Placer County Water Agency
Middle Fork American River Project
(FERC No. 2079)

FINAL

AQ 3 – AQUATIC MOLLUSK TECHNICAL STUDY REPORT – 2008

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April 2009

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1.0 INTRODUCTION

This report describes the aquatic mollusk study elements of the AQ 3 – Macroinvertebrate and Aquatic Mollusk Study conducted by the Placer County Water Agency (PCWA) in 2008 in accordance with the AQ 3 – Macroinvertebrate and Aquatic Mollusk Technical Study Plan (AQ 3 – TSP) for the Middle Fork American River Project (MFP or Project). In addition to the aquatic mollusk study elements, the overall AQ 3 – TSP also includes a benthic macroinvertebrate study element and a drift macroinvertebrate study element that have been or are being reported in other documents[1]. The stakeholder-approved AQ 3 – TSP was included in Supporting Document (SD) H of the Pre-Application Document (PAD) filed with the Federal Energy Regulatory Commission (FERC or Commission) on December 13, 2007 (PCWA 2007).

The aquatic mollusk study was conducted in the vicinity of the MFP during July and August 2008 to search for the presence of three special-status[2] mollusk species and identify potential habitat. The study consists of field data collection, mollusk specimen identification, data analysis, and reporting.

The following sections provide a detailed description of the study objectives, study implementation, extent of the study area, study approach, study results, and literature cited.

2.0 STUDY OBJECTIVE

The objective of the aquatic mollusk study in the AQ 3 – TSP was to:

- Determine the presence, or lack thereof, of three special-status mollusk species (California Floater, *Anodonta californiensis*; scalloped juga, *Juga occata*; and Great Basin rams-horn snail, *Helisoma newberryi*) and identify potentially suitable habitat for these species (Furnish 2007).

3.0 STUDY IMPLEMENTATION

Figure AQ 3-1 shows the AQ 3 – TSP objectives and the study elements and activities that relate to completion of the study. Note that the aquatic mollusk study elements of the AQ 3 – TSP are shown in the 2008 fieldwork portion of the figure. Figure AQ 3-1 also shows how the information developed during the study will be documented and provided to the stakeholders. The following sections summarize the aquatic mollusk study elements completed, deviations from the TSP, outstanding study elements, and proposed modifications to the TSP.

[1]The benthic macroinvertebrate study component was presented in the Final AQ 3 – Macroinvertebrate and Aquatic Mollusk Technical Study Report (TSR) – 2007 (PCWA 2008). The drift macroinvertebrate study component will be included in the AQ 5 – Bioenergetics TSR that will be distributed to the Aquatic Technical Working Group (TWG) in June 2009.

[2]Special-status species are defined as any species that are listed as rare, threatened, or endangered or as a species of special concern by a federal, state, or local agency. USDA-FS sensitive species are also included.

3.1. STUDY ELEMENTS COMPLETED

The following aquatic mollusk study elements have been completed:

- Identified potential aquatic mollusk habitat in the study area;
- Determined the number and location of representative study sites based on the extent of identified suitable habitat and incidental sightings made during earlier aquatic field studies (e.g., AQ 2 – Fish Population Technical Study Report (TSR) – 2007, AQ 3 – Macroinvertebrate and Aquatic Mollusk TSR – 2007, and AQ 12 – Special-Status Amphibian and Aquatic Reptile TSR – 2007);
- Conducted protocol-level surveys for aquatic mollusks at a total of 26 sites;
- Identified mussels and collected shells, if present, for further identification; and
- Identified gastropods and collected and preserved representative specimens.

3.2. DEVIATIONS FROM TECHNICAL STUDY PLAN

There were no deviations in the implementation of the aquatic mollusk study elements of the AQ 3 – TSP.

3.3. OUTSTANDING STUDY ELEMENTS

All components of the aquatic mollusk study elements of the AQ 3 – TSP were completed. The only element of the AQ 3 – TSP that has not yet been completed is the analysis and report of the invertebrate drift sampling element of the study plan:

- Invertebrate drift sample analysis will be included in the AQ 5 – Bioenergetics TSR and distributed to the Aquatic TWG in July 2009.

3.4. PROPOSED MODIFICATION TO TECHNICAL STUDY PLAN

No modifications are proposed to the aquatic mollusk study elements of the AQ 3 – TSP or the overall AQ 3 – TSP.

4.0 EXTENT OF STUDY AREA

The study area included accessible bypass reaches, the peaking reach, and comparison reaches. The aquatic mollusk study sites are listed in Table AQ 3-1 and are shown on Map AQ 3-1.

5.0 STUDY APPROACH

This section describes the targeted species and aquatic mollusk sampling methods.

5.1. TARGETED SPECIES

This study focused on determining the presence, or lack thereof, of one special-status mussel species (California floater, *Anodonta californiensis*), and two special-status aquatic snail species (scalloped juga, *Juga* (*Calibasis*) *occata*; and Great Basin rams-horn snail, *Helisoma newberryi*). Suitable habitat for the California floater includes natural lakes, reservoirs, and low-gradient reaches of lowland rivers, generally with finer substrates and slow currents (Nedeau et al. 2005). The scalloped juga is a large-river species restricted to swift, unpolluted, well-oxygenated areas with large substrates (Frest and Johannes 1993). Suitable habitat for the Great Basin rams-horn snail includes large lakes, low-velocity rivers, large spring sources, and spring-fed creeks (Taylor 1981).

5.2. POTENTIAL HABITAT

The bypass, peaking, and comparison reaches, and inflows into the Project reservoirs were all identified as potential habitat for the three special-status aquatic species described above. Potential habitat in the study area also included small spring/seep areas. Aerial photograph, helicopter video, Project maps, United States Geological Survey (USGS) 7.5 topographic maps, and existing literature were reviewed to identify potential habitat in the study area.

5.3. STUDY SITES

To determine the distribution of aquatic mollusks in the study area, three types of study sites were selected. These included: (1) representative habitat sites in the bypass and peaking reaches; (2) comparison sites in river reaches unaffected by Project operations; and (3) incidental mussel observation study sites.

- **Representative Habitat Study Sites.** The locations of most of the representative habitat study sites were determined in the field in coordination with the Aquatic TWG in August 2007 during the selection of the AQ 1 – Instream Flow study sites. These mollusk sampling sites were co-located at the benthic macroinvertebrate sampling sites and the AQ 1 – Instream Flow study sites. Other representative habitat sites were located where resources such as special-status amphibians (AQ 12 – TSR 2007) were sampled. In many cases, the mesohabitat mapping results from the 2006 Aquatic Habitat Characterization Study (SD G, Book 2 of 2, Study Reports) (PCWA 2007) were used to help identify sites with mesohabitat types in similar proportion to the larger geomorphic reaches of the river.
- **Comparison Study Sites**. Comparison study sites were selected at the tributaries (Middle Fork American River, Five Lakes Creek, Rubicon River) to the large reservoirs (French Meadows and Hell Hole reservoirs), in stream reaches above Project diversions (Duncan Creek, South Fork Long Canyon Creek, North Fork Long Canyon Creek), at Otter Creek (a tributary to the peaking reach), and in nearby rivers unaffected by the Project (North Fork American River, North Fork of the Middle Fork American River).

- **Incidental Mussel Observation Study Sites.** The incidental mussel observation study sites were located at places where incidental sightings of western pearlshell mussels (*Margaritifera falcata) (*live specimens or shells) were observed during earlier studies (Table AQ 12-6 in the AQ 12 – TSR 2007) or were identified as potentially being present during discussions with the Aquatic TWG members.

Twenty-six study sites were located in the study area (Table AQ 3-1 and Map AQ 3-1). Seven of these study sites were not explicitly identified in the AQ 3 – TSP (PCWA 2007) study sites map (Map AQ 3-1 in the TSP) and were surveyed in addition to the 19 that were identified on the TSP map. These include study sites located upstream of the large reservoirs (R36.2, MF51.8, and Five Lakes Creek), at tributary confluences (NFMF0.0, LC0.0, and Otter Creek), and on the Middle Fork American River near Driver's Flat Road (MF9.1).

5.4. DISTRIBUTION SURVEYS

Mollusk surveys followed established methods (Furnish et al. 1997) for determining the presence, or lack thereof, of special-status aquatic mollusk species in identified suitable habitat in the selected study sites. Sites were surveyed by at least two people moving in an upstream direction for a minimum distance of 100 meters and a minimum search time of 2 person-hours (2 surveyors searching for at least one hour). When necessary, distances searched and search times were extended (e.g., 400 meters and 4 person-hours) to ensure that multiple habitat types (e.g., pools, runs, riffles) were thoroughly searched. Survey results, diversity and abundance, were reported on a per site basis assuming an approximately equal coverage of habitat types. Analysis of the data using diversity and abundance by site or diversity and abundance scaled by length of stream sampled and/or by person hours search effort, indicated similar patterns in the study area regardless of the reporting method.

Surveys on mainstem rivers included river-influenced portions of tributary confluences (i.e., areas inundated by the mainstem at approximately high water/bankfull flow). Surveys on tributaries included habitat upstream of the river-influenced zone. Edgewater and shallow mid-channel habitats were searched by examining the surfaces and undersides of gravels, cobbles, small boulders, and woody debris for attached mollusks. Viewing tubes and/or snorkeling were used to survey substrate surfaces in swifter and deeper water. If mud or silt substrate was present, then it was searched by excavating to a depth of up to 30 centimeters to search for sphaeriacean clams (i.e., fingernail clams or peaclams).

After the timed searches were completed, the physical habitat characteristics of each site were recorded. Recorded information included air and water temperatures, types of habitat searched (e.g., riffles, pools, runs), water depth, substrate composition and percent embeddedness, channel gradient, presence of springs or seeps, and presence of braided channel segments. If mollusks were found, then the specific microhabitat in which they were found was also recorded. In addition to aquatic mollusks, surveyors

noted terrestrial mollusk species, as well as some notable non-mollusk species observed within each study site.

5.4.1. Specimen Identification

Freshwater mussels (Superfamily Unionoidea) were identified in the field and photographed. Mussel shells, if present, were collected as voucher specimens, but no live mussels were collected. Species identifications for mussels were made based on shell morphology using Burch (1975b).

Sphaeriacean clams and aquatic gastropods were field identified to family or genus and voucher specimens were collected and preserved in 83 percent ethanol. Aquatic gastropods were relaxed using menthol prior to preservation. In the laboratory, larger specimens were removed from their shells and dissected for anatomical examination, when necessary for species identification. Identifications to family, genus, or species were made using the descriptions/keys in Burch (1975a) for sphaeriacean clams and Burch (1989) and Frest and Johannes (1999) for gastropods.

Terrestrial gastropods found during the aquatic mollusk surveys were photographed and shells were collected as vouchers. Genera were identified using the keys/descriptions in Forsythe (1999) and Burch and Pearce (1990), and species names were tentatively applied using the distributional checklist in Roth and Sadeghian (2006) and species descriptions in Pilsbry (1939), Berry (1933), and Henderson (1928).

5.5. DATA ANALYSIS

The number of live individuals (abundance) and shells of each aquatic mollusk (freshwater mussel, sphaeriacean clam, and aquatic gastropods) species counted or estimated during the surveys at each study site was summarized in tabular format. Aquatic and terrestrial mollusk diversity was determined for each bypass, peaking, and comparison study site, and by reach by averaging the total number of species within each study site over the reach. The results are summarized in tabular format.

6.0 RESULTS

6.1. SPECIAL-STATUS AQUATIC MOLLUSK SPECIES

No live specimens or shells of special-status mollusk species including California Floater, *Anodonta californiensis*; scalloped juga, *Juga (Calibasis) occata*; and Great Basin rams-horn, *Helisoma newberryi* were found at any of the study sites in the bypass, peaking, and comparison reaches.

6.2. COMMON AQUATIC MOLLUSK AND INCIDENTAL SPECIES

Aquatic mollusk species found in the study area included: (1) four bivalves—the freshwater mussel *Margaritifera falcata*, and three peaclams, *Pisidium casertanum*, *Pisidium walkeri*, and an unidentified *Pisidium* species; and (2) five gastropods—*Ferrissia rivularis, Fossaria obrussa, Juga* (*Oreobasis) nigrina, Menetus opercularis,*

and *Physella gyrina* (Table AQ 3-2). The peaclams and most of the aquatic gastropods identified in the study area are common native species that occur throughout most of North America. *Juga nigrina* is a cold water taxon characteristically found in small springs and perennial creeks in northern California and in Oregon (Burch 1989, Frest and Johannes 1999). Typical habitat where each of these species is found is summarized in Table AQ 3-2. Photographs of the common aquatic and terrestrial mollusk species found in the study area are provided in Appendix A. Mollusk habitat data collected at each study site is provided in Appendix B.

Other common invertebrates observed in the study area during the aquatic mollusk surveys included five native species of terrestrial gastropods and the signal crayfish (*Pacifastacus leniusculus*), which is not native to the Sierra Nevada drainages. The terrestrial gastropods included banana slugs (*Ariolimax* species), reticulate taildropper slugs (*Prophysaon andersoni*), sideband snails (*Monadenia* species), hesperian snails (*Vespericola* species), and western glass-snails (*Vitrina pellucida*)[3]. Appendix C shows the presence/absence of terrestrial mollusk species and crayfish at the study sites.

6.3. BYPASS, PEAKING, AND COMPARISON REACHES

Aquatic mollusks (bivalves and gastropods) were patchily distributed with low diversity and typically low abundance throughout the study area. Combined bivalve and gastropod diversity per site ranged from 0 to 4 species for all study sites, with 19 of the 26 study sites having two or fewer species present. Sixteen of the 26 study sites had combined abundances of eight or fewer individuals. The 10 sites with higher abundance (i.e., >25–1000+ individuals) were dominated by one or two species of gastropods. The abundance of bivalves was low at all sites. Table AQ 3-3 summarizes the estimated abundance of each aquatic mollusk species observed at each study site. Table AQ 3-4 lists the aquatic mollusk species found in each study site, and compares total number of species found and mean number of species per site between reaches. The distribution and abundance of aquatic bivalues and gastropods are shown on Maps AQ 3-2 and AQ 3-3, respectively. Map AQ 3-4 shows the combined bivalve and aquatic gastropod distribution and abundance.

Bivalve shells or live individuals were observed at 17 of the 26 study sites. Live bivalve specimens (four taxa of mussels and clams) were observed at 11 study sites; however, only a total of 36 individuals were found at the study sites. At six other study sites, only bivalve shells were observed. Western pearlshell mussels (*Margaritifera falcata)* (live specimens and/or shells) were found at a total of seven sites (2 peaking, 2 bypass, and 3 comparison reach sites); all of the sites were low elevation (e.g., Long Canyon Creek

[3]The banana slug, sideband snail, and hesperian snail species expected to occur in the area are *Ariolimax buttoni*, *Monadenia mormonum mormonum*, and *Vespericola orius* (Roth and Sadeghian 2006). Without anatomical and/or genetic analysis, species of these genera are difficult to distinguish. The *Ariolimax* and *Monadenia* specimens examined, however, were consistent in general shell and body characteristics with the species described above. The *Vespericola* specimens, on the other hand, were more densely hirsute (similar to the type specimens of *Vespericola pilosus*-see Henderson 1928) than specimens of *Vespericola orius* described by Berry (1933). None of the species described above has special-status designation.

and Rubicon River confluence or lower). Two *Pisidium* species, *casertanum* and *walkeri*, were scarce (3 live individuals and 3 shells total at three low elevation sites). A third *Pisidium* species that was unidentified[4] was found in low numbers (24 live specimens and 16 shells total) in eight sites that were mostly high elevation sites (MF26.2, MF44.7, MF51.8, R25.7, LC9.0, NFLC1.9, SFLC2.3, and SFLC4.2).

Gastropods (five taxa) were found at 16 of the 26 sites. Abundances of two species (*Juga (Oreobasis) nigrina* and *Physella gyrina*) were relatively high (>500 individuals) at some sites. The sites with the highest abundances (>25 individuals) were the lower elevation sites (less than about 3,800 feet elevation; Map AQ 3-3), except for the peaking reach sites. Both the higher elevations sites (elevation >3,800 feet) and the peaking reach sites had low abundances (≤7 individuals) (Map AQ 3-3).

Comparing the study results between the bypass or peaking reach study sites and the comparison reach study sites is somewhat tenuous due to the low diversity and abundance of mollusk species throughout the study area. Diversity was compared using the combined bivalve and gastropod data. Abundance was compared using only the gastropod data, as gastropods dominated the abundance at the study sites. Potential comparisons are as follows:

- Comparison river sites (NFMF0.0, NFMF2.3, NF31.3, and Otter Creek) had slightly lower observed diversity per site (3 versus 4 species) than similar elevation bypass reach study sites (MF26.2, R3.5, and LC0.0) (Table AQ 3-4 and Map AQ 3-4). Gastropod abundance at the comparison river sites was similar or possibly slightly higher than abundance at the bypass sites (higher at two sites and similar at the other site) (Table AQ 3-3 and Map AQ 3-3). Total abundance at most of the sites was determined by one gastropod species (*Physella gyrina)* that was particularly abundant (Table AQ 3-3 and Map AQ 3-3).
- Comparison river sites (NFMF0.0, NFMF2.3, NF31.3, and Otter Creek) had slightly higher observed diversity of aquatic mollusks per site (3 versus 1–2 species) than the peaking reach sites (MF4.8, MF9.1, MF14.1, MF19.1, and MF 24.1) (Tables AQ 3-4 and Map AQ 3-4). Gastropod abundance was higher in the comparison sites (50–>1000 individuals) than in the peaking reach sites (0–8 individuals) (Table AQ 3-3 and Map AQ 3-3).
- Mollusk abundance and diversity was very low both upstream and downstream of the small stream diversions (Duncan, North Fork Long Canyon, and South Fork Long Canyon creeks) and upstream and downstream of the large reservoirs (Hell Hole Reservoir and French Meadows Reservoir). Diversity ranged from 0–2 species and gastropod abundance ranged from 0–4 individuals at the study sites (Tables AQ 3-3 and AQ 3-4).

[4]Some shells of this species keyed out to *Pisidium adamsi,* but there was considerable variation in shell diagnostic characteristics that limited the efficacy of traditional morphology-based identification.

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TABLES

Table AQ 3-1. Descriptions of Aquatic Mollusk Study Sites.

Study Sites	Reach Type					Downstream Starting Location (UTM)[1]		Approximate Survey Length (m)	Elevation (ft)	Survey Times (person-hours)	Study Site Description
	Peaking Reach	Bypass Reach	Comparison Reach	Tributary Streams	Reservoir Inflow	Easting	Northing				
Middle Fork American River Downstream of Ralston Afterbay (Peaking Reach)											
MF4.8	●					675249	4310850	480	640	2.5	Middle Fork American River at Buckeye Bar
MF9.1	●					679057	4314666	400	690	4	Middle Fork American River at Driver's Flat (Ruck-a-Chucky Rapids), near Gas Canyon Creek
MF14.1	●					685681	4314189	400	820	2.5	Middle Fork American River at Otter Creek
Otter Creek				●		685765	4314137	325	825	4	Small tributary flowing into site MF 14.1 beginning upstream of Middle Fork American River high water mark
MF19.1	●					689242	4318581	650	920	4	Middle Fork American River at Volcano Creek
MF24.1	●					694893	4320305	480	1075	4	Middle Fork American River at the North Fork of the Middle Fork American River confluence
Middle Fork American River from Middle Fork Interbay to Ralston Afterbay											
MF26.2		●				696433	4320038	240	1180	2.7	Middle Fork American River from Middle Fork Interbay to Ralston Afterbay
Middle Fork American River Upstream of Middle Fork Interbay											
MF36.2		●				708273	4322431	160	2560	2	Middle Fork American River upstream of Middle Fork Interbay
MF44.7		●				716569	4329703	330	4400	4	Middle Fork American River below French Meadows Dam
MF51.8					●	724193	4334956	330	5280	4	Middle Fork American River upstream of French Meadows Reservoir at the high water mark
Rubicon River											
R3.5		●				700277	4319361	350	1390	4	Rubicon River at the Long Canyon Creek confluence
R20.9		●				717725	4314621	480	3320	4	Rubicon River from Deer Creek to Long Canyon Creek confluence
R25.7		●				720854	4320556	325	4320	2.3	Rubicon River from Hell Hole Dam to Deer Creek
R36.2					●	729446	4328848	245	4640	3.4	Rubicon River upstream of Hell Hole Reservoir at the high water mark
Five Lakes Creek											
FLC					●	729538	4329076	200	4600	3.4	Five Lakes Creek upstream of the Hell Hole Reservoir high water mark
Long Canyon Creek											
LC0.0	●					700277	4319361	160	1395	2	Long Canyon Creek about 10 meters upstream from the Rubicon River confluence
LC9.0	●					712163	4319386	326	3720	4	Long Canyon Creek downstream from confluence of North and South Forks
South Fork Long Canyon Creek											
SFLC2.3	●					717898	4324290	200	4520	3.7	South Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
SFLC4.2			●			720074	4326270	200	4760	3.7	South Fork Long Canyon Creek upstream of Diversion
North Fork Long Canyon Creek											
NFLC1.9	●					716538	4324418	160	4480	3.7	North Fork Long Canyon Creek from Diversion to confluence with Long Canyon Creek
NFLC3.8			●			718466	4326174	200	4960	3.7	North Fork Long Canyon Creek upstream of Diversion
Duncan Creek											
D6.3	●					715470	4332015	250	4780	3	Duncan Creek from Diversion to confluence with the Middle Fork American River
D9.0			●			718074	4334908	225	5280	3	Duncan Creek upstream of Diversion
North Fork of the Middle Fork American River											
NFMF0.0			●	●		695221	4320358	160	1070	2	North Fork of the Middle Fork American River about 10 meters upstream from the Middle Fork American River confluence
NFMF2.3			●	●		697269	4321654	245	1240	2	North Fork of the Middle Fork American River near Circle Bridge
North Fork American River											
NF31.3			●	●		676912	4317879	400	760	2.5	North Fork American River above Lake Clementine

[1]Universal Transverse Mercator Zone 10 North, North American Datum 1983

Table AQ 3-2. Summary of Aquatic Mollusks Found in the Study Area.

Scientific Name	Common Name	Family	Typical Habitat	Habitat Where Found	Special-Status
Bivalves (Mussels and Clams)					
Margaritifera falcata	Western pearlshell mussel	Margaritiferidae		Burrowed in sand and gravel substrate near the top of pools or in lower velocity portions of runs	No
Pisidium casertanum	Ubiquitous peaclam	Sphaeriidae	Has a nearly cosmopolitan distribution and is widely adaptable to a broad range of habitats (Burch 1975a).	Burrowed in sand/silt in edgewaters and eddies	No
Pisidium walkeri	Walker peaclam	Sphaeriidae	Typically found in creeks and rivers with slow currents and small lakes with soft mud bottoms (Burch 1975a).	Burrowed in sand/silt in edgewaters and eddies	No
Pisidium species[1]		Sphaeriidae		Burrowed in flocculent silt/organic matter permeated by spring/seep inflow along the stream margins	No
Gastropods (Aquatic Snails)					
Ferrissia rivularis	Creeping ancylid	Lymnaeidae	Aquatic pulmonate (i.e., air breathing) snails that acquire oxygen through their mantles and can thus occupy calm, warm, and often stagnant water where dissolved oxygen concentrations are low (Sturm et al. 2006).	Attached to gravels and cobbles in shallow edgewaters	No
Fossaria obrussa	Golden fossaria	Lymnaeidae		Attached to rocks or woody debris in shallow, warm edgewaters	No
Menetus opercularis (also known as Menetus callioglyptus)	Button sprite	Planorbidae		Attached to cobbles and boulders in shallow spring and tributary inflow areas	No
Physella gyrina (also known as Physa gyrina)	Tadpole physa	Physidae		Attached to rocks or woody debris in warm, low-velocity areas	No
Juga (Oreobasis) nigrina	Black juga or smooth river juga	Pleuroceridae	A prosobronch snail that has retained the ancestral gilled oxygen uptake and thus requires clean, well oxygenated waters (Sturm et al. 2006).	Attached to rocks or woody debris in flowing water or edgewaters receiving spring inflow	No

[1]Some shells of this species keyed out to *Pisidium adamsi*, but there was considerable variation in shell diagnostic characteristics that limited the efficacy of traditional morphology-based identification.

Table AQ 3-3. Mollusk Abundance by Study Site in the Bypass, Peaking, and Comparison Reaches.

Species		Aquatic Mollusks										
		Bivalves (Mussels and Clams)				Total Number of Live Bivalves	Gastropods (Aquatic Snails)					Total Number of Live Gastropods
		Margaritifera falcata	*Pisidium casertanum*	*Pisidium walkeri*	*Pisidium* species		*Ferrissia rivularis*	*Fossaria obrussa*	*Juga (Oreobasis) nigrina*	*Menetus opercularis*	*Physella gyrina*	
Middle Fork American River												
Peaking Reach	MF4.8		1 shell			**0**						**0**
	MF 9.1	1 live				**1**						**0**
	MF14.1	2 live[1]				**2**					6 live	**6**
	MF19.1		2 shells			**0**						**0**
	MF24.1					**0**				5 live	2 live	**7**
Tributary	Otter Creek	shell fragments				**0**				1 live	>500 live	**>500**
Bypass Reach	MF26.2			3 live	1 shell	**3**	4 live, 3 shells				15 - 30 live	**19 - 34**
	MF36.2					**0**			>500 live	1 live		**>500**
	MF44.7				5 live, 2 shells	**5**						**0**
Reservoir Inlet	MF51.8				1 shell	**0**						**0**
Number of Live Specimens		**1**	**0**	**3**	**5**		**4**	**0**	**>500**	**7**	**>500**	
Rubicon River												
Rubicon River Bypass Reach	R3.5	shell fragments[2]				**0**	2 live			3 live	>500 live	**>500**
	R20.9					**0**			20 - 30 live	5 live		**25 - 35**
	R25.7				2 live	**2**				3 live		**3**
Reservoir Inlet	R36.2					**0**						**0**
	FLC					**0**						**0**
Number of Live Specimens		**0**	**0**	**0**	**2**		**2**	**0**	**20 - 30**	**11**	**>500**	
Long Canyon Creek												
Downstream of Diversions (Div)	LC0.0	1 live[3]				**1**	1 live			1 live	>500 live	**>500**
	LC9.0				10 live, 10 shells	**10**				20 - 30 live		**20 - 30**
	NFLC1.9				1 live	**1**				3 live, 6 shells		**3**
	SFLC2.3				5 live, 2 shells	**5**				2 live, 3 shells		**2**
Upstream of Div	NFLC3.8					**0**						**0**
	SFLC4.2				1 live	**1**				4 live		**4**
Number of Live Specimens		**1**	**0**	**0**	**16**		**0**	**0**	**0**	**30 - 40**	**0**	

Table AQ 3-3. Mollusk Abundance by Study Site in the Bypass, Peaking, and Comparison Reaches (continued).

Species		Aquatic Mollusks										
		Bivalves (Mussels and Clams)				Total Number of Live Bivalves	Gastropods (Aquatic Snails)					Total Number of Live Gastropods
		Margaritifera falcata	*Pisidium casertanum*	*Pisidium walkeri*	*Pisidium* species		*Ferrissia rivularis*	*Fossaria obrussa*	*Juga (Oreobasis) nigrina*	*Menetus opercularis*	*Physella gyrina*	
Duncan Creek												
Downstream of Div	D6.3					**0**						**0**
Upstream of Div	D9.0					**0**						**0**
Number of Live Specimens		**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	
Comparison Rivers												
North Fork of Middle Fork American River	NFMF0.0	shell fragments[4]				**0**	6 live				>1000 live	**>1000**
	NFMF2.3					**0**	5 live		30 - 40 live		>1000 live	**>1000**
North Fork of American River	NF31.3	5 live				**5**		30 - 40 live			20 - 30 live	**50 - 70**
Number of Live Specimens		**5**	**0**	**0**	**0**		**11**	**30 - 40**	**30 - 40**	**0**	**>2000**	

[1]Incidental sightings near Otter Creek confluence in 2007.
[2]Incidental sighting of shells downstream of the Long Canyon Creek confluence in 2007.
[3]Incidental sighting of one live specimen in 2007.
[4]Incidental sighting upstream of the Middle Fork American River confluence in 2007.

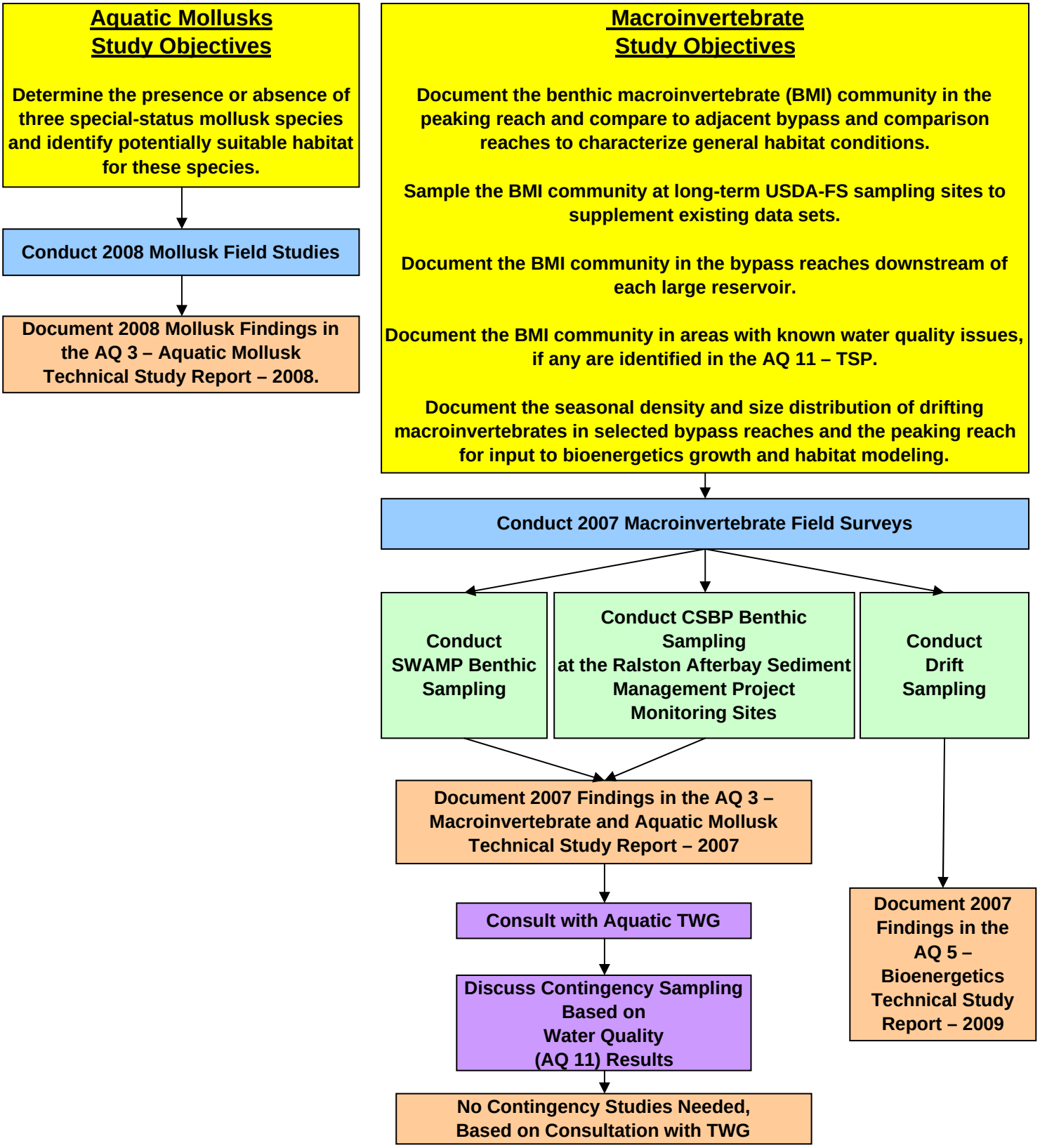
Table AQ 3-4. Aquatic Mollusk Diversity by Study Site in the Bypass, Peaking, and Comparison Reaches.

Species		Aquatic Mollusks												
		Bivalves (Mussels and Clams)				Number of Bivalve Species per Site	Gastropods (Aquatic Snails)					Number of Gastropod Species per Site	Total Number of Species per Site	Total Number of Species per Reach
		Margaritifera falcata	*Pisidium casertanum*	*Pisidium walkeri*	*Pisidium* species		*Ferrissia rivularis*	*Fossaria obrussa*	*Juga (Oreobasis) nigrina*	*Menetus opercularis*	*Physella gyrina*			
Middle Fork American River														
Peaking Reach	MF4.8		O			**1**						**0**	**1**	**4**
	MF 9.1	X				**1**						**0**	**1**	
	MF14.1	**X**				**1**					X	**1**	**2**	
	MF19.1		O			**1**						**0**	**1**	
	MF24.1					**0**				X	X	**2**	**2**	
Tributary	Otter Creek	**O**				**1**				X	X	**2**	**3**	**3**
Bypass Reach	MF26.2			X	O	**2**	X				X	**2**	**4**	**6**
	MF36.2					**0**			X	X		**2**	**2**	
	MF44.7				X	**1**						**0**	**1**	
Reservoir Inlet	MF51.8				O	**1**						**0**	**1**	**1**
Number of Sites		**3**	**2**	**1**	**3**		**1**	**0**	**1**	**3**	**4**			
Rubicon River														
Rubicon River Bypass Reach	R3.5	**O**				**1**	X			X	X	**3**	**4**	**6**
	R20.9					**0**			X	X		**2**	**2**	
	R25.7				X	**1**				X		**1**	**2**	
Reservoir Inlet	R36.2					**0**						**0**	**0**	**0**
	FLC					**0**						**0**	**0**	**0**
Number of Sites		**1**	**0**	**0**	**1**		**1**	**0**	**1**	**3**	**1**			
Long Canyon Creek														
Downstream of Diversions (Div)	LC0.0	**X**				**1**	X			X	X	**3**	**4**	**5**
	LC9.0				X	**1**				X		**1**	**2**	
	NFLC1.9				X	**1**				X		**1**	**2**	**2**
	SFLC2.3				X	**1**				X		**1**	**2**	**2**
Upstream of Div	NFLC3.8					**0**						**0**	**0**	**0**
	SFLC4.2				X	**1**				X		**1**	**2**	**2**
Number of Sites		**1**	**0**	**0**	**4**		**1**	**0**	**0**	**5**	**1**			
Duncan Creek														
Downstream of Div	D6.3					**0**						**0**	**0**	**0**
Upstream of Div	D9.0					**0**						**0**	**0**	**0**
Number of Sites		**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**			
Comparison Rivers														
North Fork of Middle Fork American River	NFMF0.0	**O**				**1**	X				X	**2**	**3**	**4**
	NFMF2.3					**0**	X		X		X	**3**	**3**	
North Fork of American River	NF31.3	X				**1**		X			X	**2**	**3**	**3**
Number of Sites		**2**	**0**	**0**	**0**		**2**	**1**	**1**	**0**	**3**			
Total in Study Area		**7**	**2**	**1**	**8**		**5**	**1**	**3**	**11**	**9**			

Notes:
X – Indicates sites where live specimens were found
O – Indicates sites where only shells were found
Bolded **O or X** indicates incidental sightings by other researchers during the 2007 aquatic studies

FIGURES

Figure AQ 3-1. Macroinvertebrate and Aquatic Mollusk Objectives and Related Study Elements and Reports.



MAPS

APPENDIX A

Photographs of Aquatic and Terrestrial Mollusks Found in the Study Area

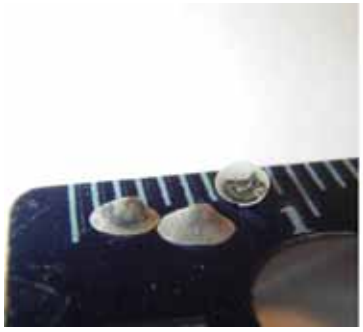
Aquatic Mollusks Found in the Study Area.


Margaritifera falcata

Pisidium casertanum

Pisidium walkeri

Pisidium species



Ferrissia rivularis

Fossaria obrussa

Physella gyrina

Juga nigrina

Menetus opercularis

Terrestrial Mollusks Found in the Study Area.

Ariolimax species

Prophysaon andersoni

Vespericola species

Monadenia species

Vitrina pellucida

APPENDIX B

Mollusk Study Site Habitat Data Summary Table

Appendix B. Mollusk Study Site Habitat Data Summary (comparison sites are shaded).

Site ID	Project-Affected Site	Date Surveyed	River Miles Searched	Total River Miles	Meters Searched	Begin Survey Time	End Survey Time	Total Survey Time	Mollusk Search Time[1]	Total Crew	Search Person Hours	Water Temp (°C)	Air Temp (°C)	Mesohabitat Units Searched (McCain Channel Type)	Springs or Seeps Present	Spring Temp (°C)	Braided Segments Present	Dominant Substrates[3]	Embeddedness (%)	Estimated Max Depth (ft)	Channel Gradient[4]	Other Species Found
MF4.8	Yes	7/29/2008	4.20 to 4.50	0.3	483	7:30	9:30	2:00	1:15	2	2.5	13	18	LGR, RUN, MCP, BPW, LSBK				BDR, COB, SND	76-100	12	0.01	signal crayfish , Sacramento sucker stranded on shore
MF9.1	Yes	8/1/2008	9.00 to 9.30	0.3	483	8:31	10:38	2:07	2:00	2	4	11.5	22.5	LGR, RUN, MCP, BWP				BDR, BLD, SND	51-75	15	0	signal crayfish, foothill yellow-legged frog (FYLF) adults
MF14.1	Yes	7/29/2008	14.00 to 14.25	0.25	402	6:15	8:15	2:00	1:15	2	2.5	11	14.5	HGR, LGR, MCP				BLD, COB	26-50	10	0.01	Western pond turtles
Otter Creek	No	8/1/2008	0 to 0.2	0.2	322	12:06	14:15	2:09	2:00	2	4	20	31	LGR, EDW, MCP				COB, GRV	0-25	4	0.03	FYLF tadpoles, chorus frog adults, signal crayfish claw
MF19.1	Yes	8/1/2008	19.10 to 19.50	0.4	644	6:10	8:15	2:05	2:00	2	4	10	18.5	HGR, LGR, MCP, LSP, SCP				BLD, COB	51-75	12	0	signal crayfish, hesperian snail shell
MF24.1	Yes	8/2/2008	24.00 to 24.30	0.3	483	5:59	8:00	2:01	1:00	4	4	9	18	LGR, EDW, MCP				BDR, GRV, SND	0-25	15	0.02	river otters, signal crayfish
MF26.2	Yes	7/29/2008	26.05 to 26.20	0.15	242	10:45	13:00	2:15	1:20	2	2.7	17	28	HGR, LGR, RUN, POW, EDW, MCP, BWP			Yes	COB, GRV	51-75	6	0.01	river otters, signal crayfish
MF36.2	Yes	7/29/2008	36.10 to 36.20	0.1	161	10:33	12:33	2:00	1:00	2	2	17.5	26.5	CAS, HGR, RUN, MCP, STP	Yes	15.5	Yes	BLD, COB	0-25	20	0.02	banana slugs
MF44.7	Yes	7/31/2008	44.70 to 44.90	0.2	322	11:00	13:03	2:03	2:00	2	4	10.5	24	CAS, HGR, LGR, EDW, PLP, MCP, STP	Yes	14.5, 17.0		BDR, BLD	76-100	15	0.05	banana and taildropper slugs, sideband snails, Western glass-snails
MF51.8	No	7/31/2008	51.80 to 52.00	0.2	322	8:17	10:18	2:01	2:00	2	4	13	21.5	LGR, EDW, MCP, BWP				BDR, BLD	51-75	3	0	
R3.5	Yes	7/28/2008	3.60 to 3.65	0.05	81	14:19	14:39	0:20	0:20	2	0.7	22.5	33	MCP				BDR, BLD	0-25	10	0.01	signal crayfish, FYLF adults and tadpoles
R3.5 (2)	Yes	7/31/2008	3.50 to 3.70	0.2	322	14:00	15:45	1:45	1:40	2	3.3	23	33.5	HGR, LGR, RUN, MCP, LSBK				BDR, BLD	26-50	10	0.01	Pacific Treefrog tadpoles, FYLF adults
R20.9	Yes	7/30/2008	20.85 to 21.15	0.3	483	13:05	15:20	2:15	2:00	2	4	16	26.5	CAS, HGR, LGR, SRN, EDW, MCP	Yes	15.5, 15.8	Yes	BDR, BLD	0-25	20	0.02	
R25.7	Yes	7/28/2008	25.65 to 25.85	0.2	322	15:06	17:07	2:01	1:10	2	2.3	14	29.5	HGR, LGR, RUN, MCP, LSP				BDR, BLD	0-25	--	0.05	
R36.2	No	7/31/2008	35.80 to 35.95	0.15	242	11:05	13:05	2:00	1:40	2	3.4	16	23.5	HGR, LGR, RUN, EDW, MCP				COB, BLD	26-50	2	0.09	newt larva
FLC	No	7/31/2008	not mapped		190	8:50	10:50	2:00	1:40	2	3.4	13	21.5	CAS, HGR, LGR, EDW, MCP				COB, BDR	26-50	2	0.03	
LC0.0	Yes	7/28/2008	0 to 0.10	0.1	161	13:13	14:23	1:10	1:00	2	2	23	33	POW, EDW, GLD				BDR, BLD	0-25	4	0.03	one FYLF adult
LC9.0	Yes	7/30/2008	8.80 to 9.00	0.2	322	9:30	12:10	2:40	2:00	2	4	15	22	HGR, LGR, RUN, MCP, BWP	Yes	No data		BDR, BLD, COB	0-25	5	0.03	California newt adult, banana and taildropper slugs, hesperian snails
SFLC2.3	Yes	8/1/2008	2.30 to 2.40	0.1	161	14:16	16:15	1:59	1:50	2	3.7	18		HGR, LGR, TRN, EDW, MCP, LSP	Yes	12.2		COB, BLD	0-25	3	0.01	newt larva
SFLC4.2	No	8/1/2008	4.20 to 4.30	0.1	161	11:45	13:51	2:06	1:50	2	3.7	14	25.5	LGR, EDW, MCP	Yes	8.0, 12.0		COB, BLD	26-50	2.5	0.03	
NFLC1.9	Yes	7/31/2008	1.90 to 2.00	0.1	161	15:56	17:57	2:01	1:50	2	3.7	15.5	23.5	HGR, LGR, EDW, MCP, STP, LSP, BWP	Yes	No data		BLD, COB	26-50	2.5	0.03	
NFLC3.8	No	7/31/2008	3.70 to 3.80	0.1	161	13:50	15:50	2:00	1:50	2	3.7	16	22	LGR, MCP				BLD, COB	51-75	2.5	0.09	
D6.3	Yes	7/30/2008	6.15 to 6.30	0.15	242	13:35	15:56	2:21	1:30	2	3	17.5	29.5	CAS, HGR, LGR, RUN, POW, EDW, MCP, PLP	Yes	8.0, 10.5		BDR, BLD	0-25	3	0.06	
D9.0	No	7/30/2008	8.90 to 9.05	0.15	242	10:32	12:42	2:10	1:30	2	3	13.5	27	CAS, LGR, POW, EDW, MCP, STP	Yes	No data		BDR, COB	0-25	3	0.08	
NFMF0.0	No	7/28/2008	0 to 0.10	0.1	161	10:20	12:20	2:00	1:00	2	2	21	28	CAS, LGR, GLD, EDW, MCP				COB, BLD	0-25	4	0.04	FYLF adults and Pacific treefrog tadpoles
NFMF2.3	No	7/28/2008	2.15 to 2.30	0.15		13:35	15:35	2:00	1:00	2	2	21	33	HGR, LGR, POW, MCP				BLD, BDR	0-25	4	0.03	
NF31.3	No	7/28/2008	30.25 to 30.5	0.25	402	9:20	11:20	2:00	1:15	2	2.5	23.5	26	LGR, POW, MCP, BWP, SCP				BLD, COB, GRV	51-75	10	0	one FYLF adult

[1]Excludes time spent scouting, recording data, and/or photographing specimens.

[2]LGR: low gradient riffle; EDW: edgewater; MCP: mid-channel pool; HGR: high gradient riffle; RUN: run; POW: pocket water; BWP: backwater pool; STP: step pool; CAS: cascade; STP: step pool; LSBK: lateral scour pool bedrock formed; SRN: step run; LSP: lateral scour pool; POW: pocket water; GLD: glide; PLP: plunge pool; SCP: secondary channel pool.

[3]BDR: bedrock; BLD: boulder; COB: cobble; GRV: gravel; SND: sand.

[4]Calculated for the length of each site surveyed using topographic map software.

APPENDIX C

Terrestrial Mollusk Diversity by Study Site in the Bypass, Peaking, and Comparison Reaches

Appendix C. Terrestrial Mollusk Diversity by Study Site in the Bypass, Peaking, and Comparison Reaches.

Species		Terrestrial Mollusks					Crayfish
		Vespericola	*Ariolimix sp.*	*Prophysaon andersoni*	*Monademia sp.*	*Vitrina pellucida*	*Pacifastacus leniusculus*
Middle Fork American River							
Peaking Reach	MF4.8						X
	MF 9.1						X
	MF14.1						
	MF19.1	X					X
	MF24.1						X
Tributary	Otter Creek						O
Bypass Reach	MF26.2						X
	MF36.2						
	MF44.7		X	X	X	X	
Reservoir Inlet	MF51.8						
Number of Sites		**1**	**1**	**1**	**1**	**1**	**6**
Rubicon River							
Rubicon River Bypass Reach	R3.5						X
	R20.9						
	R25.7						
Reservoir Inlet	R36.2						
	FLC						
Number of Sites							**1**
Long Canyon Creek							
Downstream of Diversions (Div)	LC0.0						
	LC9.0	X	X	X			
	NFLC1.9						
	SFLC2.3						
Upstream of Div	NFLC3.8						
	SFLC4.2						
Number of Sites		**1**	**1**	**1**	**0**	**0**	**0**
Duncan Creek							
Downstream of Div	D6.3						
Upstream of Div	D9.0						
Number of Sites		**0**	**0**	**0**	**0**	**0**	**0**
Comparison Rivers							
North Fork of Middle Fork American River	NFMF0.0						
	NFMF2.3						
North Fork of American River	NF31.3						
Number of Sites		**0**	**0**	**0**	**0**	**0**	**0**
Total in Study Area		**2**	**2**	**2**	**1**	**1**	**7**

Notes:
X – Indicates sites where live specimens were found
O – Indicates sites where only shells were found
Bolded **O or X** indicates incidental sightings by other researchers during the 2007 aquatic studies