

Sensitive Freshwater Mussel Surveys in the Pacific Southwest Region: Assessment of Conservation Status



Scott River near Kelsey Creek in the Klamath National Forest. All three genera of mussels that occur in the western United States (floater mussel *Anodonta* spp., western ridge mussel *Gonidea angulata*, and the western pearlshell *Margaritifera falcata*) were found here in July 2008.

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INTRODUCTION

Freshwater mussels are one of the most imperiled groups of organisms on the planet (Williams et al. 1993, Strayer et al. 2004, Strayer 2006, R'Egnier et al. 2009). Although western freshwater mussels have been declining as well (Taylor 1981, Hovingh 2004), recent surveys have not generally been conducted disallowing any clear indication of current compared to historic distribution and abundance. The California floater mussel, *Anodonta californiensis* (Lea 1852) (Family Unionidae) was designated by the Forest Service as a Regionally Sensitive species in 1999. However, distributions of *A. californiensis* on public lands in California were poorly defined and taxonomic affinities across the western states were confused because of high genetic variability (Mock et al. 2004). This species has been a C2 candidate species for listing under the Endangered Species Act and is presently given a conservation status designation of "C3Q", meaning that globally there are probably no more than 300 populations in existence and that taxonomic problems preclude accurate assessment of actual conservation status.

To address this data gap, surveys for *A. californiensis* and other Regionally Sensitive species have been conducted since 2001 (Brim Box et al. 2005, Howard 2008, Mock et al. 2010). Based on these earlier surveys, it became apparent that systematic surveys concentrated in specific geographic areas such as individual national forests would yield poor success in finding occupied sites (Howard 2008). Therefore during 2008-09, a strategic survey method was employed by prioritizing and revisiting locatable historic sites and water bodies to enhance chances of locating the dwindling number of extant populations.

OBJECTIVE/PURPOSE OF PROJECT

The purpose of this project was to develop a strategic survey design and to resurvey historical sampling sites² for the freshwater mussel *Anodonta californiensis* (Figure 1a), a regionally sensitive aquatic bivalve mollusk. Although two other species belonging to different genera, namely the western pearlshell *Magaritifera falcata* (Gould, 1850) (Family Margaritiferidae, Figure 1b), and western ridge mussel *Gonidea angulata* (Lea, 1838) (Family Unionidae, Figure 1b), currently have no federal status, there is a concern that their populations and distributions may be declining (Taylor 1981, Frest and Johannes 1995, Mock et al. 2004, Howard 2008). Therefore, surveys were conducted for these two species also to better define their status as a basis for evaluating whether they warrant any protections. All of these species may co-occur, so a survey targeting the regionally sensitive *Anodonta californiensis*, was effective in detecting whether the other two species were present.

Specimens and non-lethal tissue samples taken during the surveys were also provided to Dr. Karen Mock of Utah State University to conduct further genetic analyses to better delineate *Anodonta* clades in the western U.S. (Mock et al. 2004, Mock et al. 2010). When coupled with distribution records, these genetic studies can provide insights on major *Anodonta* clades and may better inform conservation and management activities.

² For this study, we define historical sites as those before 1995; current sites as those after 1995.



Figure 1a. Photo of *Anodonta californiensis* (Lea 1852). Lectotype specimen from United States National Museum No. 86393 collected from the Colorado River near Yuma, Arizona. Left panel, exterior of left valve; right panel, interior of right valve. Length = 58 mm along longest axis. A lectotype is a specimen selected from the original material to serve as the type specimen when it was not designated in the original description or to replace a missing holotype.



Figure 1b. Top panel – Specimens of the two other (besides *Anodonta*) genera of freshwater mussels found in California. Top panel - *Gonidea angulata* (Lea, 1838), western ridge mussel. Shell length = 61 mm. Top left, exterior of left valve; top right, interior of left valve. Bottom panel- *Magaritifera falcata* (Gould, 1850), western pearlshell. Bottom left, exterior of left valve. Bottom right, interior of right valve. CAS 154CW. Shell length = 89 mm.

METHODS OR TECHNIQUES USED:

Historical Data Collection

A variety of methods were employed to explore the historical occurrence of freshwater mussels in California rivers and lakes as follows:

Published and unpublished records

A literature search was conducted to obtain published records of freshwater mussels from California drainages (Appendix 1). In addition, the USDA Forest Service Freshwater Mollusk Database at Utah State University was queried to obtain published and unpublished records of freshwater mussels in the state. This database contains over 1,000 records of historical occurrences of bivalves in the western United States, dating back to the 1830s.

Museum Collections

Bivalve collections at the California Academy of Sciences (CAS) in San Francisco, the Academy of Natural Sciences in Philadelphia, Pennsylvania, and the United States National Museum (USNM) in Washington, D.C. (Smithsonian), were physically inventoried³. This entailed searching the museum collections containing freshwater mussel shells, and recording accounts of all specimens from California.

Personal Communication

In addition to published, unpublished and museum collection records, we included personal communications into the historical record database. These observations were translated to us via telephone or email and were included as part of the database.

Field Surveys

Database Development

From the historical data collection efforts, we developed a database of all historical sites within California (see Table 2 for a list of historical and new sites surveyed for this study). The database includes a variety of historical information including collection date, species collected/observed, the site locality, waterbody, collector and historical collection/observation source. We categorized the historical data records by specificity of the site, that is, how well the historical information describes the site locality. This information was used to relocate historical sites. For example, many historical sites do not provide enough information for the sites to be relocated – many simply list a river such as the Sacramento, or county, such as Kern County. Using the specificity data, a survey design was developed to ensure coverage throughout California including major stream systems in the state. Sites without enough information to relocate were not included in the sample survey design. However, these records are included in the historical database, which is available from Joseph Furnish, PSW Regional Office, Vallejo, California.

³ The museum inventories were conducted under contract with the Confederated Tribes of the Umatilla Indian Reservation in 2004-5.

Historical sites selected to resurvey were based on three site classes, listed in order of priority: 1) sites within National Forest lands; 2) sites on any public lands to obtain broad geographic coverage and 3) any remaining accessible sites to obtain broad geographic coverage. We report our findings first as sites on National Forest lands.

In addition, based on a study that provides the first global biogeographic regionalization of the Earth's freshwater biodiversity⁴ (Abell et al. 2008), we added a field to the database which groups the historical sites into 7 freshwater ecoregions of California as follows (Figure 2):

- Colorado
- Death Valley
- Lahontan
- Oregon and Northern California
- Oregon Lakes
- Sacramento-San Joaquin
- Southern California and Baja

These ecoregions contain distinct assemblages of natural freshwater communities and species. The freshwater species, dynamics, and environmental conditions within the defined ecoregions are more similar to each other than to those of surrounding ecoregions and therefore form unique conservation units. These 7 freshwater ecoregions fall within two major habitat types – Temperate Coastal and Xeric (Abell et al. 2008). The Sacramento-San Joaquin and the Oregon and Northern California freshwater ecoregions fall within the temperate coastal major habitat type; all other ecoregions are within the xeric major habitat type.

The following provides a brief overview of California's freshwater ecoregions as described by Abell et al. (2008) and Howard and Revenga (2009).

Freshwater Ecoregions

Colorado Freshwater Ecoregion

The Colorado freshwater ecoregion is comprised of the Colorado River drainage. Thirty-nine species of fish are found in the entire Colorado freshwater ecoregion with 26 found in the lower basin. The Colorado region hosts 8 endemic fish species.

Forty percent of the species (14 taxa) found in this ecoregion are considered imperiled as determined by the 2008 American Fisheries Society (AFS) Endangered Species Committee (Jelks et al. 2008). Eight of the 14 imperiled fishes are considered endangered. The endangered species that fall within California's borders include the bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and the desert pupfish (*Cyprinodon macularius*). Springs in this ecoregion also support endemic spring snails, including the Overton assiminea (*Assiminea* sp.), found in separate springs in the vicinity of Lake Mead.

⁴ Freshwater Ecoregions of the World (www.feow.org).

Death Valley Freshwater Ecoregion

The Death Valley freshwater ecoregion makes up the majority of the southwest corner of the state and reaches into southwestern Nevada. The region is part of the Mojave high desert and is characterized by a warm temperate climate, receiving low annual precipitation. This ecoregion is a closed basin into which the Owens, Amargosa, and Mojave rivers drain. It has few perennial rivers and streams but contains abundant springs rising along faults, which provide much of the habitat for freshwater species.

Like other arid ecoregions of North America, the Death Valley fish assemblage exhibits low species diversity but extraordinarily high endemism. While this ecoregion has only 9 species of fish, 8 of those species are found nowhere else on earth. With the exception of the fish in the Owens River and Mojave River basins, all of the endemic freshwater species in this ecoregion depend on springs or spring margins.

Eight of the 9 species of fish found in this region are considered endangered, and four subspecies are extinct.

Lahontan Freshwater Ecoregion

The Lahontan Basin ecoregion is a closed drainage system that does not flow outward into any rivers or oceans. The climate of this desert basin is dry and hot in the summer and cold and dry in the winter, with precipitation occurring primarily in the spring in the north and primarily in the winter in the south.

The Lahontan ecoregion includes Lake Tahoe which is distinguished by being one of the largest high-mountain lakes in the world. The Lahontan's harsh conditions and few perennial freshwater habitats (which become torrents during infrequent storms) have excluded all but the hardiest and most adaptable fish species. Those that remain have, in some cases, become extraordinarily differentiated within isolated habitats; for instance, six subspecies each of tui chub (*Gila bicolor*) and five of speckled dace (*Rhinichthys osculus*) are recognized in the ecoregion (Hubbs et al. 1974; Williams et al. 1985; Sigler & Sigler 1994).

The Lahontan contains 14 species of fish, 4 of which are endemic. Nearly 65% (n=9) of the fish species found in this ecoregion are considered imperiled by the AFS. The High Rock Springs tui chub (*Gila bicolor ssp.*), once found within California's borders, is considered extinct (Jelks et al. 2008).

Oregon and Northern California Freshwater Ecoregion

The Oregon-Northern California freshwater ecoregion extends along the Pacific Coast of Oregon and California to the northern shore of San Francisco Bay. In southern Oregon and Northern California, the ecoregion reaches inland, encompassing the western drainages of the Klamath and Siskiyou Mountains. Main rivers in California include the Klamath and the Eel.

The Oregon-Northern California freshwater ecoregion contains the highest fish richness of California's freshwater ecoregions, totaling 48 fish species. It ranks highest in its habitat type

in percentage of endemic fishes as roughly a quarter (13) of the species of fish are endemic . More than half of fish species (25) are considered imperiled; six of which are federally endangered (Jelks et al. 2008). Of the 6 species listed as endangered, 5 occur in California including white sturgeon (*Acipenser transmontanus*), shortnose sucker (*Chasmistes brevirostris*), Lost River sucker (*Deltistes luxatus*), Coho salmon (central California coastal population Humboldt to Santa Cruz counties) (*Oncorhynchus kisutch*), and the tidewater goby (*Eucyclogobius newberryi*).

Oregon Lakes Freshwater Ecoregion

The Oregon Lakes freshwater ecoregion is a closed drainage system that does not flow outward into any rivers or oceans. The landscape is characterized by a pattern of basins and raised terraces that run in a north-south orientation (Minckley et al. 1986). These desert basins are largely defined by alkaline lakes such as Goose Lake, which straddles the California-Oregon border. The ecoregion contains 23 native fish species, 75% of which are considered imperiled (15 species) (Jelks et al. 2008), and two of which are endemic.

Sacramento-San Joaquin Freshwater Ecoregion

The Sacramento-San Joaquin is the largest ecoregion in California comprising 45 percent of the state. Nearly half of the state's runoff from five major rivers empties into the Sacramento-San Joaquin freshwater ecoregion, which is then channeled to urban and agricultural users in the San Francisco Bay Area, the southern Central Valley, Southern California, and the Sacramento Delta itself. In many ways this freshwater ecoregion supplies the life blood of the state. But sadly, the Sacramento-San Joaquin river system has recently been listed as America's most endangered river by American Rivers (<http://www.americanrivers.org/our-work/protecting-rivers/endangered-rivers>).

The confluence of the Sacramento and San Joaquin rivers form an inverted river delta that flows into San Francisco Bay, the largest estuary on the West Coast of North America. The Sacramento-San Joaquin supports nearly 40 native freshwater fishes, including the southernmost populations of five anadromous fish species as well as four runs of Chinook (Abell et al. 2000). Fish groups with high representation in the Sacramento-San Joaquin include anadromous lampreys, sturgeons, smelt, and salmonids, as well as cyprinids and suckers. Additionally, there are threespine stickleback (*Gasterosteus aculeatus*), Sacramento perch (*Archoplites interruptus*), tule perch (*Hysterothorax traski*), and tidewater goby (*Eucyclogobius newberryi*).

Seventy five percent (30) of the fish species in this freshwater ecoregion are considered imperiled in North America (Jelks et al. 2008). One species, the thicktail chub (*Gila crassicauda*), is considered extinct as no living individual has been documented in its natural habitat for 50 years or more (Jelks et al. 2008). The Clear Lake splittail (*Pogonichthys ciscooides*) is considered possibly extinct as it has been between 20 and 50 years since an individual was observed in nature. Five species are listed as endangered in the United States including: white sturgeon (*Acipenser transmontanus*), Modoc sucker (*Catostomus microps*), Little Kern River golden trout (*Oncorhynchus mykiss whitei*),

California's Freshwater Ecoregions



Data source: Freshwater ecoregions - Abell et al., 2008

Figure 2. Map of California's 7 freshwater ecoregions per Abell et al. 2008: Oregon and North California Coastal, Oregon Lakes, Sacramento-San Joaquin, Lahontan, Death Valley, Southern California Coastal and Baja California, and Colorado. See Freshwater Ecoregions of the World for more details ([www. feow.org](http://www.feow.org)).

Chinook salmon (Sacramento River winter run population)(*Oncorhynchus tshawytscha*) and the tidewater goby (*Eucyclogobius newberryi*) (Jelks et al. 2008).

Southern California and Baja Freshwater Ecoregion

The Southern California-Baja freshwater ecoregion begins just south of Monterey and encompasses southwestern California and the entire Baja Peninsula in Mexico. This ecoregion is characterized by extreme aridity and geological activity (Moyle 2002). Twenty species of fish are found in this ecoregion and most occur at the edge of their respective ranges. Much of the fish fauna is marine-derived, and is represented by the killifish (Fundulidae), lamprey (Petromyzontidae), sculpin (Cottidae), and salmonid (Salmonidae) families. In general, the ecoregion has a relatively limited fish fauna due to aridity and geological activity but it is biologically noteworthy because it includes the southernmost range for anadromous fishes such as steelhead (*Oncorhynchus mykiss*) and the Pacific lamprey (*Lampetra tridentata*).

Sixty percent of the fish species (12 taxa) found in this ecoregion are considered imperiled as determined by the 2008 American Fisheries Society (AFS) Endangered Species Committee. Six of the 14 imperiled fishes are considered endangered, four of which fall within California's borders: steelhead-southern California populations (*Oncorhynchus mykiss*), Santa Ana stickleback (*Gasterosteus aculeatus santaeannae*), unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), and the tidewater goby (*Eucyclogobius newberryi*).

To better understand the context of the mussel sites, we report our findings based on these freshwater ecoregions. These ecoregional subdivisions are consistent with genetic diversity found in the *Anodonta californiensis/nuttalliana* clade structuring reported by Mock et al. (2010). In that study, *Anodonta spp.* specimens sampled in the the upper Sacramento basin – the Pit River watershed – are genetically distinct from the lower-Sacramento region.

Field Survey Design and Methods

Field surveys were designed to resurvey as many historical sites as possible given time and access constraints with the priority being all historical sites on National Forest lands. The survey design was planned to locate sites within all hydrologic regions/freshwater ecoregions in California and to visit sites where *Anodonta* historically occurred. We included as many sites as possible where *Anodonta* occurred with other species in the past.

In the summers of 2008 and 2009 freshwater mussels were inventoried throughout California based on historical records described above. The field surveys were conducted using timed searches, which are effective for detecting the majority of mussel species present at a site (Strayer and Smith 2003). All mussels were hand collected by snorkeling or scuba diving, and by direct observation in shallow areas. At each site all possible habitats where mussels could occur were checked, including both banks and all channel area, root and sedge mats, rock crevices, under woody debris (logs), and within aquatic vegetation. At most sites, density estimates were obtained by counting all mussels observed within the area surveyed.

California's Historic Mussel Sites



Data sources:
Mussel sites - Jeanette Howard, 2009, Freshwater ecoregions - Abell et al., 2008
U.S. Forest Service lands - California Resources Agency Legacy Project, 2004
Urban areas - CDF- FRAP, 2005

Figure 3. Map of 113 historical sites in California based on 400 historical records. The different colored dots represent the various species found at the historical sites. Note that *Margaritifera falcata* was not historically found in Southern California. National Forest lands are displayed in green; urban areas in gray.

The presence of all mussel species encountered was recorded for each site. Auxiliary data for each site were also recorded, including drainage name, site locality, qualitative information such as discharge, channel morphology and local site conditions. Each site was surveyed until we were satisfied that all potential habitats had been examined within the area surveyed. A minimum of one-person hour was spent at each site.

As part of a study to better define the taxonomic relationships for *Anodonta* within the western United States (including California, Oregon, Washington, Utah and Idaho), non-lethal tissue samples and in some cases, whole specimens, were collected from survey sites and sent to Dr. Karen Mock at Utah State University. Dr. Mock is conducting studies on the patterns of genetic divergence within *Anodonta* and the patterns of genetic clustering and allocation of diversity among populations in California and western North America.

RESULTS

Historical Data Collection Results

A total of 447 records were compiled from published, unpublished and museum records (Table 2). For this study, we define historical records as those recorded/collected before 1995; recent records are defined as post-1995. From our search of museum and written records, there are a total of 400 historical records (pre-1995), with 152 from the California Academy of Sciences, 53 from the Smithsonian, 40 from the Academy of Natural Sciences and 153 from published records, and 2 personal communications. In addition, a total of 47 recent records (post-1995) were compiled, including 1 from CAS, 34 from published records and 12 personal communications. Table 2 presents records for all recently surveyed sites, as well as the 57 records from historic sites not resurveyed during this study. All of these records are available as a Microsoft Access database or Excel spreadsheet from Joseph Furnish, PSW Regional Office, Vallejo, CA.

Of the 400 total historical records, 243 provided enough information to relocate specific sites. These 243 records were observed or collected from 113 separate (by context “historical”) sites as multiple observations or collections were made from individual sites (Table 2, Figure 3). For example, there are 20 records from Clear Lake over a period of 100+ years – dating from 1870 to 1981. These 20 records account for just 1 site. Of the 113 historical sites, we were unable to relocate three on current maps as they had been drained or filled since the historical collection was made.

The 157 historical records without specific site localities provide the following general information: a specific city (4 records), a specific county (15 records), a general location (23 records), State of California (2 records) or a specific river (115 records). The 115 records that list only rivers with no specific site locations cover the following rivers (note that names in bold are rivers that flow within National Forest boundaries): Alameda, Arroyo Seco, Ballona Creek, Big River, Borrego Springs, **Chino Creek**, **Coyote Creek**, **Dry Creek**, **Eel River**, Feather River, **Guadalupe Creek**, **Kern River**, **Klamath River**, Lagunitas Creek, Los Angeles River, Los Banos River, **Lost River**, **Mojave River**, Napa River, **New River**, Olequa Creek, **Owens River**, Pacheco Creek, Pajaro River, Petaluma Creek, **Pit River**, Putah Creek, Russian River,

Sacramento River, Salinas River, Salmon Creek, San Joaquin, San Lorenzo, San Luis Rey, Santa Ana , Santa Margarita, Shasta, Smith, South Fork American, Susan River, Truckee, Willow Creek and Yuba River. In our field surveys we attempted to survey multiple sites on many of these creeks/ rivers.

From the historical records, we found that *Anodonta* was by far the most commonly observed or recorded mussel historically (Figure 4). Of the 113 sites, 53% (n=59) were sites where only *Anodonta* were observed or collected. *Gonidea* was recorded at 8 percent (n=9) of the sites; and *Margaritifera* at 11% (n=13) of the sites. *Anodonta* and *Gonidea* co-occurred at 15% of the sites (n=17), and all three genera were found at 11% of the historical sites (n=12). *Gonidea* and *Margaritifera* co-occurred at 3% of the sites (n=3); *Anodonta* and *Margaritifera* never co-occurred at historical sites (Figure 4). *Anodonta* and *Gonidea* historically occurred throughout California, whereas *Margaritifera* appear to occur in the central and northern portions of the state in streams with historical runs of their host fishes – salmonids.

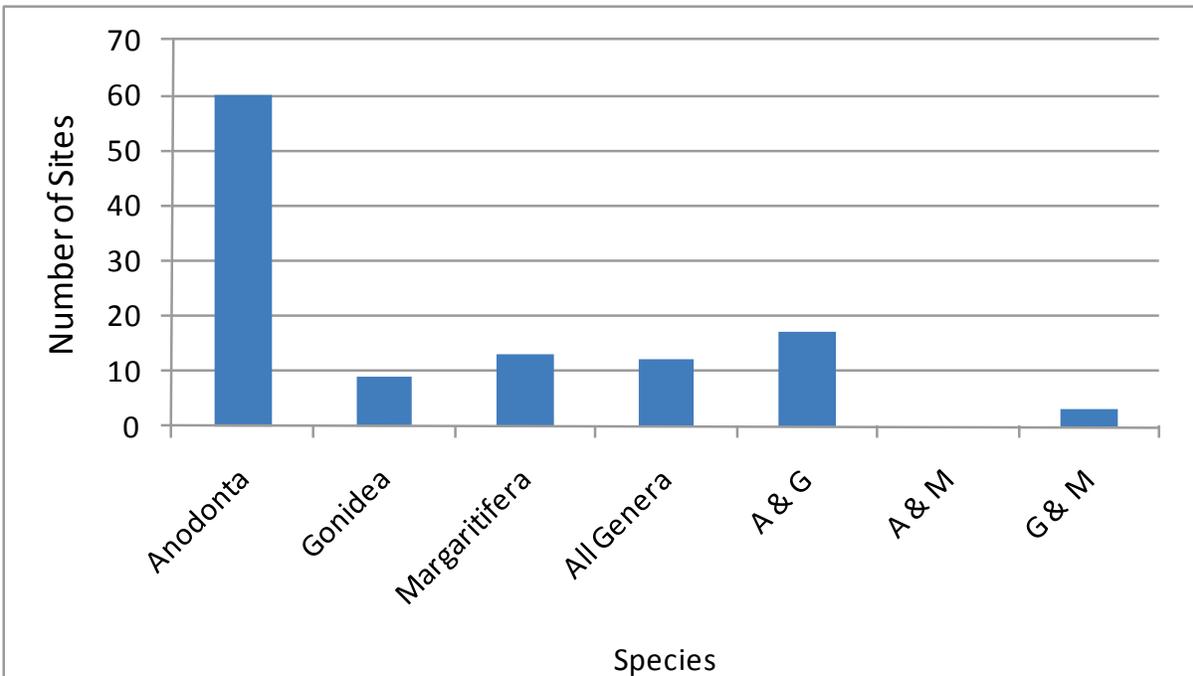


Figure 4. Breakdown of the species found at the 113 historical sites in California. Historically, *Anodonta* were found at 88 sites – co-occurring with the *Gonidea* and *Margaritifera* at 12 sites, with *Gonidea* at 17 and alone at 59 sites.

A total of 68 historical records, representing 13 different sites, are located within National Forest boundaries, including the Cleveland (1 site, 1 record), Eldorado (1 site, 2 records), Klamath (2 sites, 23 records), Lassen (1 site, 1 record), Modoc (1 sites, 2 records), Plumas (1 sites, 10 records), Shasta-Trinity (3 sites, 14 records), Shasta Lake (1 site, 1 record) Sierra (1 site, 1 record) and Tahoe (1 site, 13 records)(Tables 1 and 2, Figure 3). The oldest record on National Forest lands in California is dated 1856 from the Yuba River in the Tahoe National Forest (Lea 1856).

In terms of freshwater ecoregions, the greatest number of historical records were located within the Sacramento-San Joaquin freshwater ecoregion (n=205), representing observations or collections from 45 sites (Figure 5). Ninety-six historical records were found within the North Coast ecoregion, representing 33 separate sites. There are historical records for mussels in all freshwater ecoregions in California except the Oregon Lakes ecoregion (Figures 3 and 5). As Figures 4 and 6 show, *Margaritifera* were historically found in all ecoregions except Death Valley and Southern California; *Gonidea* were found only in the North and South Coast and Sacramento-San Joaquin regions. Sites where all three genera co-occurred are also located in the North and South Coast and Sacramento-San Joaquin regions (Figures 3 and 5).

Prior to this study, the only synthesis of historical distribution of freshwater mussels in California was reported by Taylor (1981) which provided general distributions for the three genera. The current study adds to Taylor’s general distributional accounts by providing a more detailed and fine-scale look at the historical distribution of the species in the state with information about historical accounts compiled in a searchable database (Table 2).

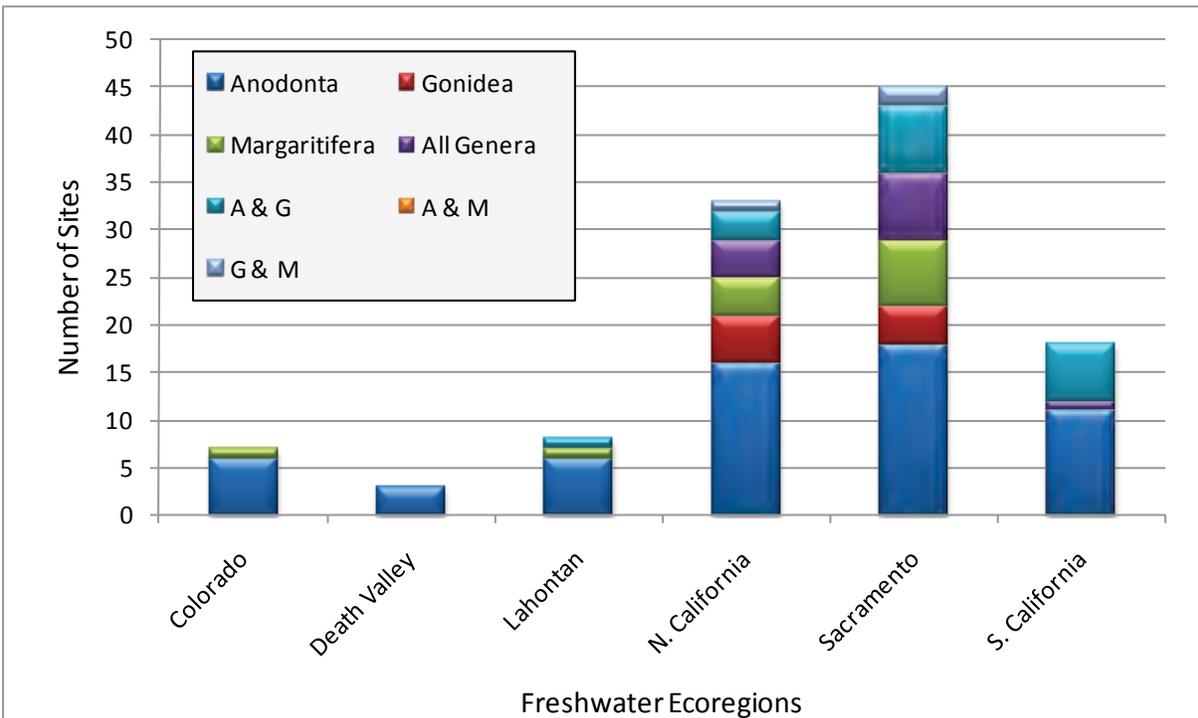


Figure 5. Breakdown of the species found at the 113 historical sites in California based on freshwater ecoregion (horizontal axis). Freshwater mussels were historically found in all California freshwater ecoregions. As shown, the greatest number of historical sites fall within the Sacramento ecoregion, followed next by the Northern California ecoregion. *Margaritifera* were historically found in all ecoregions except Death Valley and Southern California; *Gonidea* were found only in the North and South Coast and Sacramento-San Joaquin regions. Sites where all three genera co-occurred are also located in the North and South Coast and Sacramento-San Joaquin regions.

Field Surveys

A total of 56 water bodies were surveyed for freshwater mussels as part of this study (Table 2). These waterbodies include all of the major river systems in California. Where possible, multiple sites were surveyed on major river systems where multiple historical records exist (without enough specific information to relocate sites), for example the Sacramento, Russian, and Eel rivers.

A total of 76 sites were surveyed during the summers of 2008-2009 at or near historical site localities (Figure 6 and Table 2). A total of 58 of the 113 historical sites were resurveyed (47 as a result of the 2008-2009 field seasons, 7 surveyed in 2006 (Howard 2008), 3 others surveyed by Lorrie Haley of Spring Rivers Ecological Sciences during a 2008 field survey, and one additional site by Jayne Brim Box for a 2003 survey of the Lassen National Forest (Brim Box et al. 2005). All of these records are included in Table 2. Fifty-five historical sites in California therefore, have yet to be resurveyed in the state (2 are located in the Colorado ecoregion, 3 in Death Valley, 2 in Lahontan, 19 in Northern California, 23 in the Sacramento-San Joaquin and 6 in Southern California).

In addition to the 76 sites surveyed in 2008 and 2009, 29 additional sites are included in the database as recent sites surveyed within the last 5 years based on previous known survey work. Nine of these sites were recently surveyed by Lorrie Haley of Spring Rivers Ecological Sciences, 10 sites were surveyed by Steve Holdeman of the U.S. Forest Service, 8 sites surveyed as part of previous studies conducted for the U.S. Forest Service (Brim Box 2008, Howard 2008), and an additional 2 sites reported from personal communications. Therefore, a total of 105 sites are included in this survey effort. Table 2 lists those 105 sites and the additional 55 historical sites that were not surveyed as part of this study.

Mussels were found at 52% (n=55) of the 105 sites included in the current survey (Figures 6-8). Only *Anodonta* were found at 20% (n=21) of the sites, only *Gonidea* at 6% (n=6), only *Margaritifera* at 15% (n=16), *Anodonta* and *Gonidea* co-occurred at 3% (n=3), *Anodonta* and *Margaritifera* co-occurred at 3% (n=3), *Gonidea* and *Margaritifera* co-occurred at 1% (n=1), and all species co-occurred at 5% (n=5).

Focusing on historical sites, mussels were found at 43% (n=25) of the 58 historical sites resurveyed. Only *Anodonta* were found at 17% of the sites (n=9), only *Gonidea* at 10% (n=6), only *Margaritifera* at 7% (n=4), *Anodonta* and *Gonidea* at 2% (n=1), *Anodonta* and *Margaritifera* at 2% (n=1), *Gonidea* and *Margaritifera* at 2% (n=1), and all three species at 5% (n=3).

California's Currently Sampled Mussel Sites



Data sources:
 Mussel sites - Jeanette Howard, 2009, Freshwater ecoregions - Abell et al., 2008
 U.S. Forest Service lands - California Resources Agency Legacy Project, 2004
 Urban areas - CDF-FRAP, 2005

Figure 6. Map of 105 sites surveyed and included as part of this study. The different colored dots represent the species found at the sites. Note that the black dots indicate that no mussels were found at those sites.

Twenty-four sites were surveyed within National Forest boundaries (Tables 1 and 2, Figure 6). These included 11 of the 13 historical sites located within National Forest boundaries. Historical sites in the upper San Joaquin in the Sierra National Forest and in Clear Lake in Modoc County were not surveyed as part of the current effort. Additional sites surveyed by Steve Holdeman, Aquatic Biologist, Stanislaus National Forest, and Lorrie Haley, Private Consultant, Spring Rivers Ecological Sciences, LLC were also included in the survey database. Mussels were found at 68% (n=16) of the sites on National Forest lands as follows:

- Cleveland National Forest (1 site surveyed): no mussels found.
- Eldorado National Forest (1 site surveyed): only *M. falcata* found at the site.
- Klamath National Forest (3 sites surveyed): *G. angulata* found at 2 sites, all three genera at 1 site.
- Lassen National Forest (1 site surveyed): no mussels found at the site.
- Modoc National Forest (2 sites surveyed): no mussels found at 2 sites.
- Plumas National Forest (1 site surveyed): only *M. falcata* found at the site.
- Shasta Lake (1 site surveyed): no mussels found.
- Shasta-Trinity National Forest (4 sites surveyed): All three genera at 1 site and no mussels were found at 3 sites.
- Stanislaus National Forest (10 sites surveyed): only *M. falcata* were found at all sites.
- Tahoe National Forest (1 site surveyed): no mussels found.

Table 1. Summary of mussel species found on Pacific Southwest Region National Forest lands. Note that mussels may co-occur at the sites as listed above. Since thorough surveys were done at all sites, it may be assumed that since no mussels were observed at historically occupied sites, they have probably been extirpated. Some sites also lost some, but not all mussel species.

National Forest	Mussel Taxon	Historical Sites (#)	# Sites Surveyed	# Sites Possibly Extirpated	Current Sites	Comments
Cleveland	<i>Anodonta</i>	1	1	1	0	
Eldorado	<i>Margaritifera</i>	1	1	0	1	
Klamath	<i>Anodonta</i>	0	3	0	1	
Klamath	<i>Gonidea</i>	2	3	0	3	
Klamath	<i>Margaritifera</i>	0	3	0	1	
Lassen	<i>Anodonta</i>	1	1	1	0	
Modoc	<i>Anodonta</i>	1	2	N/A	0	Historical site not sampled
Plumas	<i>Anodonta</i>	1	1	1	0	<i>M. falcata</i> found here
Plumas	<i>Margaritifera</i>	1	1	0	1	Site historically occupied by <i>Anodonta</i>
Shasta Lake	<i>Anodonta</i>	1	1	1	0	
Shasta-Trinity	<i>Anodonta</i>	1	4	0	1	
Shasta-Trinity	<i>Gonidea</i>	1	4	0	1	
Shasta-Trinity	<i>Margaritifera</i>	3	4	2	1	
Sierra	<i>Gonidea</i>	1	N/A	N/A	N/A	Did not sample site
Stanislaus	<i>Margaritifera</i>	0	10	N/A	10	
Tahoe	<i>Margaritifera</i>	1	1	1	0	

In addition to the 25 sites located within National Forest boundaries, an additional 39 sites are located within 5 miles of National Forest lands. These include 1 site near the Angeles NF, 6 additional sites near the Klamath NF, 8 near the Lassen NF, 2 near the Mendocino NF, 4 near the Modoc NF, 2 near the Plumas NF, 1 near the Sequoia NF, 5 near the Shasta-Trinity NF, 2 near the Tahoe NF, and 8 near the Toiyabe NF. Mussels were found at 24 of the 39 sites (62%) within a 5-mile radius of National Forest lands detailed in Figure 7. These sites near National Forest boundaries represent private lands and property under other jurisdictions. However, because in many cases mussels were found in fairly close proximity to National Forest boundaries we make the assumption that suitable habitat may be found within those river systems within National Forest lands.

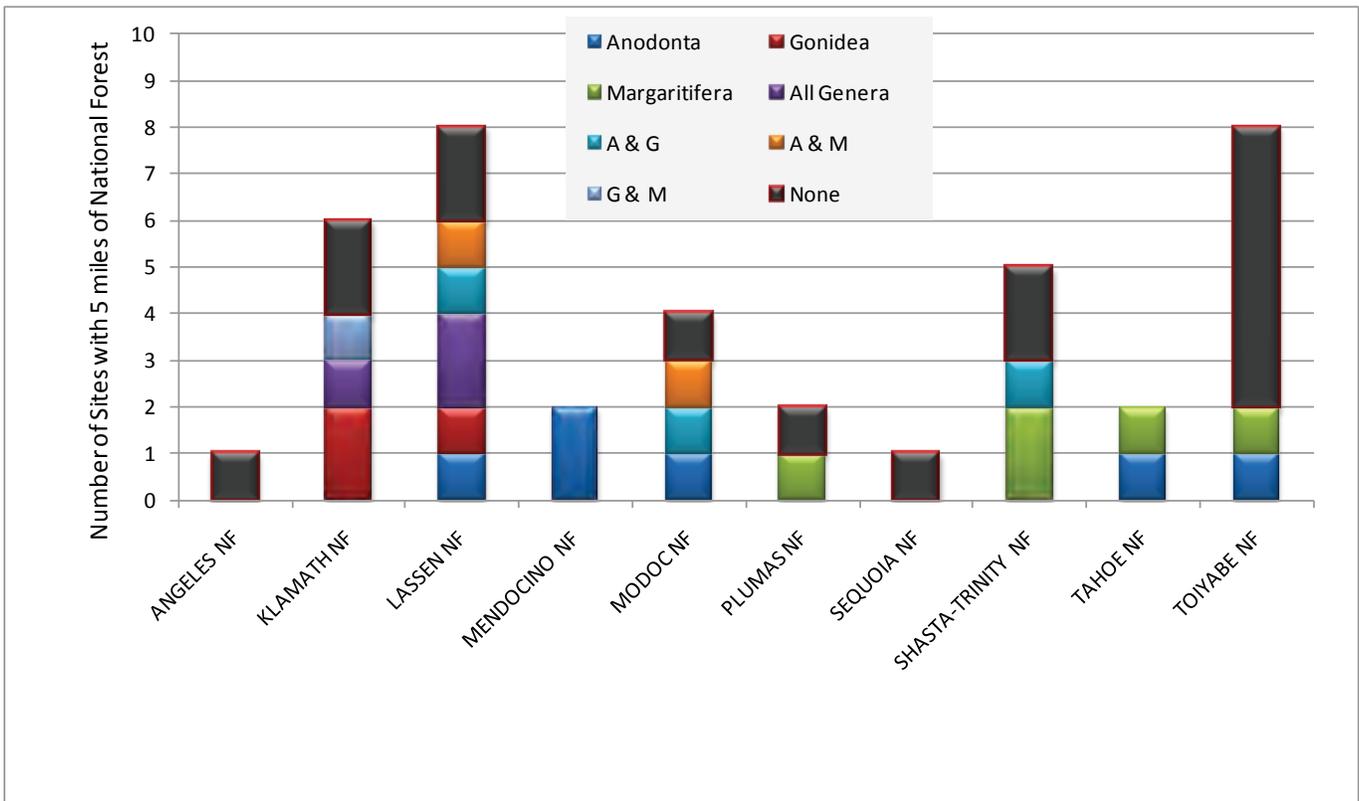


Figure 7. Species found at 39 sites that are located within 5 miles of National Forest lands. Note that sites were surveyed in the Toiyabe National Forest but that only 2 of those sites contained mussels (*Anodonta* spp. and *M. falcata*).

The number of surveyed sites per freshwater ecoregion is displayed in Figure 8. As shown, 52 sites were surveyed in the Sacramento-San Joaquin freshwater ecoregion; mussels were found at 63% (n=33) of those sites. Twenty-two sites were surveyed in the Northern California ecoregion with mussels found at 73% (n=16) of those sites. Nine sites were surveyed in the Lahontan region and mussels found at 3 sites (40%). Five sites were surveyed in the Colorado ecoregion however no mussels were found at those sites. Of the 17 sites surveyed in the Southern California ecoregion, mussels were found at only 1 site (6%) (Table 2, Figure 8).

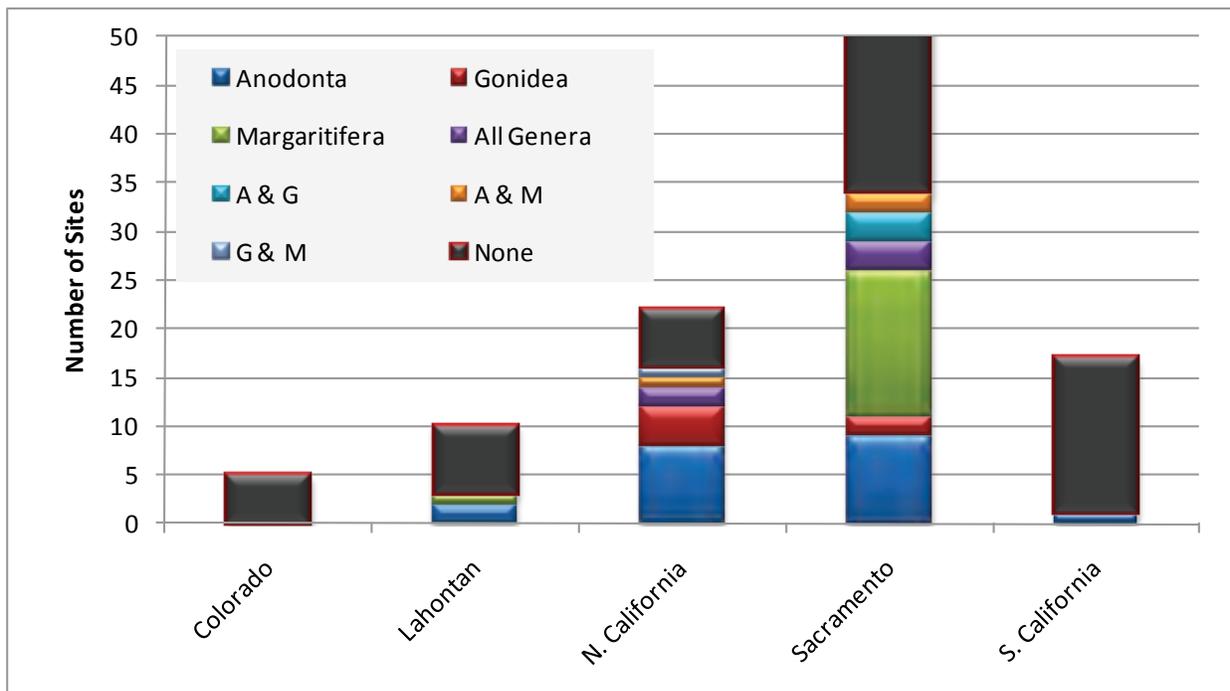


Figure 8. Results of mussel surveys for the 105 sites surveyed in 2008-2009. Five freshwater ecoregions were surveyed for mussels, and mussels were found in 4 ecoregions (mussels were not found in the Colorado region). Note that the black color in the graph depicts sites surveyed, but where no mussels were encountered.

More specifically, only *Anodonta spp.* were found at 2 sites in the Lahontan ecoregion, 8 sites in the Northern California ecoregion, 9 sites in the Sacramento ecoregion, and 1 site in the Southern California ecoregion. Note that the site where mussels were found in the Southern California ecoregion is the Pajaro River, which is located in the northern portion of the ecoregion – in Central California. *G. angulata* were found at 4 sites in the Northern California ecoregion and 2 sites in the Sacramento. *M. falcata* were found at 15 sites in the Sacramento ecoregion and 1 site in the Lahontan. All three species co-occurred at 2 sites in Northern California, and 3 sites in the Sacramento-San Joaquin. *Anodonta spp.* and *M. falcata* co-occurred at 1 site in Northern California and 2 sites in the Sacramento-San Joaquin. *G. angulata* and *M. falcata* co-occurred at 1 site each in Northern California, and *Anodonta* and *G. angulata* co-occurred at 3 sites in the Sacramento-San Joaquin (Figure 8).

Tissue samples from 24 sites surveyed were collected from the Lahontan, Northern California and Sacramento freshwater ecoregions and sent to Dr. Karen Mock's lab as part of the Forest Service's genetics project (Mock et al. 2010). Although samples were collected from the San Joaquin River, more samples from that drainage are needed to fill in the genetic gaps. In addition, gaps still exist for the Central and Southern California Coastal regions.

DISCUSSION

From our search of museum records and published literature we have evidence that freshwater mussels were historically found throughout California in all ecoregions of the state (Table 2, Figure 3). Given that multiple records were found for a number of sites and river systems, we believe mussels were found in great abundances at those sites. For example, over 20 records exist for Clear Lake over a period of 100 years and a similar number of records exist for the San Joaquin and Sacramento rivers over a period of 80 years (Table 2). Given that earlier collectors were unlikely to have been snorkeling or scuba diving, we assume these collections/observations were made from the shore and were likely visible in great numbers.

A survey of 58 of the 113 historical sites in California shows that mussels are persisting at 43% (n=25) of the historical sites although, with few exceptions, in low numbers (Figure 6). In general, where found, mussels were sparsely dispersed and not found in dense beds. Five sites are noted exceptions: 3 sites on the mainstem Klamath in Klamath National Forest (Figures 9-11) and 1 site on the upper Pit River within the Modoc National Forest where thousands of *G. angulata* individuals were densely packed near channel banks (Figure 12); and 1 site on the South Fork Eel River on a University of California Natural Reserve system property where thousands of *A. californiensis* and *M. falcata* are packed into a 100-meter-long meander bend (Figure 13).

Forty-eight of the 105 sites sampled in California as part of this study are located on some type of public/protected land (BLM lands, conservation easements, National and State Parks, National Wildlife Refuge, National Recreation Area, Water District and Regional parks). A total of 57 are located on private lands with no restrictions). Mussels were found at 53% of the private lands and on 50% of the public/protected lands (n=30 private; n=24 public). On National Forest lands, mussels were found at 67% of the sites surveyed.

From our survey results it appears that mussels are extirpated from Southern California historical sites. This conclusion is based on the absence of mussels from all sites surveyed in Southern California, south of Santa Cruz and also from a recent report by Coney (1993), where it was concluded that after eight years of searching for freshwater mussels in southern California, that they are “undoubtedly extirpated from all of Southern California.”

In terms of freshwater ecoregions, mussels were historically found in all ecoregions except the Oregon Lakes ecoregion. Only three historical sites were located in the Death Valley region. This is likely a result of the region containing few perennial stream channels and few fish species that may serve as host fish for mussels (see Freshwater Ecoregions section above). The Sacramento-San Joaquin has the greatest number of historical records numbering 205 which represented 45 sites. A resurvey of historical and additional sites surveyed in the region found mussels at 33 of those sites (63%). The Northern California ecoregion had the greatest percentage of sites with mussels totaling 73%. The Northern California ecoregion is the least modified hydrologic region in the state and likely includes some of the best habitat for freshwater mussels in the state.

As noted earlier, fishes in all freshwater ecoregions have suffered severe declines and have high percentages of imperiled fishes. For example, 89% of the fish in the Death Valley ecoregion are

imperiled; 75% in the Sacramento San Joaquin ecoregion; 65% in the Lahontan; 60% in the Southern California region; 50% in Northern California and 40% in the Colorado ecoregions. Because fishes serve as hosts for larval freshwater mussels, this degree of imperilment of fishes is likely to have a great impact on recruitment and will therefore likely result in declining populations of mussels.

Based on our survey of specific historical sites and additional sites in rivers noted in both museum collections and the literature, we conclude that all three genera of freshwater mussels are declining throughout the state. This study suggests that *M. falcata* and *G. angulata* may in the future be considered as C2 candidate species for listing under the Endangered Species Act in addition to the candidate species *Anodonta californiensis*.

This study shows the importance of historical data in better understanding the current status of freshwater mussels. By making use of historical references, we were able to provide a record of freshwater mussels in California dating back to the 1880s and relocate many of the historical collection sites. By comparing mussel occurrences from the historical records and current survey results, a better understanding of the distribution and persistence of mussels can be realized. Figures 14A-C illustrate this by mapping the historical distribution of *Anodonta* spp. (A), the historical *Anodonta* sites resurveyed (B), and the historical sites that were resurveyed where *Anodonta* were currently found (C).

FUTURE RESEARCH DIRECTIONS

To further our understanding of freshwater mussels in California, future research may wish to resurvey the remaining 55 historical sites in the state that have enough information to be relocated. Only two of these unsurveyed historical sites are on National Forest lands. Although historical records were not located on all National Forests in the state, including the Six Rivers and Trinity National Forests, good freshwater mussel habitat exists on those forest lands (see Figure 15) and anecdotal accounts provide evidence that freshwater mussels are persisting in rivers such as the Smith, Salmon and Trinity.

Although only 13 historical sites with enough specific information to relocate were within National Forest boundaries, numerous historical freshwater mussel records were recorded from rivers that run through National Forests including Chino Creek, Dry Creek, Eel River, Guadalupe Creek, Kern River, Klamath River, Lost River, Mojave River, Napa River, New River, Owens River, Pit River, Sacramento River, Salinas River, Salmon Creek, San Joaquin, San Luis Rey, Santa Ana, Santa Margarita, Shasta, Smith, South Fork American, Susan River, and Willow Creek. Future work may wish to focus on the rivers/creeks listed above that fall within National Forest boundaries. Given past research and analyses we hypothesize that freshwater mussels are located in reaches of streams with slopes less than 4% (see Figure 15; Howard and Cuffey 2003, Brim Box et al. 2006, Howard 2008). Should additional inventories be conducted on National Forest lands, survey designs may want to emphasize efforts on the above listed rivers focusing on stream reaches of less than 4% to obtain a better understanding of freshwater mussels on National Forest lands. Figure 15 depicts perennial stream channels and channels with slopes <4% that fall on National Forest lands. Additional freshwater mussel surveys conducted in the stream

reaches shown on this map would provide a better understanding of the distribution and abundance of mussels within National Forest lands.

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Figure 9. Klamath River at Clear Creek tributary off CA State Highway 96 (Field ID JKH08-006 – See Table 2). Thousands of *Gonidea angulata* were found within this pool. Upper left photo is the view looking downstream; upper right photo is the view looking upstream. This site is located in the Oregon and Northern California Coastal freshwater ecoregion, which is characterized by relatively slow streams and rivers in alluvial channels that terminate primarily in brackish estuaries. Temperate coniferous forests make up a majority of this ecoregion, with dominant species including Douglas fir (*Pseudotsuga menziesii*) and coast redwood (*Sequoia sempervirens*) forests unique to the northern California coast.



Figure 10. Klamath River near Hamburg at Sarah Totten National Forest campground in the Klamath National Forest off CA State Highway 96 (Field ID JKH08-008 – See Table 2). Hundreds of *Gonidea angulata* were found situated among the sedges across the river channel as shown in the photos. Upper left photo is the view looking downstream; upper right photo is the view looking upstream.

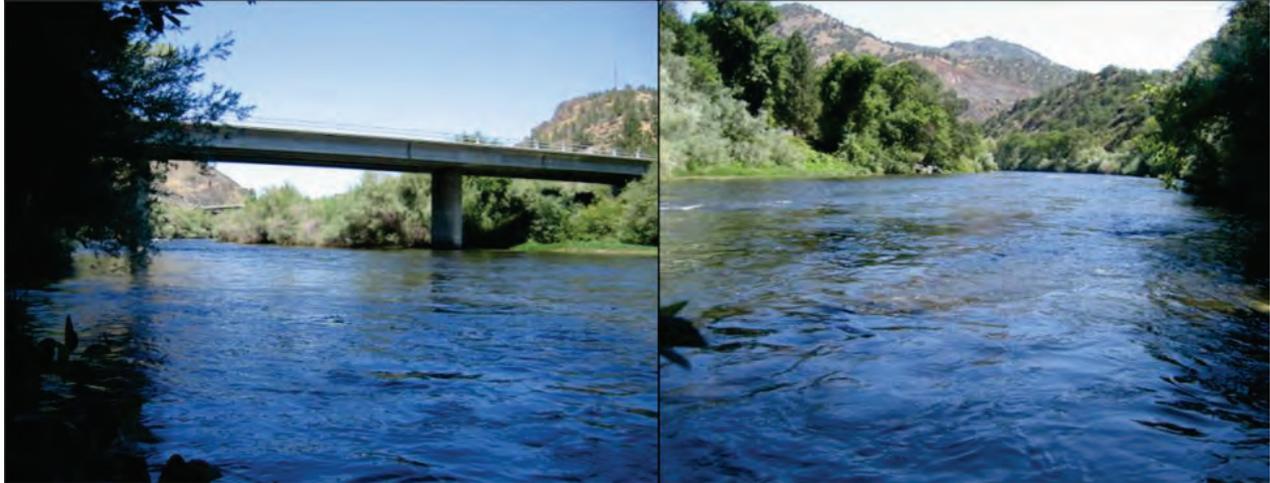


Figure 11. Klamath River @ intersection of CA State Highway 96 and Interstate Highway 5 at Rest Area in the Klamath National Forest (Field-ID JKH08-009). Thousands of *Gonidea angulata* found along the river banks. In addition, hundreds of *Lanx alta*, a genus of freshwater limpet associated with good water quality and endemic to (i.e. found only in) the Pacific Northwest, were found at this site. This site on the Klamath River appears to be in good shape and has abundant aquatic invertebrates. Upper left photo is the view looking upstream; upper right photo is the view looking downstream.



Figure 12. Site on the upper Pit River within the Modoc National Forest (Field ID JKH09-029). Thousands of *Gonidea angulata* and hundreds of *Anodonta californiensis* were found in this 50-meter-long pool. Upper left photo looking upstream; upper right photo looking downstream. Upper left, inset photo shows *Anodonta californiensis* specimens collected for tissue samples and sent to Karen Mock at Utah State University for genetic analysis.



Figure 13. Site on the South Fork Eel River on the Angelo Coast Range Reserve, a University of California Natural Reserve system property (Field ID JKH09-001 – See Table 2). Thousands of *Anodonta californiensis* are densely packed into the 100-meter-long meander bend pool. Upper left photo depicts the pool looking upstream, upper right photo shows the riffle below the pool looking downstream. The Angelo Coast Range Reserve has been the subject of extensive studies on both *Anodonta californiensis* and *Margaritifera falcata* (Howard and Cuffey 2003, Howard 2004, Howard et al. 2005, Howard and Cuffey 2006).



Data sources:
Mussel sites - Jeanette Howard, 2009. Freshwater ecoregions - Abell et al., 2008
U.S. Forest Service lands - California Resources Agency Legacy Project, 2004
Urban areas - CDF-FRAP, 2005

Figure 14A. Sites where *Anodonta californiensis* had been observed prior to 1995 (i.e. historical sites). Note that the sites are located throughout California. See Figure 14B for historical sites that were resurveyed as part of this effort and Figure 14C for sites where *Anodonta* were currently found.



Data sources:
Mussel sites - Jeanette Howard, 2009, Freshwater ecoregions - Abell et al., 2008
U.S. Forest Service lands - California Resources Agency Legacy Project, 2004
Urban areas - CDF- FRAP, 2005

Figure 14B. Historical sites that were resurveyed as part of this effort. See Figure 14C for which of these sites were found to have *Anodonta* during this survey.



Data sources:
Mussel sites - Jeanette Howard, 2009, Freshwater ecoregions - Abell et al., 2008
U.S. Forest Service lands - California Resources Agency Legacy Project, 2004
Urban areas - CDF- FRAP, 2005

Figure 14C. Resurveyed historical sites (see Figure 14B) where *Anodonta* spp. were currently found. Details for all sites are included in Table 2. Note that *Anodonta* were found at only a fraction of the resurveyed historical sites (see Figures 14A and 14B).

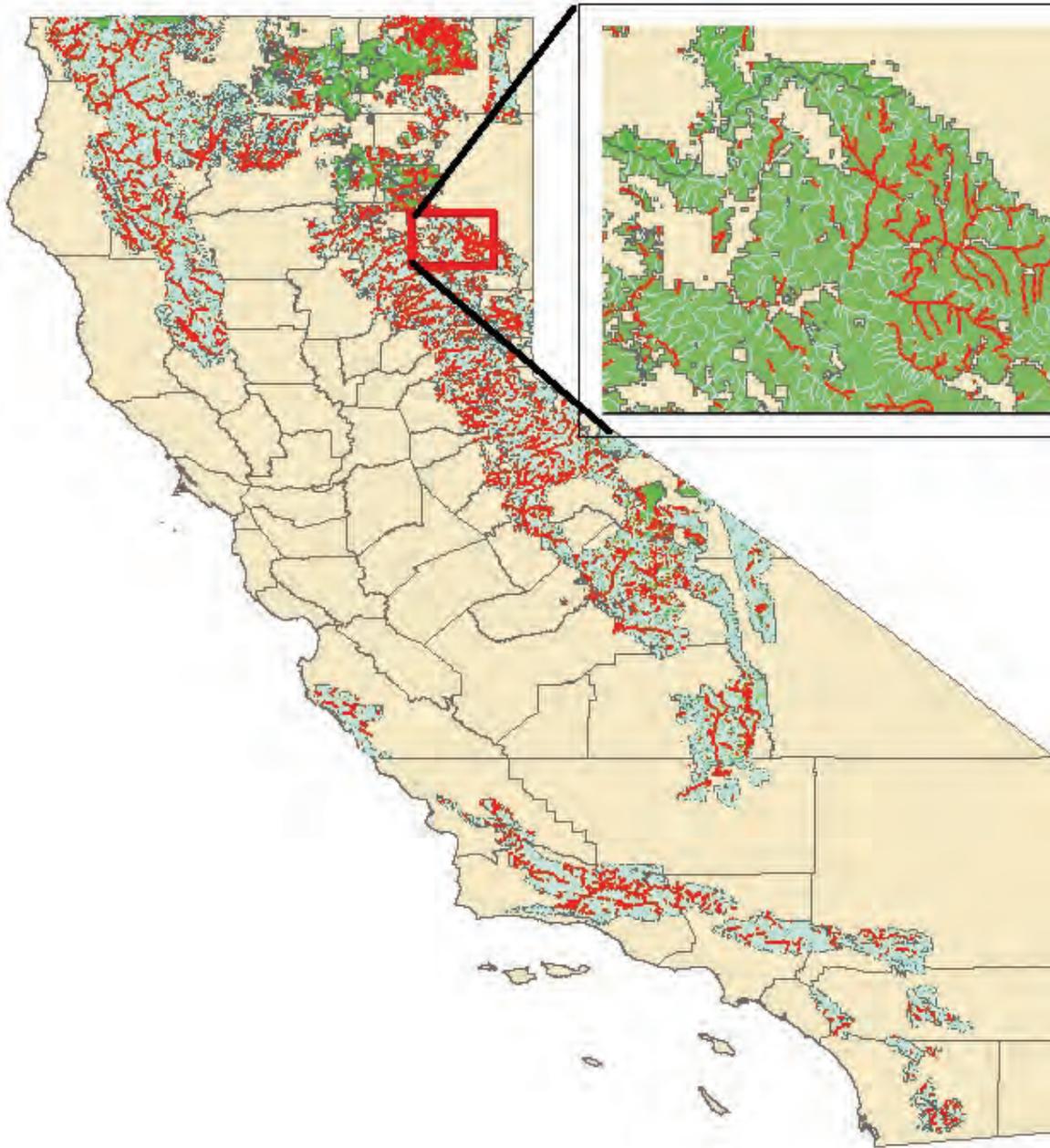


Figure 15. Map showing National Forest lands (green) and all perennial stream channels on those lands (light blue). Note that the stream lines are so dense that they obscure the mapped National Forests. See inset for a clearer view of perennial stream channels. The red lines on the map depict the stream reaches less than 4% on National Forest lands (red). Note that these low slope reaches make up just a fraction of all perennial stream channels on Forest lands. Spatial data are available for these stream channels from the author at The Nature Conservancy, San Francisco California. Note from the figure that there is suitable habitat on all national forests in the Pacific Southwest Region.

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Table 2. Table of 160 records: 105 records for sites surveyed for this study and an additional 55 records of historical sites not surveyed. Three of the sites not resurveyed are located on National Forest lands. Historical records are shown in bold; historical records that were resurveyed are shown in bold and lightly shaded. For mussel accounts: A = *Anodonta*, G = *Gonidea* and M= *Margaritifera*. N/A means not know or resurveyed. Table is sorted by owner agency. Data are available in excel spreadsheet format and also as a Google Earth kml from the author at The Nature Conservancy, San Francisco, California.

OWNER AGENCY	LAND TENURE TYPE	LAND TENURE NAME	FW ECO-REGION	FIELD NUMBER	DATE SAMPLED	COUNTY	WATER-BODY	LOCALITY	MUSSELS FOUND HISTORICALLY	MUSSELS FOUND NOW
Bureau of Indian Affairs	American Indian Reservations -Federally Recognized	Round Valley	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Mendocino	Long Valley Creek	Long Valley Creek at Junction with North Fork Eel River	A	N/A
Bureau of Indian Affairs	American Indian Reservations -Federally Recognized	Colorado River	Colorado	NONE (DID NOT SAMPLE)	HISTORICAL	San Bernardino	Big River	Big River, San Bernardino	M	N/A
California Department of Fish and Game	Other Fish and Game Land	Hidden Valley	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE)	HISTORICAL	San Bernardino	Chino Creek	Chino Creek, seven miles southwest of Ontario	AG	N/A
California Department of Fish and Game	State Wildlife Management Area	East Walker River Wildlife Area	Lahontan	JKH09-038	8/5/2009	Mono	E. Fork Walker River	CA 182 - About 1 mile north from site 037 - down gravel road to fishing access spot about 100 meters down river from dam.	N/A	0
California Department of Fish and Game	State Wildlife Management Area	East Walker River Wildlife Area	Lahontan	JKH09-039	8/5/2009	Mono	E. Fork Walker River	~ 1.5 mile N. on 182 from 038 @ pullout for fishing access.	N/A	0
California Department of Parks and Recreation	State Park	Samuel P. Taylor State Park	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	Lagunitas Creek	Lagunitas Creek	A	N/A

OWNER AGENCY	LAND TENURE TYPE	LAND TENURE NAME	FW ECO-REGION	FIELD NUMBER	DATE SAMPLED	COUNTY	WATER-BODY	LOCALITY	MUSSELS FOUND HISTORICALLY	MUSSELS FOUND NOW
California Department of Parks and Recreation	State Wild or Scenic River	Humboldt Redwoods State Park	Oregon & Northern California Coastal	JKH09-002	7/18/2009	Humboldt	S. Fork Eel River	Humboldt State Park - Nelson Grove - Turn off at mile marker 12 on 254. Down marked trail at high point of road off 254.	N/A	A
California Department of Parks and Recreation	State Wild or Scenic River	Humboldt Redwoods State Park	Oregon & Northern California Coastal	JKH09-003	7/18/2009	Humboldt	S. Fork Eel River	Humboldt State Park. Williams Grove River Access.	A	A
California Department of Parks and Recreation	State Wild or Scenic River	Humboldt Redwoods State Park	Oregon & Northern California Coastal	JKH09-004	7/18/2009	Humboldt	S. Fork Eel River	Humboldt State Park, Marin Garden Club Group Campground. Weott.	A	A
California Department of Parks and Recreation	State Wild or Scenic River	Humboldt Redwoods State Park	Oregon & Northern California Coastal	JKH09-005	7/18/2009	Mendocino	Eel River	Humboldt State Park. 10 Miles N. of Weott. Avenue of the Giants. Sivley turn-off.	AGM	0
California Department of Water Resources	Regional Park	Lake Del Valle	Sacramento - San Joaquin	Catherine Mandella (CA Department of Fish and Game)	RECENT	Alameda	Lake Del Valle	Lake Del Valle Marina Parking Lot	N/A	A
Department of Defense	Other Land (DOD/DOE)	Travis Air Force Base	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Solano	Union Creek	Union Creek - Travis Air Force Base, Union Creek.	A	N/A

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Department of Defense	Other Land (DOD/DOE)	Marine Corps Base Camp Pendleton	Southern California Coastal - Baja California	JKH09-054	9/21/2009	San Diego	Santa Margarita River	Santa Margarita River at Oceanside. No Access - Camp Pendleton	A	0
East Bay Regional Park District	Regional Park	Alameda Creek Regional Trail	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Alameda	Alameda Creek	Alameda Creek at Western Pacific R.R. bridge below Niles, California, latitude 37, 34, 11 north; longitude 121, 59, 13 west,	AG	N/A
Los Angeles - Dept. of Water and Power, City of	City Park	Los Angeles Department of Water & Power	Death Valley	NONE (DID NOT SAMPLE)	HISTORICAL	Inyo	Owens Lake	Keeler, California	A	N/A
Los Angeles - Dept. of Water and Power, City of	City Park	Los Angeles Department of Water & Power	Death Valley	NONE (DID NOT SAMPLE)	HISTORICAL	Inyo	Owens River	Owens River	A	N/A
Los Angeles County Flood Control District	Water District Parks	Peck Road Water Conservation Park	Southern California Coastal - Baja California	JKH09-056	9/21/2009	Los Angeles	Savannah Pond	El Monte, CA. Rio Hondo Water Conservation Park. Peck St. off Live Oak. Industrial area - near big quarry.	A	0

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Los Angeles, City of	City Park	Ernest E Debs Regional Park	Southern California Coastal - Baja California	JKH09-057	9/21/2009	Los Angeles	Eastlake Pond	Lake in Eastlake Park, Los Angeles, CA now called Ernest C. Debs Park. Up steep cement path from parking lot.	A	0
Los Angeles, City of	City Park	Elysian Park	Southern California Coastal - Baja California	JKH09-058	9/21/2009	Los Angeles	Elysian Reservoir	Elysian Park near Dodger Stadium	A	0
Los Angeles, County of	County Park	Cerritos Regional County Park	Southern California Coastal - Baja California	JKH09-055	9/21/2009	Los Angeles	Cerritos Lake	Cerritos Regional Park - Bloomfield @ La Palma in Cerritos, CA	A	0
Marin Agricultural Land Trust	Local Land Trust Easement	Ielmorini/Moody	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Marin	Salmon Creek	Salmon Creek between Freestone & Valley Ford, Marin County, CA	A	N/A
Monterey, County of	County Park	San Lorenzo Park	Southern California Coastal - Baja California	JKH09-062	9/23/2009	Monterey	Salinas River	San Lorenzo Regional Park - King City, CA	A	0
North Tahoe Public Utilities District	Regional Open Space	Secline Beach	Lahontan	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Placer	Lake Tahoe	Lake Tahoe at outlet	A	N/A
Oceanside, City of	City Open Space	San Luis Rey Open Space	Southern California Coastal - Baja California	JKH09-052	9/20/2009	San Diego	San Luis Rey River	@ Oceanside. Foussat Rd. San Luis Rey Trail-head (to Benet?)	N/A	0

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Palo Alto, City of	City Park	Baylands Preserve	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	San Francisco Creek	San Francisco Creek, Stanford	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NO ACCESS	HISTORICAL	San Benito	Soap Lake	Soap Lake, Gilroy, California, San Benito County	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Kern	Buena Vista Lake	Buena Vista Lake, Kern County, California	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Kings	Tulare Lake	Tulare Lake Bed, Kings County, California	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Fresno	San Joaquin River	San Joaquin River 14 mi. NE of Fresno	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	San Benito	Tequesquite Creek	Tequesquite Creek - Big Pool San Benita County, Hollister Road, San Jon Tequesquite Creek	A	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Cruz	Smith Reservoir	Smith Reservoir, Watsonville, Calif.	A	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Cruz	San Lorenzo River	San Lorenzo River, below Felton	M	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Merced	Los Banos River	Los Banos	A	N/A

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Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	San Lorenzo River	San Lorenzo River, Big Trees, Santa Clara County	M	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	Quinto Creek	Quinto Creek, Agnew, Santa Clara County	A	N/A
Private	Private Land - No Known Restriction	Private	Colorado	NONE (DID NOT SAMPLE)	HISTORICAL	Imperial	New River	New River at Laguna Station	A	N/A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE)	HISTORICAL	Los Angeles	Santa Ana River	Santa Ana River (Los Angeles Basin)	AG	N/A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE)	HISTORICAL	Los Angeles	Los Angeles River	Los Angeles River	AG	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Kern	Cedar Creek	Cedar Creek, 3 miles upstream from White Mill Road, Kern County, California	M	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	Coyote Creek	Coyote Creek, Milpitas	AG	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Stanislaus	Tuolumne River	Tuolumne River 2 miles upstream from Modesto, Stanislaus County	AG	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Stanislaus	Dry Creek	Dry Creek, Modesto	AG	N/A

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	San Joaquin	Delta Mendota Canal	Delta-Mendota Canal: CA: between mile station 4.98 and 5.67	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	San Joaquin	San Joaquin River	San Joaquin River, at Antioch, California	A	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Marin	Nicasio Lake	Nicasio Lake, Marin County	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Sacramento	North Fork Mokelumne	North Fork Mokelumne River - Snodgrass Sl., North Fork Mokelumne River, North and East of Walnut Grove, Sacramento County, Calif.	A	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Sonoma	Petaluma Creek	Petaluma Creek, Sonoma County, California	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Lake	Blue Lake	Upper Blue Lake, Lake County	AG	N/A
Private	Private Land - No Known Restriction	Private	Lahontan	NONE (DID NOT SAMPLE)	HISTORICAL	Lassen	Willow Creek	Upper waters of Willow Creek. Tributary to Susan River	A	N/A

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Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Del Norte	Mill Creek	Mill Creek in Jedediah Smith State Park, Del Norte County, California	M	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Modoc	Goose Lake	Goose Lake	M	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Del Norte	Smith River	Smith River	M	N/A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Los Angeles	Ballona Creek	Ballona Creek near end of West Adams street, Los Angeles, (now drained)	AG	N/A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Orange	UNKNOWN	Ontario, California	AG	N/A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Los Angeles	Arroyo Seco River	Arroyo Seco, Los Angeles	A	N/A

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	San Joaquin	Middle River	Middle River at Santa Fe R.R. ferry, San Joaquin County	G	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Sutter	Sacramento River	Sacramento River Meridian	G	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Butte	Feather River	Feather River about 3 miles east of Live Oak, Butte County, Calif.	AGM	N/A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE) – Concrete channel now – Visited in July 2009	HISTORICAL	Mendocino	Eel River	Eel River near Scotia, California	A	N/A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	NOT ENOUGH INFORMATION TO FIND SITE	HISTORICAL	San Joaquin	San Joaquin River	San Joaquin River at Stevenson, Calif.	A	N/A

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	Bill Shepard	RECENT	Alameda	Suisun Marsh	Suisun Marsh Hunt Club off Chadbourne Road, Fairfield	N/A	A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH08-007	7/7/2008	Siskiyou	Klamath River	Klamath River at Klamath River Resort Inn ~ 2 miles east of Happy Camp, CA off CA State Highway 96.	N/A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH08-017	7/24/2008	Shasta	Little Tule River	Little Tule River, Eastman Lake	N/A	0
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-006	7/18/2009	Mendocino	East Fork Russian River	Bu-Shay Campground under bridge on CA 20	N/A	0
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-007	7/18/2009	Mendocino	East Fork Russian River	CA20 to Potter Valley Road. Under Potter Valley Road Bridge	N/A	0
Private	Private Land - No Known Restriction	Private	Lahontan	JKH09-035	8/4/2009	Mono	W. Fork Walker River	CA 395 to Topaz Lane About 50 meter S. on Topaz Lane @ bridge	N/A	A
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-053	9/21/2009	San Diego	San Luis Rey River	Under historic 1925 bridge @ Old River Road exit off CA 76. Down path near memorial sign.	N/A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-061	9/23/2009	San Luis Obispo	Arroyo Grande Creek	Through empty lot @ end of Cerro Vista Lane where it meets Cerro Vista	N/A	0

OWNER AGENCY	LAND TENURE TYPE	LAND TENURE NAME	FW ECO-REGION	FIELD NUMBER	DATE SAMPLED	COUNTY	WATER-BODY	LOCALITY	MUSSELS FOUND HISTORICALLY	MUSSELS FOUND NOW
								Circle.		
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-002	N/A	Shasta	Big Lake	Big Lake	N/A	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-022	8/2/2009	Shasta	McCloud River	About 100 meters downstream of McCloud River Bridge @ McCloud River Campground	N/A	M
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-023	8/2/2009	Shasta	McCloud River	About .3 mile upstream of McCloud River Bridge. Path on Rt bank to end.	N/A	M
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-004	6/27/1905	Shasta	Fall River	Fall River Pond	N/A	AG
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-008	10/21/2008	Shasta	Tule River	Tule River Diversion canal	N/A	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-025	8/2/2009	Shasta	Fall Creek	15 @ Castle Crag exit. Castle Crag State Picnic Area	N/A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-003	N/A	Shasta	Fall River	Fall River	N/A	AG
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-009	6/30/1905	Shasta	Hat Creek	Hat Creek Wild Trout Area	N/A	AM

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Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-013	7/25/2009	Sonoma	Russian River	Right bank across from "beach" at Cassini Campground.	A	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-009	7/19/2009	Lake	Clear Lake	About 2 mi. S. of Lucerne. CA 20 @ mile marker 23.62	AG	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-016	7/31/2009	Solano	Putah Creek	Off Putah Creek Road @ "Creekside Park". Parking lot @ horse stable.	A	0
Private	Private Land - No Known Restriction	Private	Lahontan	JKH09-034	8/4/2009	Mono	Topaz Lake	CA 395 about .5 miles S. of Topaz Lodge	A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-041	8/29/2009	San Benito	Santa Ana Creek	About 2 miles NE of Hollister @ bridge on Fallon Road east of Junction of San Felipe.	A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-005	7/1/1905	Shasta	Pit River	Pit 4 Reach, Malinda Gulch	AGM	AGM
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-019	8/1/2009	Glenn/Butte	Sacramento River	Under Ord Ferry Road Bridge near Ord Bend Park Boat Launch	N/A	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH06-007	7/19/2006	Plumas	Feather River	Middle Fork Feather. Near Junction CA 70/ A 23 near town of Beckworth Dirt Road Access - under bridge	G	0

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH06-023	7/22/2006	Plumas	Spanish Creek	Spanish Creek off CA 70 between Spanish Bridge & Keddie access via private driveway	M	M
Private	Private Land - No Known Restriction	Private	Lahontan	JKH06-065	8/19/2006	Nevada	Truckee River	1/2 mile upstream from San Francisco Flycasting Club @ pullout on dirt road leading from the club house.	M	M
Private	Private Land - No Known Restriction	Private	Lahontan	JKH06-068	8/19/2006	Nevada	Donner Lake	North side @ private dock/private beach.	A	A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH08-003	7/6/2008	Siskiyou	Scott River	Scott River near Kelsey Creek off Scott River Road	GM	AGM
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH08-006	7/7/2008	Siskiyou	Klamath River	Klamath River at Clear Creek tributary off CA State Highway 96.	AGM	G
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH08-009	7/8/2008	Siskiyou	Klamath River	Klamath River @ intersection of CA State Highway 96 and Interstate Highway 5 at Rest Area	AGM	G

OWNER AGENCY	LAND TENURE TYPE	LAND TENURE NAME	FW ECO-REGION	FIELD NUMBER	DATE SAMPLED	COUNTY	WATER-BODY	LOCALITY	MUSSELS FOUND HISTORICALLY	MUSSELS FOUND NOW
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH08-011	7/9/2008	Siskiyou	Shasta River	Shasta River @ Bridge down Hudson Road off Highway 263 ~ 3 miles downstream of JKH08-010 (~ 0.5 miles upstream of confluence with Klamath River)	G	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-008	7/19/2009	Lake	Clear Lake	About 1 mile S. of Lucerne on CA 20.	AG	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-010	7/19/2009	Napa	Napa River	Napa Creek. Under bridge on CA 29 btw St. Helena and Yountville	A	G
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-011	7/25/2009	Sonoma	Russian River	About 1 mile downstream from summer crossing. Just upstream around big bend from Bohemian Grove. Reached by kayak.	G	A
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-012	7/25/2009	Sonoma	Russian River	About 2 miles downstream from site 011. About 50 meters upstream of popular beach.	G	A

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-014	7/31/2009	Yolo/Solano	Putah Creek	Putah Creek. Down gravel service road @ Putah Creek Road exit from CA 505.	AG	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-017	7/31/2009	Placer	Knights Landing Drainage District Canal	About 5 miles S. of Knights Landing under bridge @ Road 16.	A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-018	7/31/2009	Sutter	Feather River	3 miles E. of Live Oak. Down boatramp @ campground	AGM	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-020	8/1/2009	Butte	Sacramento River	Mill Creek Park - Boat Ramp	AG	0
Private	Private Land - No Known Restriction	Private	Oregon & Northern California Coastal	JKH09-026	8/3/2009	Siskiyou	Lost River	CA 161 Under Lost River Bridge (#02-0059). Just over OR/CA border near junction 39/161.	AG	A
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-029	8/3/2009	Modoc	Pit River	Pit River @ CA 299 - 4.5 miles S. of Canby about 200 meters down river of Canby Bridge. Lassen Trail Historic Marker.	AGM	AG
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-030	8/3/2009	Modoc	South Fork Pit River	CA 64 - Just inside Modoc - 5.1 miles E. of Likely	GM	AM

OWNER AGENCY	LAND TENURE TYPE	LAND TENURE NAME	FW ECO-REGION	FIELD NUMBER	DATE SAMPLED	COUNTY	WATER-BODY	LOCALITY	MUSSELS FOUND HISTORICALLY	MUSSELS FOUND NOW
Private	Private Land - No Known Restriction	Private	Lahontan	JKH09-033	8/4/2009	Mono	Topaz Lake	Topaz Lake Park - about .5 past boat ramp on gravel road. Almost directly across from boat ramp next to (dry) creek inlet.	A	0
Private	Private Land - No Known Restriction	Private	Lahontan	JKH09-036	8/5/2009	Mono	E. Fork Walker River	Behind Walker River Lodge in Bridgeport, CA near strong bend in river - within site of historic buildings. Called South Walker River in museum record.	A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-040	8/29/2009	San Benito	Santa Ana Creek	Next to road - about 2 miles East of Hollister @ John Smith Road & Fairview Road	A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-042	8/29/2009	San Benito	San Benito River	Dead end of Hospital Rd. @ Lakeside Stables.	A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-043	8/29/2009	Santa Cruz	Pajaro River	Pajaro River. Rogge Lane off CA 129. Under bridge near Aromas - about 100 ft from Monterey County line.	AGM	A

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Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-044	8/29/2009	San Benito	Pacheco Creek	Pacheco Creek. Walnut Ave. exit off 152 about 1/4 mile east of Casa De Fruta.	AG	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-045	9/19/2009	Kern	East Side Canal	1 mile east of Buttonwillow @ bridge on 58	A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH-09-046	9/19/2009	Kern	Kern River	Next to CA 178 just over border of Sequoia NF	GM	0
Private	Private Land - No Known Restriction	Private	Colorado	JKH09-047	9/20/2009	Imperial	White Water River	White Water River. Off CA 86S @ 66th Ave. Exit (west). Bridge @ intersection of Highway 195 & Buchanon St.	A	0
Private	Private Land - No Known Restriction	Private	Colorado	JKH09-050	9/20/2009	Riverside	White Water River	White Water River @ Indio	A	0
Private	Private Land - No Known Restriction	Private	Colorado	JKH09-051	9/20/2009	Riverside	White Water River	White Water River @ Coachella	A	0
Private	Private Land - No Known Restriction	Private	Southern California Coastal - Baja California	JKH09-059	9/21/2009	Los Angeles	Silver Lake Reservoir	Silver Lake Blvd.	A	0
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	JKH09-063	9/22/2009	San Joaquin	San Joaquin River	San Joaquin River downstream of Windmill Cove.	AGM	A

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Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-001	N/A	Shasta	Pit River	Pit River downstream of California Highway 299 bridge (downstream of Pit 1 Powerhouse)	AGM	AGM
Private	Private Land - No Known Restriction	Private	Sacramento - San Joaquin	LH08-006	N/A	Shasta	Pit River	Pit River bank near Pit #1 Power House of the Pacific Gas and Electric Co., Pit River, California	AGM	G
San Bernardino, County of	County Park	Mojave River Forks Regional Park	Death Valley	NONE (DID NOT SAMPLE)	HISTORICAL	San Bernardino	Mojave River	Mojave River	A	N/A
San Francisco - Public Utilities Commission, City and County of	County Open Space	Upper Crystal Springs Reservoir	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	San Mateo	Upper Spring Lake	Upper Spring Lake, San Mateo County,	A	N/A
San Francisco - Public Utilities Commission, City and County of	County Open Space	Lower Crystal Springs Reservoir	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	San Mateo	Crystal Springs Reservoir	Crystal Springs Reservoir (Central Valley)	A	N/A
San Francisco - Public Utilities Commission, City and County	County Open Space	Lake Merced	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	San Francisco	Lake Merced	Lake Merced, San Francisco County, California	A	N/A

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of										
San Francisco - Recreation and Park Dept., City of	City Park	Golden Gate Park	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	San Francisco	Stow Lake	Stow Lake, Golden Gate Park, San Francisco	A	N/A
San Jose, City of	City Park	Guadalupe Creek-Misc. Parcels	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	Santa Clara	Guadalupe Creek	Guadalupe Creek, between San Francisco Bay and San Jose, it was found in sloping clay banks, between four inches and two feet below the water level	AG	N/A
Solano Tri-City and County Cooperative Planning Group	Regional Park	Lake Solano County Park	Sacramento - San Joaquin	JKH09-015	7/31/2009	Solano	Putah Creek	Upstream from bridge at Lake Solano Recreation area and Nature Center.	A	0
The Nature Conservancy	Nature Conservancy Fee Land	Hanson	Southern California Coastal - Baja California	JKH09-060	9/23/2009	Ventura	Santa Clara River	TNC land off CA 126 @ Briggs exit. End of Mission Rock Road @ locked gate. Walked through about 300 m of Arundo forest.	N/A	0

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The Nature Conservancy	Nature Conservancy Fee Land	Gray Davis Dye Creek Preserve	Sacramento - San Joaquin	JKH09-021	8/1/2009	Tehama	Dye Creek	The Nature Conservancy Dye Creek Preserve. Behind barn - down road that fords creek.	N/A	A
The Nature Conservancy	Conservancy Easement (The Nature Conservancy)	North Coast Range - Angelo	Oregon & Northern California Coastal	JKH09-001	7/17/2009	Mendocino	S. Fork Eel River	Angelo Coast Range Reserve - Past the White house @ White House Pool	N/A	AM
United States BLM	Area of Critical Environmental Concern (BLM)	BLM	Oregon & Northern California Coastal	JKH08-010	7/9/2008	Siskiyou	Shasta River	Shasta River @ Bridge down Hudson Road off Highway 263	AGM	GM
United States BLM	Public Land (BLM)	BLM	Lahontan	JKH09-037	8/5/2009	Mono	Bridgeport Reservoir	CA 182 - about 1 mile from Bridgeport @ Mono County Parks Dept.	AG	0
United States BLM	Public Land (BLM)	BLM	Colorado	JKH09-048	9/20/2009	Imperial	Salton Sea	CA 111 - Desert Beach Rd. to end near abandoned harbor area on NE shore by half buried playground.	A	0
United States Fish and Wildlife Service	National Wildlife Refuge (FWS)	Tule Lake Sump	Oregon & Northern California Coastal	JKH09-028	8/3/2009	Siskiyou	Tule Lake	Tule Lake National Wildlife Refuge. Observation site off Auto tour route along S. edge of sump 1-B. View spot #3.	AG	A

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United States Fish and Wildlife Service	National Wildlife Refuge (FWS)	Tule Lake Sump	Oregon & Northern California Coastal	JKH09-027	8/3/2009	Siskiyou	Tule Lake	Tule Lake National Wildlife Refuge. Off East West Road @ photo blind.	A	0
United States Forest Service	National Forest (USFS)	Sierra National Forest	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	San Joaquin	San Joaquin River	Upper San Joaquin River	G	N/A
United States Forest Service	Wilderness Area (USFS)	Modoc National Forest	Sacramento - San Joaquin	NONE (DID NOT SAMPLE)	HISTORICAL	Modoc	Clear Lake	Clear Lake, northern Modoc County, California, on shore at south end of lake	A	N/A
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-001	5/17/2007	Stanislaus	San Antonio Creek	San Antonio Creek, tributary to N. Fk. Calaveras River-T4N, R14E, Sec 2	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-002	5/17/2007	Stanislaus	North Fork Stanislaus	North Fk of the Stanislaus. T4N, R15E, Sec 29	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-003	5/17/2007	Stanislaus	Middle Fork Tuolumne	Tuolumne River - Middle Fk Tuolumne River. T1S, R18E, Sec 14, 21, 23, 28 & 29	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-004	5/17/2007	Stanislaus	Middle Fork Tuolumne	Tuolumne River - Middle Fk Tuolumne River. T1S, R18E, Sec 14, 21, 23, 28 & 29	N/A	M

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United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-005	5/17/2007	Stanislaus	Middle Fork Tuolumne	Tuolumne River - Middle Fk Tuolumne River. T1S, R18E, Sec 14, 21, 23, 28 & 29	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-006	5/17/2007	Stanislaus	Middle Fork Tuolumne	Tuolumne River - Middle Fk Tuolumne River. T1S, R18E, Sec 14, 21, 23, 28 & 29	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-007	5/17/2007	Stanislaus	Middle Fork Tuolumne	Tuolumne River - Middle Fk Tuolumne River. T1S, R18E, Sec 14, 21, 23, 28 & 29	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-008	5/17/2007	Stanislaus	North Fork Tuolumne	Tuolumne River- N FK Tuolumne River. Start T2N, R16E, Sec 34 / End T2N, R17E, Sec 6 on up	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-009	5/17/2007	Stanislaus	North Fork Tuolumne	Tuolumne River - N FK Tuolumne River. Start T2N, R16E, Sec 34 / End T2N, R17E, Sec 6 on up	N/A	M
United States Forest Service	National Forest (USFS)	Stanislaus National Forest	Sacramento - San Joaquin	SH07-010	5/17/2007	Stanislaus	South Fork Tuolumne	Tuolumne River - S Fk Tuolumne Above Rainbow Pool (same as above, Sec 28- near confluence w/ Middle Fk)	N/A	M

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United States Forest Service	National Forest (USFS)	Modoc National Forest	Sacramento - San Joaquin	JKH09-031	8/3/2009	Modoc	Blue Lake	CA 395 - East on FS 64 to Blue Lake	N/A	0
United States Forest Service	National Forest (USFS)	Modoc National Forest	Sacramento - San Joaquin	JKH09-032	8/3/2009	Modoc	Blue Lake	CA 395 - East on FS 64 to Blue Lake	N/A	0
United States Forest Service	Wild, Scenic & Recreation River (USFS)	Klamath National Forest	Oregon & Northern California Coastal	JKH08-004	7/6/2008	Siskiyou	Scott River	2 miles down river from Site JKH08-003	A	AGM
United States Forest Service	National Forest (USFS)	El Dorado National Forest	Sacramento - San Joaquin	JKH06-029	7/25/2006	Eldorado	South Fork American	China Flat Campground/ Scenic Area, Silver Creek Rd. off US 50 to FS Rd. 11N40, Under bridge. At parking lot for scenic area walk under bridge.	M	M
United States Forest Service	Wild, Scenic & Recreation River (USFS)	Plumas National Forest	Sacramento - San Joaquin	JKH06-025	7/23/2006	Plumas	Middle Fork Feather River	Middle Fork Feather off FS Road 120 @ Red Bridge Campground 100 meters downstream of bridge	A	M
United States Forest Service	National Forest (USFS)	Tahoe National Forest	Sacramento - San Joaquin	JKH06-069	8/21/2006	Placer	Yuba River	Off US 80 just outside Hampshire Rocks Campground, ? 6 air miles W. of Soda Springs, CA	M	0

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United States Forest Service	National Forest (USFS)	Shasta-Trinity National Forest	Sacramento - San Joaquin	JKH08-001	7/5/2008	Shasta	Sacramento River	Sacramento River @ boat dock in Redding at Lake Redding off Highway 299	M	0
United States Forest Service	Wild, Scenic & Recreation River (USFS)	Klamath National Forest	Oregon & Northern California Coastal	JKH08-005	7/7/2008	Siskiyou	Klamath River	Just upstream of Oak Flat Creek on Klamath River. At Wingate pull out off CA State Highway 96.	G	G
United States Forest Service	Wild, Scenic & Recreation River (USFS)	Klamath National Forest	Oregon & Northern California Coastal	JKH08-008	7/8/2008	Siskiyou	Klamath River	Klamath River near Hamburg at Sarah Totten NF campground off CA State Highway 96.	G	G
United States Forest Service	National Forest (USFS)	Shasta-Trinity National Forest	Sacramento - San Joaquin	JKH08-012	7/9/2008	Shasta	Sacramento River	Sacramento River near Lamoine off Highway 5 at Pollard Landing picnic area in Shasta National Forest	M	0
United States Forest Service	National Recreation Area (USFS)	Shasta Lake	Sacramento - San Joaquin	JKH09-024	8/2/2009	Shasta	Lake Shasta	Shasta Lake via Antler RV Park in Antler, CA	A	0
United States Forest Service	National Forest (USFS)	Cleveland National Forest	Southern California Coastal - Baja California	JKH09-049	9/20/2009	San Diego	San Luis Rey River	Off CA 76 @ picnic area	A	0

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United States Forest Service	National Forest (USFS)	Shasta-Trinity National Forest	Sacramento - San Joaquin	LH08-007	7/1/1905	Shasta	Pit River	Pit River sw of Pit 4 Dam, Pit 4 Bypass Reach	AGM	AGM
United States Forest Service	National Forest (USFS)	Lassen National Forest	Lahontan	SAMPLED By Brim Box 2003	6/25/1905	Lassen	Susan River	See Brim Box et al. 2005	A	0
United States National Park Service	Other NPS Protected Areas (NPS)	Presidio	Oregon & Northern California Coastal	NONE (DID NOT SAMPLE)	HISTORICAL	San Francisco	Mountain Lake	Mountain Lake, San Francisco, California	A	N/A
United States National Park Service	National Recreation Area (NPS)	Whiskeytown-Shasta-Trinity National Recreation Area	Sacramento - San Joaquin	JKH08-002	7/5/2008	Shasta	Whiskeytown Lake	Whiskeytown Lake @ Willow Creek in Shasta-Trinity Recreation Area off Highway 3	N/A	0

