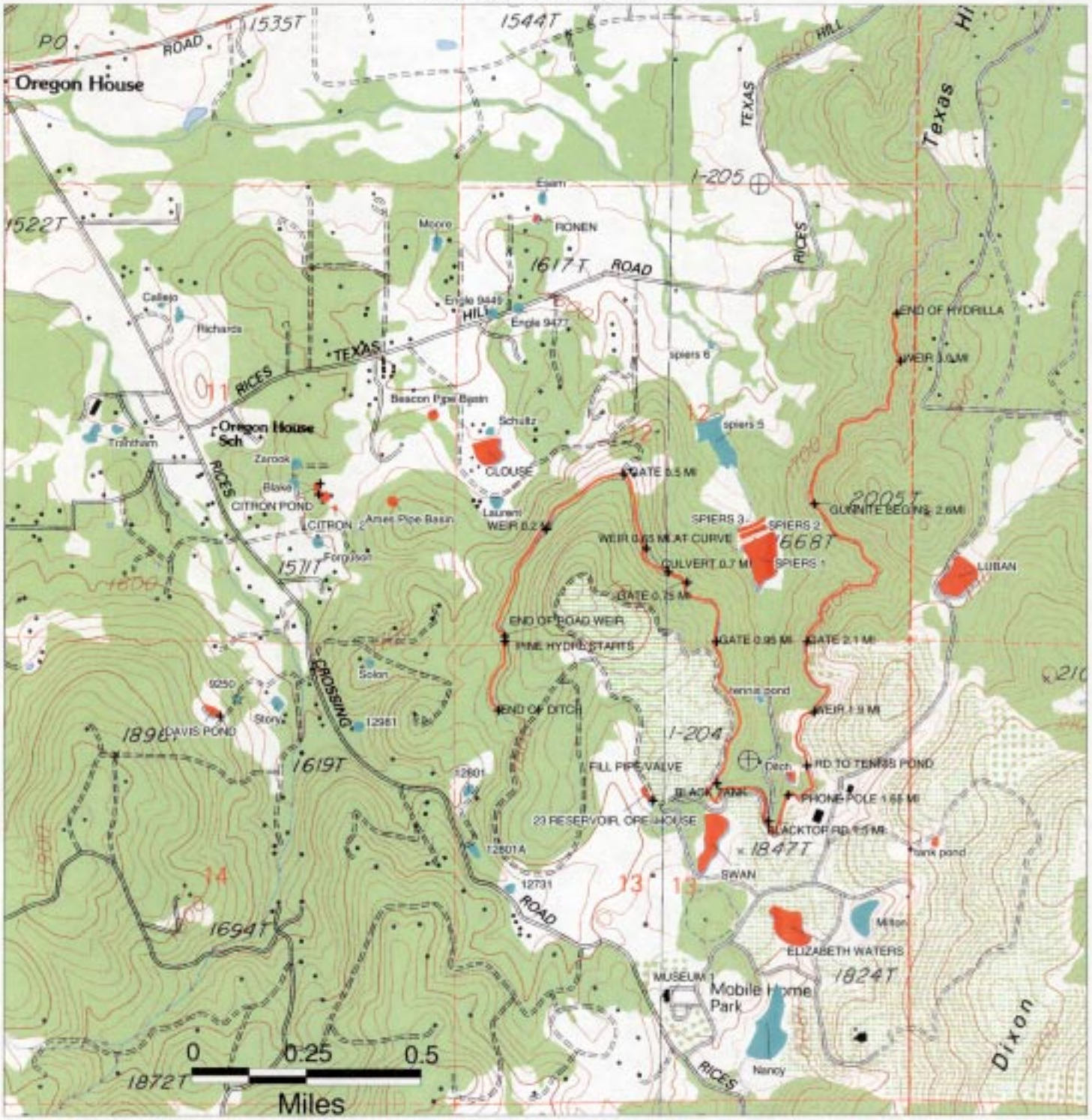
Map 15: Oregon House Hydrilla Eradication Project, Yuba County

Infested Pond data is 3m GPS data; uninfested ponds
may have been digitized from existing maps.
Data as of November, 2000



Infestation Status

- uninfested
- infested

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infested. Additional infestations were found on three private properties. One property had three infested ponds of 3.8, 0.5, and 0.4 surface acres. The two smaller ponds were used for rearing catfish. Two other private properties had infested ponds of 1.9 and 0.1 surface acres. Infestations in the above-mentioned 10 ponds ranged from very light to extremely dense. Three other small water impoundments (all less than 0.1 acre and receiving water from the infested area of the irrigation ditches) were found infested. All bodies of water were measured by using Global Positioning System receivers. Further inspections identified another two infested ponds in 2000 (Map 15).

At the start of the eradication program, delimitation surveys within a three-mile radius of infested ponds found approximately 40 other ponds that were uninfested. Numerous small creeks and the Yuba River were also surveyed and no hydrilla was found. Collins Lake and Englebright Reservoir were inspected and found free of hydrilla. The drainage from the infested areas enters Collins Lake on one side and Englebright Reservoir on the other side (Map 16). If hydrilla were to infest these bodies of water, the Yuba River and eventually the Sacramento River and Sacramento/San Joaquin Delta would become infested.

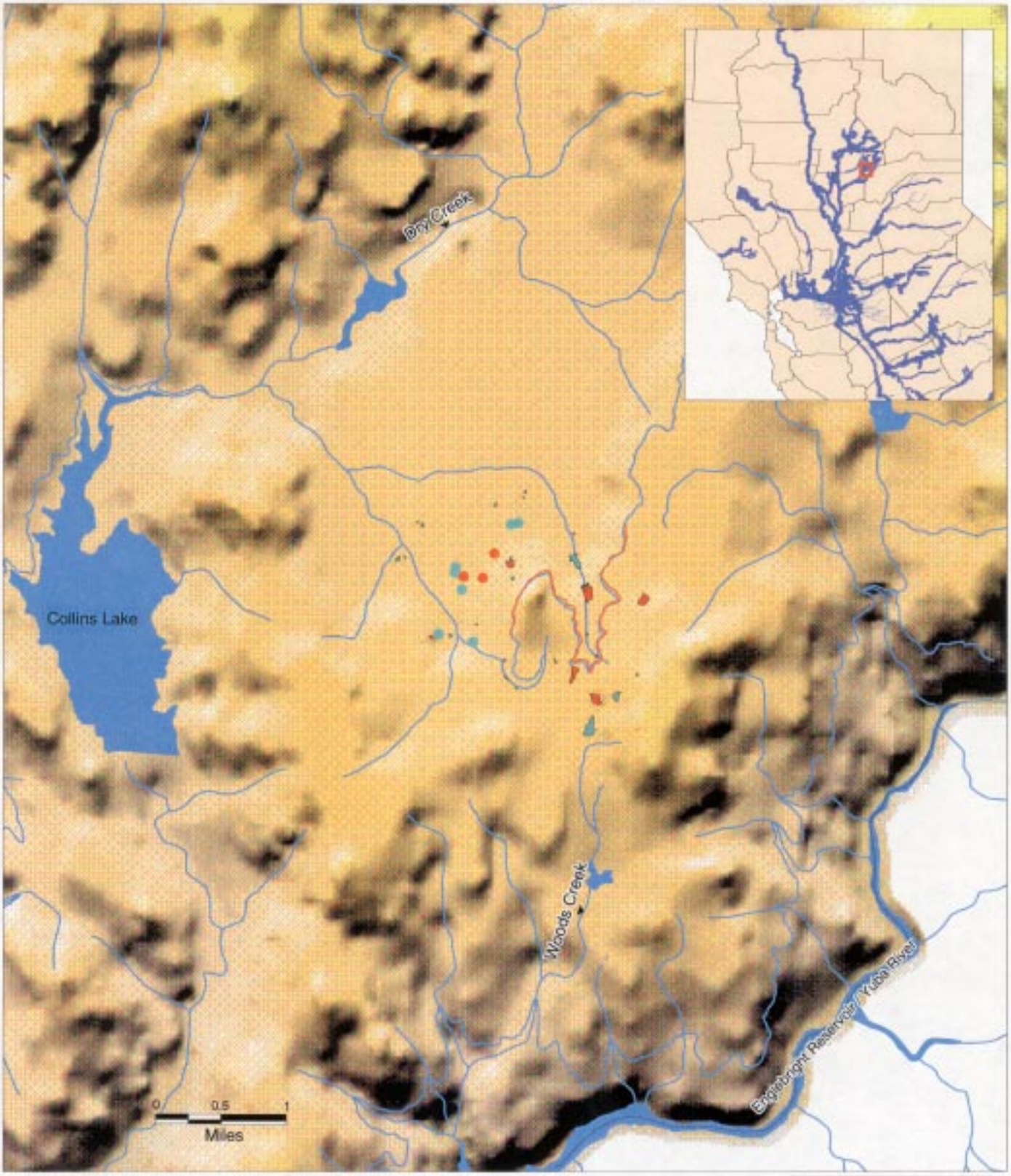
In both 1999 and 2000, surveys of infested ponds showed that hydrilla first emerged in May. This event marks the beginning of the treatment season. After the first finds of the year, surveys of infested ponds are often cursory, as treatments are a foregone conclusion for the season. Ponds were treated with Sonar™ AS or SRP, or Komeen™, depending on the immediate use of the water. The Ditch and Tank ponds on the winery are primarily used for irrigating or fertilizing the vineyard. These receive only Komeen™ treatments to avoid damage to irrigated crops. The rest of the infested ponds are mostly used for recreation, and therefore, receive treatments with Sonar™. The YCWD canal water is also primarily used for irrigation. Initially, Komeen™ was used to treat the canal, occasionally mixed with Reward™ but control was difficult to achieve. Beginning in 2000, a new technique was used to treat the canal, using a copper-based product called Nautique™, which is metered into the flowing water to achieve a one ppm concentration of copper for four to six hours. Complete control of hydrilla has resulted from this treatment method when the treatments are repeated at approximately three-week intervals.

Treatment Results for Lakes and Ponds

The Ditch Pond and Tank Pond, which are used for irrigation, received Komeen™ treatments at two- to three-week intervals in 1999 and 2000. Komeen™ destroys only the parts of a hydrilla plant that are above the hydrosoil, and a plant can regrow from its stolons after a treatment. The two-to-three-week interval was a reduction from the monthly intervals employed for 1998, in order to prevent any production of vegetative propagules by the hydrilla. Plant re-growth between treatments was still noted but was limited to no more than four to six inches, enough to suppress the production of propagules. Treatments began July 9, and ended October 8, 1999, and began June 16, and ended October 13, 2000.

The other ponds and lakes are treated with Sonar™, usually three times at 30 ppb each, generally at the beginning of May after the first hydrilla is found, then in early to mid July, and finally in late August to early September. Every infested pond received treatments in 1999 and 2000, whether or not surveys found hydrilla, because the infestation was found late in 1997 and three full seasons of treatments are desirable. Generally, suppression is very good, with only a few chlorotic fragments of hydrilla found at most ponds during the course of the season. The exception appears to be an area near the inlet stream to the pond called Spiers 1, where fragments and some regrowth of green hydrilla have occasionally been noted. Because of the

Map 16: Oregon House Hydrilla Infestation, Yuba County, Showing Relation of Infested Waters to Major Drainages



Infestation Status of Inspected Waterbodies

- uninfested
- infested

Calif. Dept. of Food and Agric., Integrated Pest Control Branch, Noxious Weed Information Project, 18 May 2001
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regrowth, that pond was treated with a mixture of Komeen™ and Reward™ in 1999, at the same time as the second Sonar™ treatment.

Treatment Results for YCWD Canal

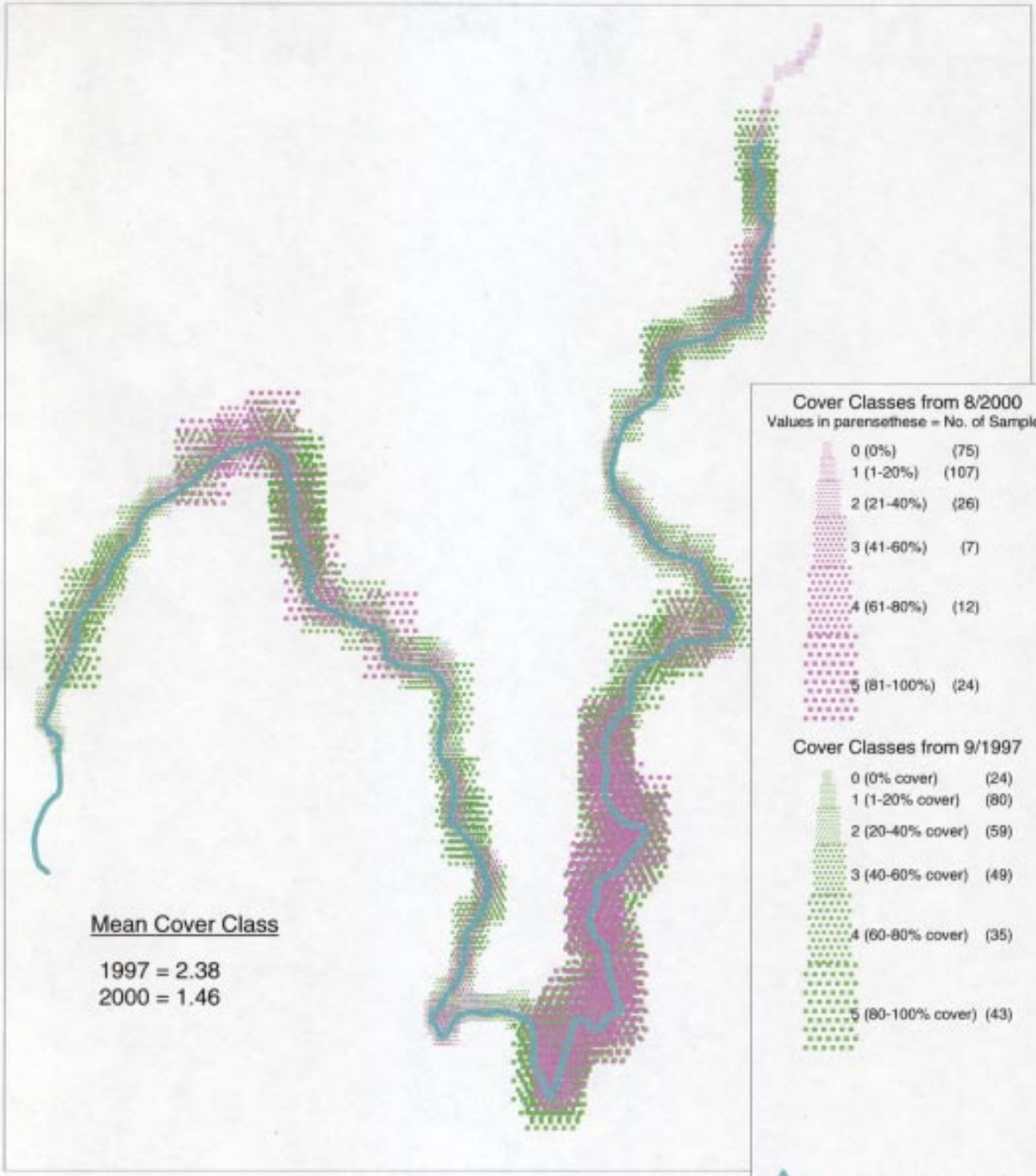
The irrigation canal is the headwaters of the entire infestation, so eradication of the hydrilla in the canal is pivotal to the success of the entire project. The canal (including two small spill basins referred to as the Ames and Beacon Basins) is in operation between April and October. Beginning in 1997, initial treatments were made with Komeen™ at the one-ppm rate. However, complete control of hydrilla was not achieved because of problems coordinating the water flow in the canal with the irrigation district. In 1998, water flows were stopped for 24 hours before a treatment, and a mixture of Komeen™ and Reward™ was used, but again could not achieve complete control. In October 1998, the YCWD also used a backhoe to remove approximately one foot of hydrosoil from the canal. The spoils were placed on the dirt road that parallels the canal and were leveled with a bulldozer. All equipment was cleaned on-site with high-pressure water hoses after the completion of work. Core samples, before and after the excavation, later showed that the tuber population was substantially reduced (Table 3). However, the plants continued to recover until estimates of the plant cover in the canal showed an abundant stand of hydrilla (Map 17), matching the biologists' subjective estimation of the situation. Additional attempts to mechanically remove the plants were problematic. The hydrilla recovered rapidly from attempts to rake out the plants and tubers, and dredging was physically difficult and extremely slow. The canal was treated again with the mixture of Komeen™ and Reward™ in September 1999, after stopping the flow, in order to hold the water for 24 hours. The treatment burned back many of the plants, but this treatment protocol has not proved to be practical because of continuing problems with water management. The entire infested portion of the canal was treated in October 1999 with Karmex™, a pre-emergent herbicide, after the water in the canal had been shut off for the season. The treatment had little impact on the re-growth of the plants. These experiences led to a determination that a different treatment method was needed. In 2000, the project initiated a method to meter Nautique™, another formulation of copper, into the flowing water of the canal at one ppm maintained over four to six hours. Treatments were made on June 14, July 12, August 2 and 23, September 6 and 21, and October 5. The numbers of metering stations were increased from one at the first treatment to three (one station per mile) for the last several treatments. The last several treatments produced very promising results, as complete control of all top growth was obtained.

Table 3: Tuber Samples from the Oregon House Irrigation Canal, September 17, 1998 and October 24, 2000, by D. F. Spencer & G. G. Ksander, USDA-ARS, Davis, CA

Year	Number of Samples	Mean Tubers/ m^2	Lower 95% Confidence Limit	Upper 95% Confidence Limit
1998	98	315.28	193.58	436.98
2000	156	84.882	44.134	125.63

T-Test: DF=119, t value = 3.56, Probability of greater t = 0.0005, unequal variance

Map 17: Percent Cover Estimates for Hydrilla in the Oregon House Irrigation District Ditch



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Conclusion

The Oregon House Hydrilla Eradication Project has put in place methods that should now lead to high levels of suppression and eventual eradication in the entire water system. While the program had achieved a high level of suppression in the various ponds in the network, the irrigation canal was the key to the program, as it is the headwaters for the infestation. Now that efficient control in the canal is achievable, the overall goal of eradication should be achieved within the next three to five years.

TULARE COUNTY

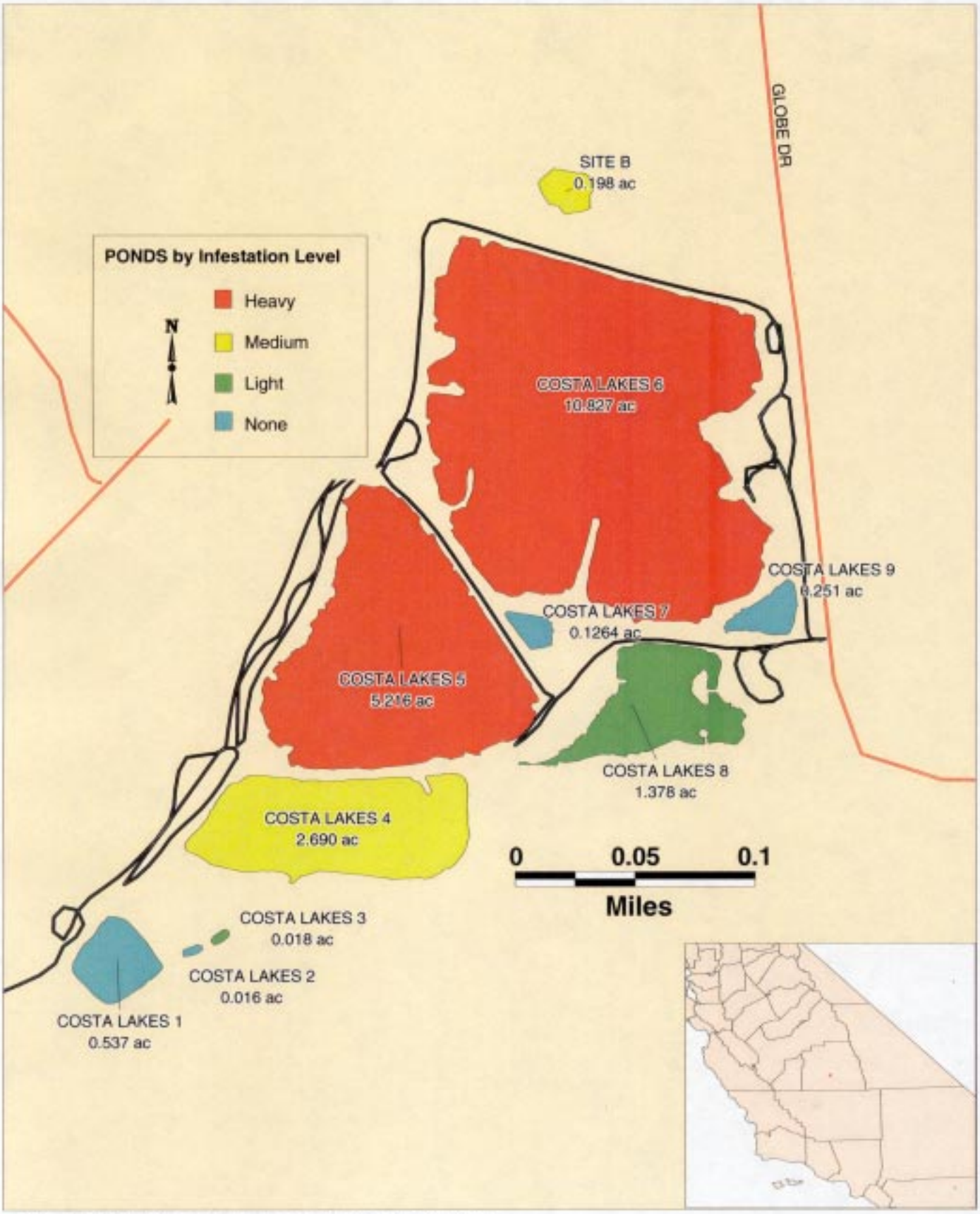
On October 7, 1996, dioecious hydrilla was detected in six ponds southwest of Springville in Tulare County. Ponds ranged in size from 0.02 acres to 10.8 acres with a total surface area of 20 acres (Map 18). The infestations in the ponds ranged from very dense to just a few scattered plants. Four other uninfested ponds were also on the property. The ponds are adjacent to the Tule River, which supplies water to Lake Success, a 2,450-acre reservoir managed by the United States Army Corps of Engineers primarily for flood control and agricultural purposes, although it is also popular for recreation. No hydrilla has been found in Lake Success, the Tule River or in any of the other 69 ponds located within the eradication project area.

Treatments began in October 1996, with applications of Komeen™ to rapidly reduce the large amounts of biomass. Once that goal was achieved, Sonar™ was applied to prevent regrowth and further production of vegetative propagules (tubers and turions). Sonar™ applications were again employed in 1997. Treatments began on July 28 and continued on a monthly basis until the maximum amount permitted by the label was achieved on September 30. The maximum label rate depends upon the size of the water body. A high level of suppression was achieved by 1998, and the hydrilla remained confined to the original six ponds.

In 1999, small amounts of plant fragments were found in ponds 5, 6, and 8, the ones that were originally the most heavily infested. In addition, two small plants were found and manually removed from pond 9, one of the previously uninfested ponds. Only the four ponds where hydrilla was found (5, 6, 8, 9) were treated with Sonar™. Surveys confirmed there was no hydrilla in the untreated ponds. The treatment rate varied according to pond size and the magnitude of the original infestation, ranging from 60 ppb applied over two applications, to 135 ppb (to pond 6, which is a 10.8-acre pond) applied over five applications. No Komeen™ was used in 1999. Some limited tuber sampling was also done. As samples were taken from areas known to already contain tubers, the sampling overestimated the true densities, but the mean density was 16.7 tubers/m^2. Tuber samples showed a 47.5 percent germination rate.

In 2000, small plants or fragments were found in two ponds (5 and 6), the two with the heaviest original infestations. This year, all seven ponds that had ever had hydrilla were treated with Sonar™ (3, 4, 5, 6, 8, 9, and Site B). Treatments began on May 23 and ended December 7. Total rates varied from 60 ppb to 120 ppb; spread over two to five treatments. No Komeen™ was used in 2000. A more extensive tuber survey was done this year in the two most heavily infested ponds, again in areas that were already known to contain tubers. There were 1,749 tubers recovered, for an average of 30.2 tubers/m^2. The survey also found nine plants. Overall, suppression continues to be very high in the project and numbers of plants found are very low.

Map 18: Costa Lakes Hydrilla Eradication Project, Tulare County
Original Infestation Levels (1996). 3 M GPS Data.



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SUMMARY AND CONCLUSIONS

Considering the tenacious qualities of hydrilla, the eradication program has been remarkably successful. There are seven infestations that can still be considered truly active: Imperial County, the Tulare ponds, Eastman Lake/Chowchilla River, Bear Creek, Clear Lake, Oregon House, and the Redding area (which could be considered two separate infestations). Of these, Imperial, Bear Creek, and Chowchilla River are approaching eradication, the Tulare ponds are under strict control, and Clear Lake and Oregon House, while still serious and at a crossroads, have turned a corner and show clear promise. Redding is under strict control, but the manner in which newly-infested ponds have appeared after an interval of several years is a cause for some concern. If eradication efforts were dropped, any of the active infestations could recover and explode, but all can achieve eradication with continued effort and a bit of good fortune.

Clear Lake is perhaps the most worrisome of the infestations, due to the heavy use of the lake, its size, and the difficult conditions for detection. The infestation is at the balancing point. A few newly-infested spots are found each year, due to the ease with which hydrilla breaks and is spread by currents, boats, or animals. This trend has pushed the number of acres that need treatment to over 1,100 and stretched the crew's ability to tend to all of them. However, over the last two years, hydrilla has begun to disappear from places where it was once heavy and routinely found. The treatments are working, and in 2001, for the first time, the amounts of herbicides will be decreased in the areas where hydrilla seems to have disappeared. With continued pressure, the eradication program in Clear Lake can succeed and prevent the escape of hydrilla into Cache Creek and the Sacramento River.

The control program in Redding works well for any given water body, and hydrilla has been eradicated from the majority of ponds in the area. The point of concern in the project is the manner in which hydrilla has materialized in widely scattered ponds over the course of the project, often with years passing between separate infestations. This pattern suggests the possibility of some unidentified source of hydrilla, or unintentional introductions through the dumping of aquaria, and is the reason behind the vigorous detection program. To date, no source has been found, but the detection program is a thoughtful precaution that needs to continue and perhaps be expanded.

The search for effective methods has proved a challenge for some of the water bodies in the Oregon House project, particularly the YCWD canal. The movement of the water and its use for irrigation precludes the use of Sonar™. The water in the canal also proved difficult to manage for the standard contact herbicides such as Komeen™ and Reward™. The YCWD has commitments to provide water to their customers, and project personnel had to negotiate to have the water stopped for 24 hours for each treatment. They also had to construct sand bag dams to maintain enough depth so the Komeen™ could make contact with the hydrilla, and then remove the dams after the treatment. The initiation of the Nautique™ treatment, where the herbicide is metered into the moving water over a prescribed contact time, greatly reduces the complexity of the treatments and improves their efficacy. The canal is the headwaters of the infestation and the source of hydrilla for all the infested ponds. An effective treatment was a prerequisite for a successful program. With such a treatment in place, progress in the infestation should be straightforward.

Hydrilla is a formidable opponent, with multiple strategies for spreading and for avoiding stresses. In places such as Florida where it has been allowed to establish, control costs exceed

$15 million per year, with little headway made on the infestation. The California hydrilla project protects the state's water resources for a fraction of that cost, maintaining its water bodies essentially free of the weed. The California program has eradicated or brought under strict control every infestation. The infestations that are still extant are the more recent ones, and on these, the program is making progress. Eradication is possible in every case, with persistence and sufficient support.