Final Report

Toxic effects of surface water in the upper San Francisco Estuary on *Eurytemora affinis*

Submitted To:

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By

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Executive Summary

The objectives of this study are to 1) investigate potential effects of Delta water on survival of *Eurytemora affinis* and 2) identify potential toxicants affecting survival of *E. affinis*. On April 9, 2008, April 23, 2008, and May 7, 2008, water samples were collected in 2L amber bottles from seven sites (Suisun, Napa, 340, 405, 508, 602, and 609) in Suisun Bay, five sites (Hood, Light55, Cache-Lindsey, Cache-Ulatis, and 711) in North Delta, and four sites [815, 902, and 915 and Rough & Ready Island (RR)] in South Delta of the Upper San Francisco estuary (also known as the "Delta"). Using the standard static renewal method for acute toxicity testing, three replicates containing 20 juvenile *E. affinis* per replicate were exposed to individual field waters from 16 sites and control waters at salinity of 0, 1, 2, and 5 ppt for 96-hr at 20 ± 0.1 °C. Six water samples where survivals of *E. affinis* were significantly affected were also submitted for organic chemical and trace metal analyses. Results indicated survivals of copepods were not affected in waters collected from all seven sites in Suisun Bay (Suisun, Napa, 340, 405, 508, 602, and 609) and one site (RR) in South Delta during all three sampling events. Significant decrease in survivals of *E. affinis* were detected in water collected from: 1) 711 and Cache-Lindsey in North Delta and 815 in South Delta on April 9, 2008, 2) Hood, L55, Cache-Lindsey, and 711 in North Delta On April 23, 2008, and 3) Hood, Cache-Lindsey, L55, and 711 in North Delta and 815, 902, and 915 in South Delta On May 7, 2008 when compared to controls and to field waters collected from Suisun Bay at the end of 96 h of exposure. These results suggested that the surface waters in North and South Delta, in general, were more toxic to *E. affinis* in the month of May than in April. Among all sites, waters collected from Cache-Lindsey and 711 were consistently toxic to *E. affinis* during all three sampling events. Waters collected from Hood and 711 on April 23, 2008 were most toxic to *E. affinis*. Unionized ammonia concentrations were consistently higher in North delta than in South delta and Suisun Bay during the three sampling events. Diuron was detected in all six water samples and was the sole chemical detected in site 902. Bifenthrin was detected in Cache-Lindsey on April 23, 2008 and in 711 on April 9 and 23, 2008. Lambda Cyhalothrin was detected in Hood on April 23, 2008. Light molecular weight PAHs (LPAH) was detected in Cache-Lindsey on April 9 and high molecular weight PAHs (HAPH) was detected in Cache-Lindsey and Hood on April 23, 2008. Trace metals (arsenic, cadmium, chromium, copper, nickel, and lead) were detected but do not seem to play a role in affecting the survival of *E. affinis*. In summary, field water samples collected from North and South Delta affect the survival of *E. affinis* and no toxicity was observed in Suisun Bay. In North Delta, Ammonia, Bifenthrin, and Diuron in 711; Ammonia, Lambda Cyhalothrin, Diuron, and HPAH in Hood; Ammonia, Bifenthrin, LPAH, HPAH, and Diuron in Cache-Lindsey while in South Delta, Diuron in 902, are the likely candidate chemicals affecting the survival of *E. affinis*. Since water samples from L55, 815, and 915 were not analyzed for organic and metal chemicals, contaminant effects on these sites were not described.

Introduction

Eurytemora affinis is an important food source for higher trophic level pelagic fish such as delta smelt and longfin smelt in the San Francisco Estuary (Delta). Therefore, it is important to understand whether surface waters in the Delta are adequate for the survival of *E. affinis*. The objectives of this study are to 1) investigate potential effects of Delta water on survival of *E. affinis* and 2) identify potential toxicants affecting survival of *E. affinis*.

Experimental Details

1. Delta Water

Table 1 and Figure 1 show the 16 locations where water samples were collected during the weeks of April 9, 2008, April 23, 2008, and May 7, 2008 by the Aquatic Toxicology Laboratory (ATL) at University of California (UCD) in the upper San Francisco estuary known as Delta. These water samples were subsamples from similar water used by UCD-ATL for toxicity testing of delta smelt (*Hypomesus transpacificus*) and amphipods (*Hyalella azteca).* For simplicity, these 16 locations were grouped into seven sites in Suisun Bay (Suisun, Napa, 340, 405, 508, 602, and 609); five sites in North Delta (Hood, Light55, Cache-Lindsey, Cache-Ulatis, and 711); and four sites in South Delta (RR, 815, 902, and 915).

2. Copepods

Two brood stocks of *Eurytemora affinis*, i.e., at 2 and 5 ppt salinity, were cultured in a temperature and light controlled environmental room in Dr. Teh's laboratory. *E. affinis* were maintained at 20 ^{0}C and fed 500 µg $C.L^{-1}.day^{-1}$ equivalent of an equal mixture of highly nutritious algae *Nannochloropsis* and *Pavlova* (Reed Mariculture, San Jose, CA).

3. *Exposure*

Field water was collected in a 2L amber rectangular Nalgene bottle, stored on ice in a cooler, and transported back to UCD-ATL within 8-hr of collection. Water sample bottles were picked up by Dr. Teh from UCD-ATL and transported to Haring Hall at UCD within 24-hr of collection. Immediately after transport to the lab, 900 ml of the water from each bottle were filtered with 20 µm filters to remove large detritus materials and field copepods. Water samples were then acclimated to 20 ^{0}C in an environmental water bath. The bottles with remaining 1100 mL water were then placed in 4 ^{0}C refrigerator. To reduce osmotic stress to the *E. affinis*, salinity in each water samples were first measured and those water samples with salinity ≥ 4 ppt were tested with *E. affinis* cultured at 5 ppt and those with salinity <4 ppt were tested with *E. affinis* cultured at 2 ppt salinity. Three replicates of 20 copepods per water samples were test for 96 h in an aerated 600 mL glass beaker using the standard static renewal method for acute toxicity testing. Due to the differences in salinity of the 16 Delta waters, control groups (n= 3 replicates) at 0, 1, 2, and 5 ppt salinity were also tested. Copepods were fed with nutritious algae and 30% of the tested water was replaced at 24, 48, and 72 h with filtered field water acclimated to 20 ^{0}C. Mortalities were recorded daily for 4 days. At the end of 96 hr, the number of survivors in each beaker was counted to derive mean percentage of survival of *E. affinis* exposed to the 16 Delta waters.

4. *Water parameters and chemical analysis*

In the laboratory, all field water samples were acclimated to 20 ^{0}C and analyzed for conductivity, temperature, pH, and salinity (Table 2). Unionized ammonia was then calculated from total ammonia nitrogen measured in the field following the method of Emmerson et al., 1975 (Table 2). When water samples were found to be toxic to *E. affinis* as indicate by the presence of high mortalities as an endpoint, subsamples of the water were immediately submitted to Mr. Dave Crane at Fish and Wildlife Water Pollution Control Laboratory of California Department of Fish and Game for pesticide and metal analyses. Due to the lack of funding for UCD-ATL, only 6 water samples were submitted for chemical analysis.

Results and Discussions

The mean survival (%) of *E. affinis* exposed to the 16 Delta and 4 control waters is given in Table 3. The 48- and 96-hr survival data, which were subjected to one-way ANOVA using Tukey HSD procedure to identify the significance at 5% level (Statistica 6.1 software), are shown in Figures 2-4 and Appendix I. Figure 5 shows the comparison of *E. affinis* survivals among the three sampling events and electric conductivity. Table 4 summarizes the concentrations of organic chemicals and metals in six water samples with significantly reduced survival of *E. affinis*.

Survivals of copepods were not affected in Delta waters collected from all 7 locations in Suisun Bay (Suisun, Napa, 340, 405, 508, 602, and 609) and one location in South Delta (RR) during the three sampling events, i.e., on April 9, 2008; April 23, 2008; and May 7, 2008 (Tables 1-2; Figures 1-4). Except for RR which had salinity ranging from (0.5 to 1.5 ppt), all water samples from Suisun Bay have salinity above 3 ppt. There were no significance difference in survival rate of *E. affinis* exposed to field waters with salinity ranging from 0.5 to 16 ppt and controls indicated that *E. affinis* can survive a wide range of salinity. Although growth and behavior were not determined, *E. affinis* seems to grow darker, bigger, and more fecund (number of eggs per female) within 96hr of exposure to Suisun and Napa water than those exposed to controls and other field Delta water samples (observation concurred by Lu Min, Ching Teh, Sarah Lesmeister, and Swee Teh). Perhaps, the presence of abundant nutritious food in Napa and Suisun waters are the major factors affecting the favorable growth and reproductive performance of *E. affinis*. The darker appearance of *E. affinis* in these locations suggests that they either consumed fine detritus materials or have developed a coloration to match the water turbidity in Napa and Suisun.

On April 9, 2008, water samples collected from two locations in North Delta [CL (47%), 711 (20%)] and one location in South Delta [815 (58%)] had significantly reduced *E. affinis* survival when compared to controls at the end of 96 hr of exposure (Table 3; Figure 2). On April 23, 2008, reduced survival of copepods were increased to four sampling locations in North Delta [Hood (5%), L55 (33%), CL (28%), and 711 (17%)] when compared to controls at the end of 96 hr of exposure (Table 3; Figure 3). On May 7, 2008, reduced survival of *E. affinis* were further increased to four locations in North Delta [Hood (42%), CL (60%), L55 (70%), 711 (32%)] and three locations in South Delta [815 (52%), 902 (43%), and 915 (65%)] when compared to control at the end of 96 hr of exposure (Table 3; Figure 4). Among all sites, waters collected from Cache-Lindsey and 711 were consistently toxic to *E. affinis* during the three sampling events and waters collected from Hood and 711 on April 23, 2008 were most toxic to *E. affinis* where 95-100% mortalities in 2 of 3 replicate beakers were observed. Furthermore, results also suggested that surface waters in North and South Delta, in general, were more toxic to *E. affinis* in the month of May than in April.

Figure 5 compares the *E. affinis* survival among all three sampling events. Results indicated that waters collected on April 23, 2008 in the North Delta, i.e., on Hood, Light55, Cache-Lindsey, and 711, in general, were more toxic to *E. affinis* than waters collected during April 9, 2008 and May 7, 2008. In contrary, waters collected on May 9, 2008 in South Delta (815 and 902) were more toxic to *E. affinis* than waters collected on April 9 and 23, 2008. When we compared electric conductivity within a location during the three sampling events to the survival of *E. affinis*, we observed small variations in conductivity but large variations in the survival of *E. affinis* suggesting the presence of other stressors in the water column that are affecting the survival of *E affinis* (Figure 5). We have not confirmed if *E. affinis* is sensitive to low EC as both 711 and Hood have the lowest EC and survivals compared to other water samples during the three sampling events (Figure 5). However, because of the high survival with low EC (180 μS/cm) in Hood samples on April 9, 2008, we speculated that EC alone is unlikely to affect *E. affinis* survival. These results further lead us to believe that EC in combination with other contaminants may have likely contributed to low *E. affinis* survival in Hood and 711.

Unionized ammonia concentrations were consistently higher in North delta than in South delta and Suisun Bay during the three sampling events (Table 2). Unionized ammonia concentrations were found to be highest in water samples collected from Hood (0.025 mg/L) and 711 (0022 mg/L) on April 9, 2008 (Table 2), however survivals of *E. affinis* were not affected in Hood but were significantly affected in 711 in water samples collected on April 9, 2008 (Figure 2; Table 3). On the other hand, while survival of *E. affinis* were 3X lower in Hood (5% survival) than in 711 (17% survival) on April 23, 2008 (Table 3), the unionized ammonia concentration in 711 (0.029 mg/L) was 3x higher than the concentration found in Hood (0.009 mg/L) suggested that other stressors in combination with unionized ammonia in Hood may have affected the survival of *E. affinis*. The dynamic equilibrium between ammonia (NH_3) and ammonium (NH_4+) is affected by water temperature and pH. For example, at a pH of six (slightly acidic) the ratio of ammonia to ammonium is 1 to 3000 but decreases to 1 to 30 when the pH rises to eight (slightly alkaline). Warm water will contain more toxic ammonia than cooler water. Although ammonia toxicity is largely controlled by temperature and pH, other variables such as dissolved oxygen and salinity can also affect ammonia toxicity. Since dissolved oxygen and temperature were maintained constantly under current laboratory condition and there are little differences in electric conductivity and salinity in waters collected from Hood and 711, these results strongly suggest that contaminants in addition to unionized ammonia, are affecting *E. affinis* survival in Hood. It should be noted that the toxicity of ammonia is apparently species specific for invertebrates and fish and is reportedly less sensitive in invertebrate than in fish species (USEPA 1986). Flow-through tests determined that ammonia was acutely toxic to 19 freshwater invertebrate species at concentrations ranging from 0.53 to 22.8 mg/L, whereas ammonia toxicity to 29 fish species ranges from 0.083 to 4.60 mg/L (USEPA 1986). Although the highest concentration of unionized ammonia detected in this study was approximately 4 to 50 fold less than the concentrations that cause 50% survival in fish and invertebrate, the chronic effect of exposure to 0.025 mg/L ammonia on fish growth and survival have been reported (Smith and Piper, 1975). Since copepods are less sensitive to ammonia than fish, it is suggested that future ammonia study should focus on sublethal and chronic effects of ammonia exposure on resident native and sport fish in the north delta between Hood and 711.

The following discussion will mainly focus on chemicals detected from six water samples submitted for chemical analysis. Please note that it is not the intention of this pilot study to provide detailed backgrounds of all chemicals detected in the water. Since mixtures of pollutants may have antagonistic or synergistic effects to an aquatic organism, separating the effects of different contaminants in the water is difficult especially for metallic and organic pollutants at concentrations below the toxic threshold levels. Where possible, only those that are likely to affect *E. affinis* survival will be described here.

Three categories of organic chemicals [carbamate pesticides (Diuron), pyrethroid pesticides (Bifenthrin and Lambda Cyhalothrin), and polycyclic aromatic hydrocarbons (PAHs)], and several trace metals (arsenic, cadmium, chromium, copper, nickel, and lead) were examined and detected among the six water samples (Table 4). No organophosphate pesticides were detected (Table 4). Please note that all organic chemical and trace metal concentrations detected were 100 folds or more below the LC50 values reported by other investigators (Readers who are interested in LC50 values of *E. affinis* are encouraged to go to EPA AQIRE database at http://www.pesticideinfo.org/List_AquireAll.jsp?Species=649). Although trace metals can be toxic if present in high concentrations, low levels are necessary for health maintenance, Since trace metals were detected at very low concentrations in all six sites, it is difficult to correlate specific trace metals to *E. affinis* survival. On the hand, carbamate and pyrethroid pesticides, and PAHs are anthropogenic chemicals and based on the significantly low *E. affinis* survivals at sites where these chemicals were also detected, we speculate that organic chemicals although present below LC50 levels, may have played a significant role in the high mortality of *E. affinis* as demonstrated in this study.

Diuron is a carbamate herbicide that is used commonly to control a wide variety of annual and perennial broadleaf and grassy weeds, Bifenthrin and Lambda cyhalothrin are two of several chemical isomers used in the formulation of pyrethroid pesticides to control a wide range of insects in agricultural fields, residences, public and commercial buildings, animal facilities, warehouses, and greenhouses. Polyaromatic hydrocarbons (PAHs) are grouped into two classes: low molecular weight PAHs (LPAH) and high molecular weight PAHs (HPAH) and are ubiquitous pollutants and carcinogens that are common constituents of complex mixtures such as automobile exhausts, petroleum refining and crude oil. Please note that HPAH are more toxic and carcinogenic than LPAH. Table 4 showed that Diuron was detected in all six water samples and was the sole chemical detected in site 902. Bifenthrin (0.001 µg/L) was detected in Cache-Lindsey on April 23, 2008 and in 711 on April 9 and 23, 2008. Lambda Cyhalothrin (0.001 µg/L) was detected in Hood on April 23, 2008. In Cache-Lindsey, LPAH was detected on April 9 and HPAH was detected on April 23, 2008. HPAH was also detected in Hood on April 23, 2008 (Table 4). Therefore, it is suggested that Diuron in sites 711, Cache-Lindsey, Hood, and 902; Bifenthrin in sites 711 and Cache-Lindsey; Lambda Cyhalothrin in Hood; LPAH in Cache-Lindsey; and HPAH in Cache-Lindsey and Hood are likely the candidate chemicals affecting the survival of *E. affinis*.

In summary, water collected from: 1) 711 and Cache-Lindsey in North Delta and 815 in South Delta on April 9, 2008, 2) Hood, L55, Cache-Lindsey, and 711 in North Delta On April 23, 2008, and 3) Hood, Cache-Lindsey, L55, and 711 in North Delta and 815, 902, and 915 in South Delta on May 7, 2008 are affecting the survival of *E. affinis*. Among all sites, waters collected from Cache-Lindsey and 711 were consistently toxic during the three sampling events and waters collected from Hood and 711 on April 23, 2008 were most toxic to *E. affinis*. Ammonia, Bifenthrin, and Diuron in 711; Ammonia, Lambda Cyhalothrin, Diuron, and HPAH in Hood; Ammonia, Bifenthrin, LPAH, HPAH, and Diuron in Cache-Lindsey; and Diuron in 902 are the likely candidate chemicals for affecting the survival of *E. affinis.* Whether these chemicals work additively or synergistically to enhance their toxic effects on *E. affinis* is unknown. It should be noted that water samples from L55, 815, and 915 were not analyzed for organic and metal chemicals; therefore, contaminant effects on these sites were not described.

Recommendations

There are several issues that were encountered during this pilot study:

1. The comparison of 48 hr and 96 hr one-way ANOVA test of *E. affinis* is shown in Appendix I. These tests indicated that a 48 hr test is as sensitive as 96 hr in evaluating the results of *E. affinis* survival. Since a short duration of toxicity testing of surface water is more relevant to the "pulse exposure scenario" that occurs in aquatic environments, I strongly recommended a 48 hr toxicity testing for all future copepods study.
2. It is unknown why *E. affinis* populations decline and *Pseudidiaptomus forbesi,* the other important prey species for larval and juvenile delta smelt populations, increase in the summer. Currently, there is no study investigating whether the growth and survival of *P. forbesi*, are also affected by the contaminants in the surface water. Since results of this study indicated that surface waters are more toxic in May than in April month, additional field water toxicity study using both copepod species is warranted. Also, changes in water qualities such as salinity, conductivity, and temperature can affect the results of laboratory toxicity testing of field water. A robust copepod culture facility is required to maintain copepods at different salinity and conductivity to reduce osmotic stress to copepods during the field water toxicity testing. Global warming has been suggested as a threat to aquatic organism survival, the tolerance of copepods to temperature stress need to be assessed. It is also necessary to correlate the sites where significant toxic effects were observed in laboratory toxicity testing with the zooplankton community survey by California Department of Fish and Games to provide better understanding of the significance of the contaminant effects on zooplankton population.
3. Chemical analysis is costly and can be a limiting factor in the success of laboratory toxicity testing of field water. Therefore, future laboratory field water toxicity testing should work in close conjunction with State Water Regional Resources Board surface water monitoring program to minimize cost of chemical analysis.
4. Finally, toxic effects of contaminants and bioaccumulation of contaminants can be species specific; therefore fish may be more sensitive to unionized ammonia and less sensitive to carbamate pesticides than copepods. Based on the initial results of this study where all contaminant concentrations are below the toxic threshold levels for *E. affinis*, a literature review is needed to better evaluate the chronic effects of ammonia, carbamate and pyrethroid pesticides, and polycyclic aromatic hydrocarbons on copepods and fish. A

laboratory exposure study may be needed to verify the additive or synergistic effects of ammonia and pesticides-contaminated field water to growth and survival of *E. affinis* and *P. forbesi*. Critical life stages (larvae and juvenile) of fish currently experiencing declines in the Delta (e.g. delta smelt, striped bass, threadfin shad, and Sacramento splittail) rely upon zooplankton for food. A combined monitoring of contaminants and diseases among threatened fish species at locations where the above contaminants were found is warranted.

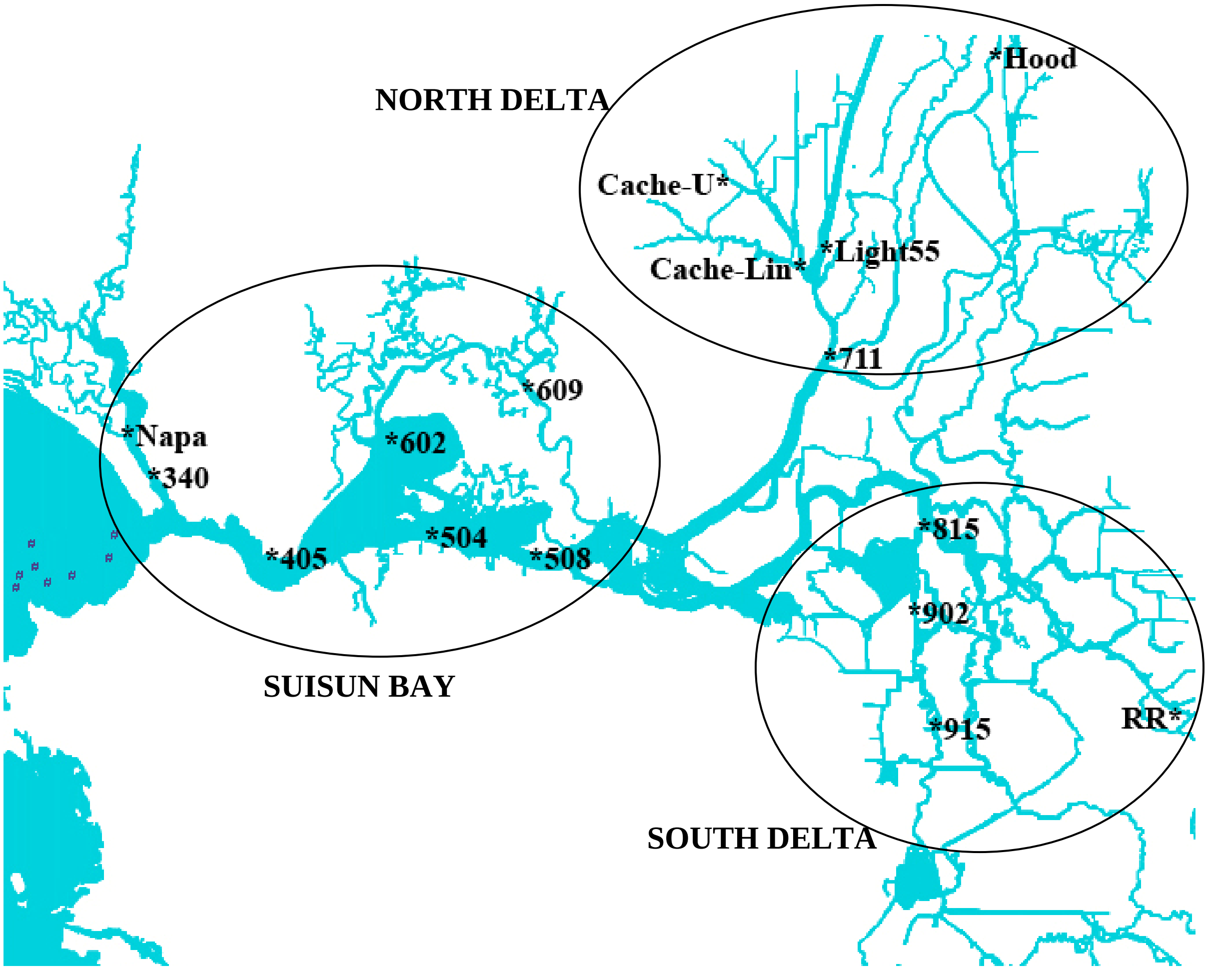
References

1. Emmerson, K., R. C. Russo, R. E. Lund, and R. V. Thurston, 1975: Aqueous ammonia equilibrium calculations effect of pH and temperature. J. Fish Res. Board Canada 32, 2379-2383.
2. Smith, CE and Piper, RG, 1975: Lesions Associated with Chronic Exposure to Ammonia The Pathology of Fishes, W. E. Ribelin, ed., The University of Wisconsin Press, Madison, Wisconsin, p 497-514.
3. U.S. Environmental Protection Agency. 1986. Quality criteria for water 1986. EPA 440/5-86-001. Washington, DC.
4. EPA AQIRE database http://www.pesticideinfo.org/List_AquireAll.jsp?Species=649.

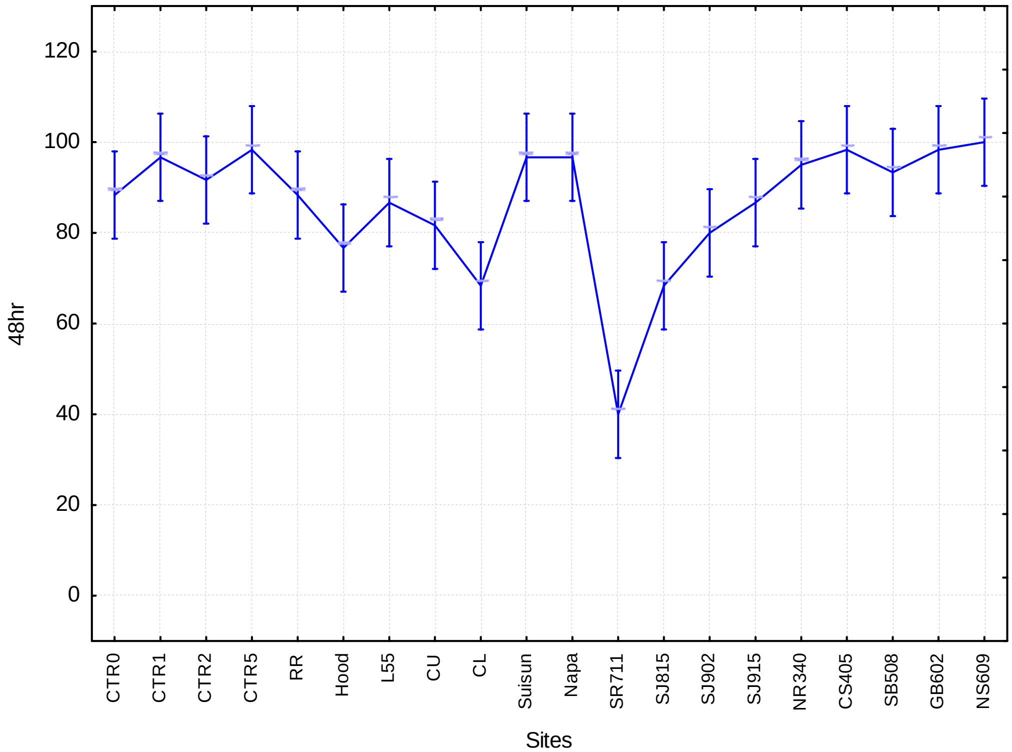
Table 1. Site locations

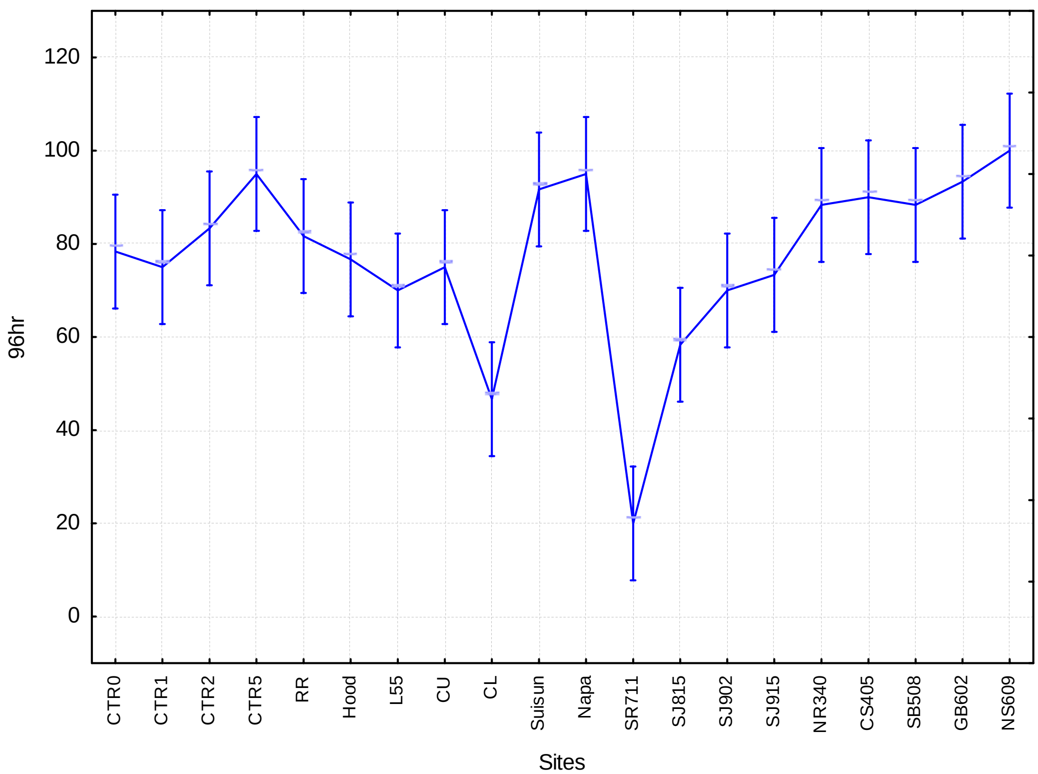
Station	Location	Latitude	Longitude
340	Napa River, Historic 340 at the seawall	38-05’-51”N	122-15’-43.9”W
405	Carquinez Straight, just west of Benicia arm dock	38-02’-22.9”N	122-09’-01.8”W
Suisun (504)	Suisun Slough downstream of Boynton Slough	38-12’-28.2”N	122-01’56.9”W
508	Suisun Bay, off Chipps Island, opposite Sac. North Ferry Slip	38-02’-43.8”N	121-55’-07.7”W
602	Grizzly Bay, northeast of Suisun Slough at Dolphin	38-06’-50.4”N	122-55’-46.3”W
609	Montezuma Slough at Nurse Slough	38-10’-01.9”N	121.56’-16.8”W
711	Sacramento River at the tip of Grand Island	38-10’-43.7”N	121-56’-55.1”W
Light 55	Sacramento River Deep Water Channel at Light 55	38-16’-26.5”N	121-39’-13.6”W
Hood	DWR water quality monitoring station	38-22’-03.6”N	121-31’-13.6”W
Cache-Lin	Confluence of Lindsey Slough/Cache Slough	38-14’-39.2”N	121-41’-19.5”W
Cache-U	Upper Cache Slough, mouth of Ulatis Creek	38-17’-02.7”N	121-43’-04.3”W
815	San Joaquin, Confluence of Potato Slough	38-17’-01.5”N	121-34’-21.5”W
902	Old River at mouth of Holland Cut	38-01’-09.1”N	121-34’-55.9”W
915	Old River, western arm at railroad bridge	37-56’-33”N	121-33’-48.6”W
RR	San Joaquin, Rough & Ready Island	37-57'-45.4" N	121- 21' 56.0"W
Napa	Napa River in Napa City at end of River Park Blvd.	38-16’-39.7”N	122-16’-56.9”W

Figure 1 Water Sampling Locations for *Eurytemora affinis* Toxicity Testing

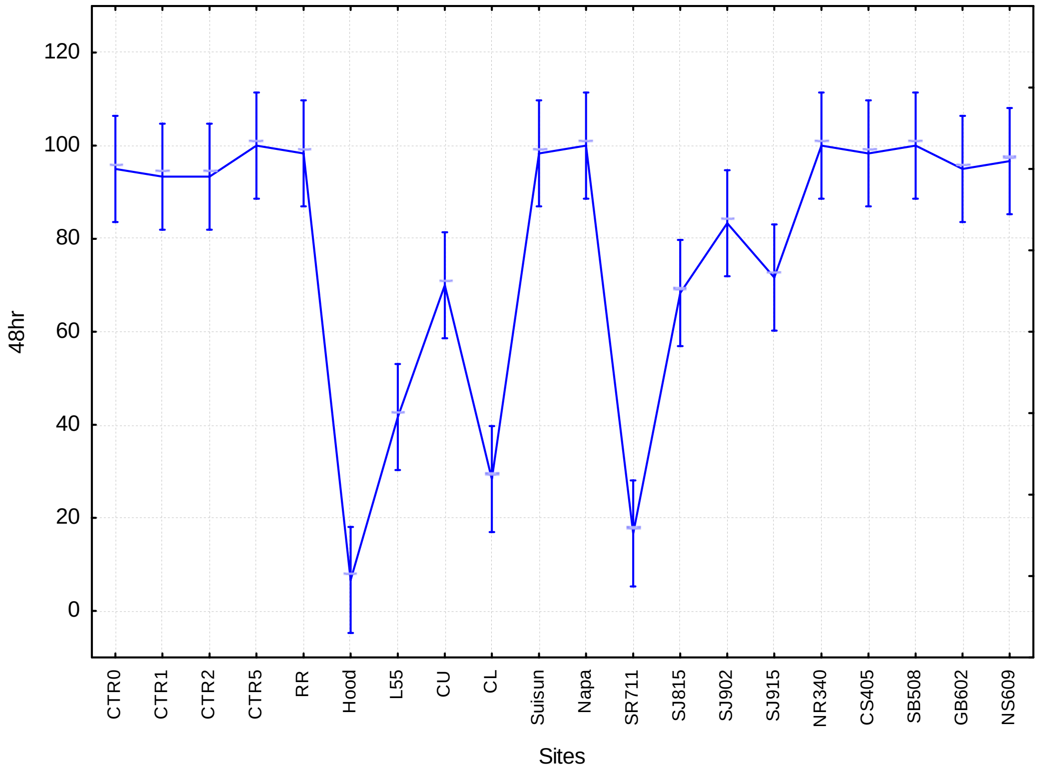


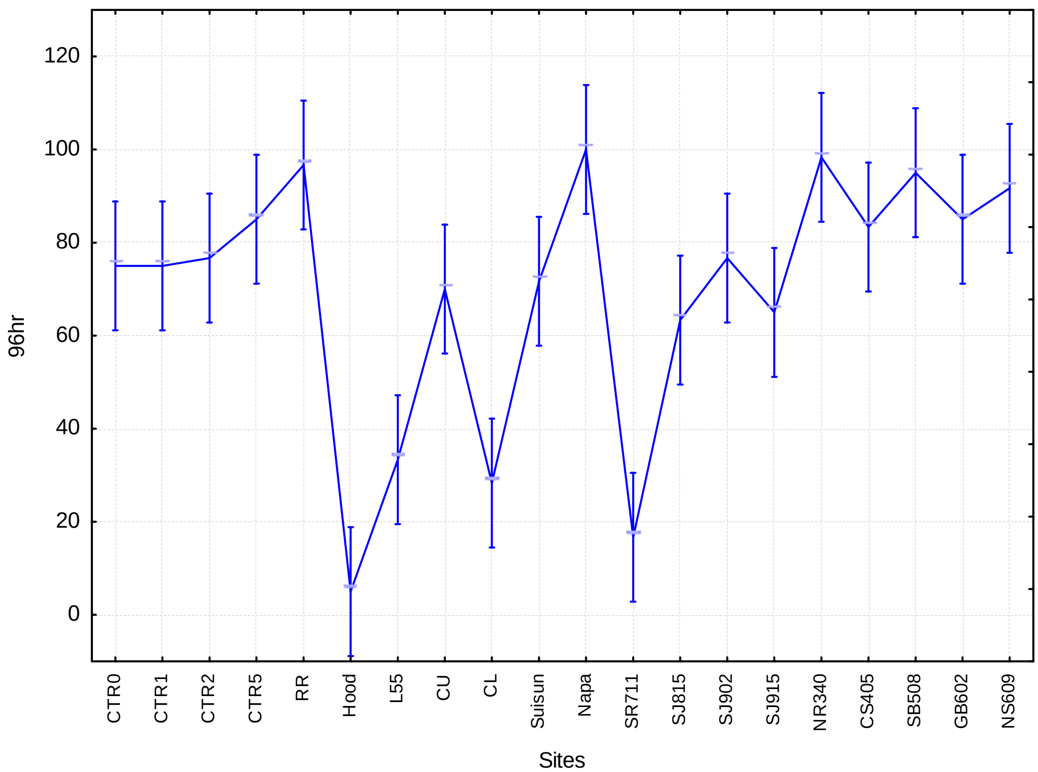
Figures 2A and 2B Survival of *Eurytemora affinis* exposed to April 9, 2008 Delta water (Vertical bars denote 0.95 confidence intervals)



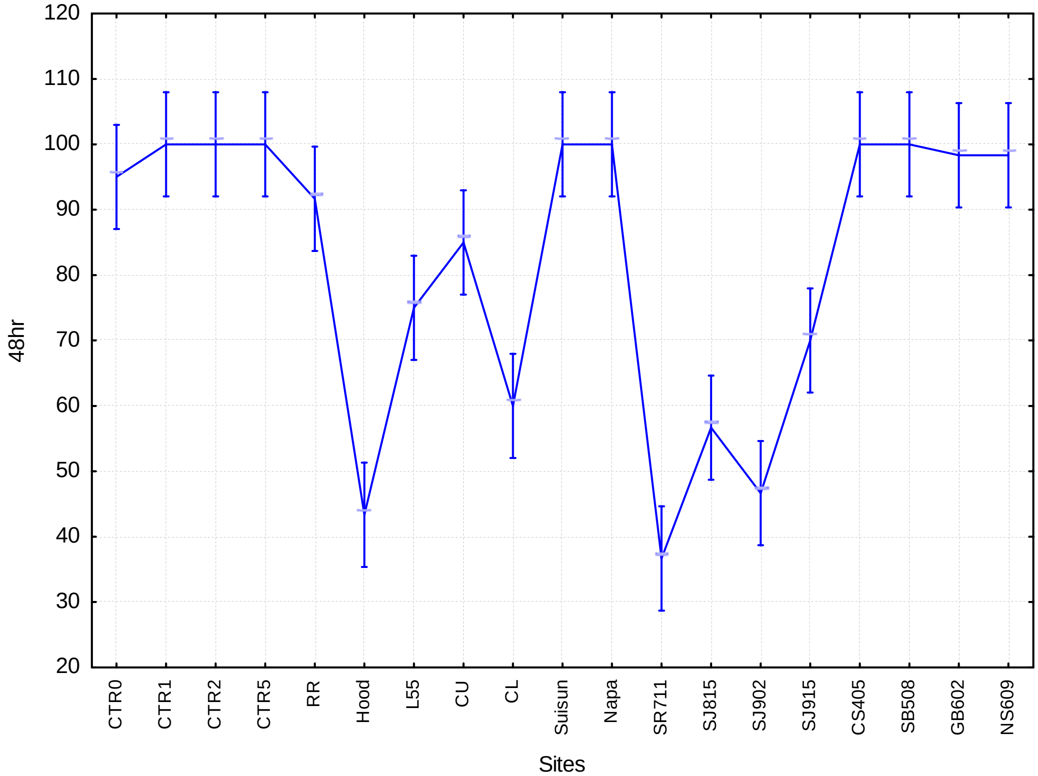


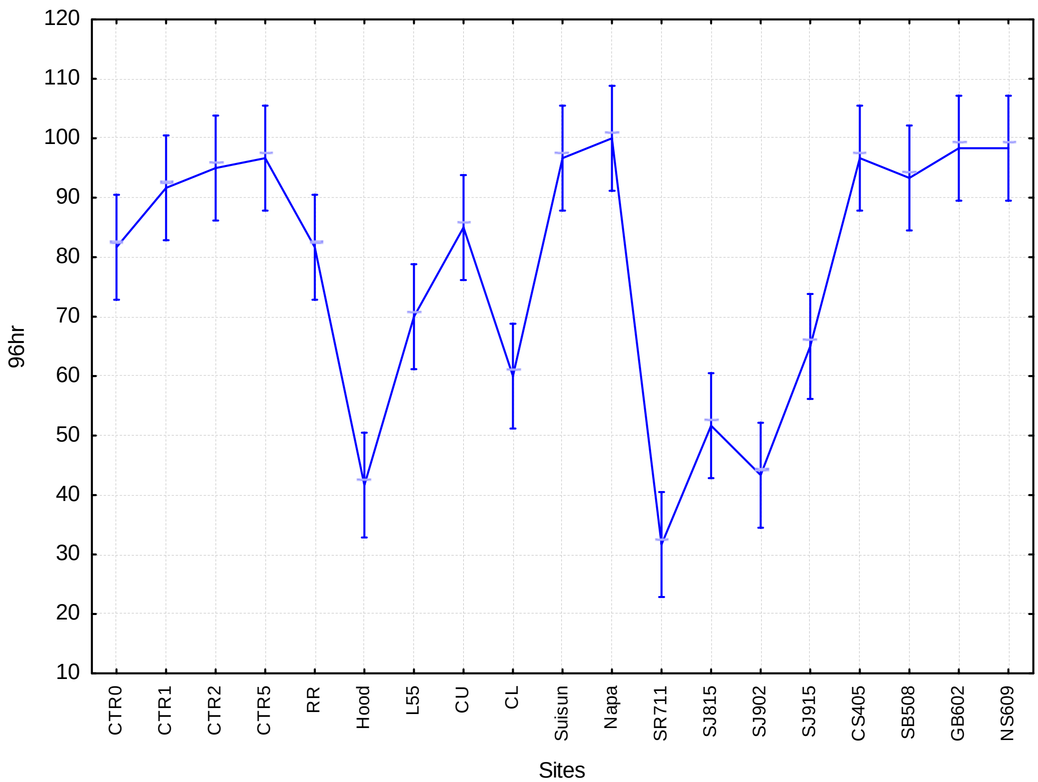
Figures 3A and 3B Survival of *Eurytemora affinis* exposed to April 23, 2008 Delta water (Vertical bars denote 0.95 confidence intervals)





Figures 4A and 4B Survival of *Eurytemora affinis* exposed to May 7, 2008 Delta water (Vertical bars denote 0.95 confidence intervals)





Figures 5 Comparison of *E. affinis* survival at 48 and 96 hr based on electric conductivity of the Delta water (Vertical bars denote 0.95 confidence intervals)

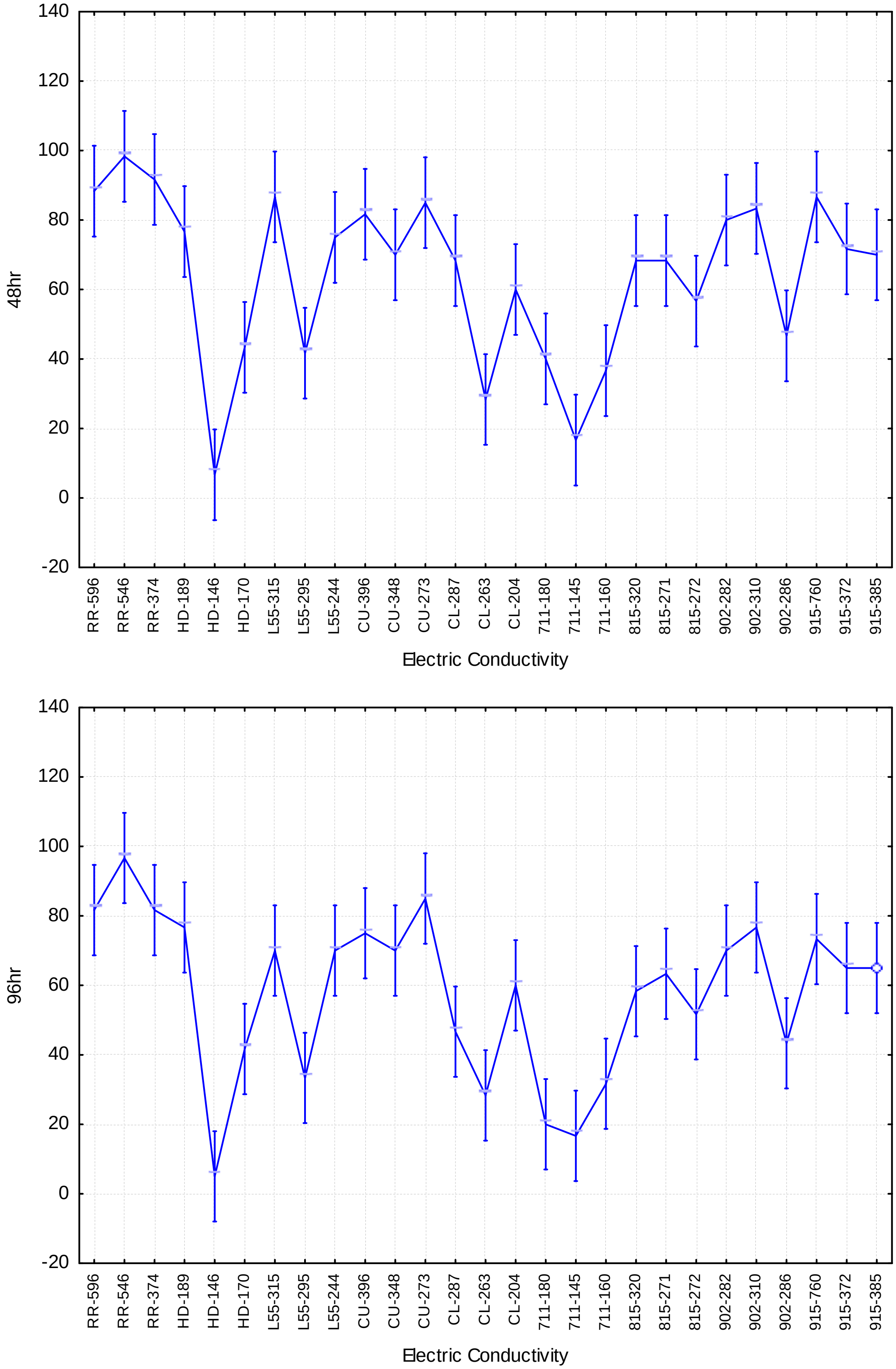


Table 2 Water chemistry at 20 ^{0}C under laboratory conditions

Dates and Locations	SC(µS/cm)	pH	*T(^{0}C)	S (ppt)	TAN(mg/L)	**AF	UA (mg/L)
April 9, 2008							
Control	280	8.20	20.0	0.0	0.000	0.060	0.000
Rough & Ready	596	7.97	16.1	1.5	0.070	0.036	0.003
Hood	189	8.05	16.4	0.0	0.590	0.043	0.025
Light 55	315	8.24	14.4	1.5	0.150	0.065	0.010
Cache-Ulatis	396	8.31	14.3	1.5	0.030	0.075	0.002
Cache- Lindsey	287	8.23	14.4	1.5	0.210	0.064	0.013
711	180	8.06	15.7	0.0	0.500	0.044	0.022
815	320	8.29	15.3	0.0	0.010	0.072	0.001
902	282	8.30	15.8	0.0	0.000	0.074	0.000
915	760	8.20	16.1	0.0	0.000	0.060	0.000
April 23, 2008							
Control	280	8.20	20.0	0.0	0.000	0.060	0.000
Rough & Ready	546	7.89	17.7	1.5	0.170	0.031	0.005
Hood	146	7.75	16.8	1.5	0.400	0.022	0.009
Light 55	295	8.36	15.9	0.0	0.130	0.083	0.011
Cache-Ulatis	348	8.40	15.0	1.5	0.040	0.091	0.004
Cache- Lindsey	263	8.29	15.5	1.0	0.170	0.072	0.012
711	145	8.15	16.6	1.0	0.530	0.054	0.029
815	271	8.28	16.1	2.0	0.060	0.071	0.004
902	310	8.22	15.9	3.0	0.020	0.062	0.001
915	372	8.17	16.4	2.5	0.040	0.056	0.002
May 7, 2008							
Control	280	8.20	20.0	0.0	0.000	0.060	0.000
Rough & Ready	374	7.86	20.1	0.5	0.050	0.029	0.001
Hood	170	7.81	20.8	1.5	0.340	0.026	0.009
Light 55	244	7.85	17.9	0.0	0.230	0.028	0.006
Cache-Ulatis	273	8.13	17.4	0.0	0.150	0.051	0.008
Cache- Lindsey	204	7.96	17.8	1.5	0.310	0.036	0.011
711	160	7.72	18.8	1.5	0.500	0.021	0.011
815	272	7.78	18.8	0.0	0.120	0.024	0.003
902	286	7.74	18.5	0.5	0.020	0.022	0.000
915	385	7.69	18.3	1.5	0.040	0.020	0.001

*C=conductivity, S=salinity, TAN=total ammonia nitrogen, UIA=unionized ammonia, * T = temperature measured in the filed, **Appropriate Factor (AF) was calculated according to Emmerson et al., 1975.*

Table 4 Concentrations of organic chemicals in the 6 water samples

Sample Identification Date Collected	711 April 9, 2008	CL April 9, 2008	711 April 23, 2008	CL April 23, 2008	HOOD April 22, 2008	902 May 12, 2008
Organophosphate Pesticides	**ppb (ug/L)**	**ppb (ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb (ug/L)**
Azinphos methyl	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND
Dimethoate	ND	ND	ND	ND	ND	ND
Disulfoton	ND	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND	ND
Methidathion	ND	ND	ND	ND	ND	ND
Parathion, Methyl	ND	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND	ND
Phosmet	ND	ND	ND	ND	ND	ND
Pyrethroid Pesticides by GC/ECD	**ppb (ug/L)**	**ppb (ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb (ug/L)**	**Ppb(ug/L)**
Bifenthrin	**0.001**	ND	**0.001**	**0.001**	ND	ND
Cyfluthrin	ND	ND	ND	ND	ND	ND
Cypermethrin	ND	ND	ND	ND	ND	ND
Deltamethrin	ND	ND	ND	ND	ND	ND
Esfenvalerate/Fenvalerate	ND	ND	ND	ND	ND	ND
Fenpropathrin	ND	ND	ND	ND	ND	ND
Lambda Cyhalothrin	ND	ND	ND	ND	**0.001**	ND
Permethrin, Cis	ND	ND	ND	ND	ND	ND
Permethrin, Trans	ND	ND	ND	ND	ND	ND
Carbamate Pesticides	**ppb (ug/L)**	**ppb (ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**
Aldicarb	ND	ND	ND	ND	ND	ND
Captan	ND	ND	ND	ND	ND	ND
Carbaryl	ND	ND	0.003	ND	ND	ND
Carbofuran	ND	ND	ND	ND	ND	ND
Diuron	**0.041**	**0.086**	**0.060**	**0.060**	**0.087**	**0.057**
Linuron	ND	ND	ND	ND	ND	ND
Methiocarb	ND	ND	ND	ND	ND	ND
Methomyl	ND	ND	ND	0.004	ND	ND
Fipronil + Metabolites	**ppb (ug/L)**	**ppb (ug/L)**	**Ppb (ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**
Fipronil	ND	ND	ND	ND	ND	ND
Fipronil Desulfinyl	ND	ND	ND	ND	ND	ND
Fipronil Sulfide	ND	ND	ND	ND	ND	ND
Fipronil Sulfone	ND	ND	ND	ND	ND	ND

Polycyclic Aromatic Hydrocarbons (PAHs)	**ppb(ug/L)**	**ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**
			Low molecular weight PAHs			
Naphthalene	ND	**0.047**	ND	ND	ND	ND
Methylnaphthalene, 2-	ND	**0.014**	ND	ND	ND	ND
Methylnaphthalene, 1-	ND	**0.008**	ND	ND	ND	ND
Naphthalenes, C1 -	ND	**0.023**	ND	ND	ND	ND
Naphthalenes, C2 -	ND	**0.014**	ND	ND	ND	ND
			High molecular weight PAHs			
Fluoranthene	ND	ND	ND	**0.011**	**0.005**	ND
Fluoranthene/Pyrenes, C1 -	ND	ND	ND	**0.010**	ND	ND
Pyrene	ND	ND	ND	**0.009**	ND	ND
Benz(a)anthracene	ND	ND	ND	**0.007**	ND	ND
Chrysene	ND	ND	ND	**0.007**	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	**0.017**	**0.008**	ND
Benzo(e)pyrene	ND	ND	ND	**0.010**	ND	ND
Benzo(a)pyrene	ND	ND	ND	**0.010**	ND	ND
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	**0.012**	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	**0.012**	ND	ND
Trace Metals	**ppb(ug/L)**	**ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**	**Ppb(ug/L)**
Silver	<0.001	0.002	0.005	<0.001	-	<0.001
Aluminum	206	771	398	1421	-	613
Arsenic	2.03	2.60	1.93	2.46	-	2.69
Cadmium	0.025	0.035	0.016	0.017	-	0.02
Chromium	2.46	6.11	1.62	4.25	-	2.91
Copper	3.01	4.10	2.16	4.41	-	3.47
Manganese	26.3	37.6	24.9	43.3	-	26.7
Nickel	2.21	5.41	2.22	6.75	-	3.53
Lead	0310	0.56	0.21	0.62	-	1.31
Selenium	<0.45	<0.45	<0.45	<0.45	-	<0.45
Zinc	7.04	6.52	2.43	6.50	-	3.91

Table 3 Mean survival (%) of *E. affinis* exposed to delta water

April 9, 2008

Sampling Locations	24h	48h	72h	96h
Lab control 1 (0ppt)*	93	88	78	78
Lab Control 2 (1ppt)	97	97	93	75
Lab Control 3 (2ppt)	95	92	92	83
Hood (0ppt)	85	77	77	77
711 (0ppt)	58	40	38	20
Cache-Lindsey (1.5ppt)	82	68	57	47
Cache-Ulatis (1.5 ppt)	93	82	82	75
Light55 (1.5ppt)	90	87	87	70
Rough & Ready (1.5ppt)	100	88	82	82
815 (0ppt)	68	68	68	58
902 (0ppt)	82	80	77	70
915 (0ppt)	95	87	78	73
508 (5ppt)	93	93	93	88
Lab Control 4 (5ppt)	100	98	98	95
602 (5ppt)	98	98	95	93
609 (6ppt)	100	100	100	100
Suisun (3ppt)	100	97	95	92
Napa (4ppt)	100	97	95	95
405 (12ppt)	98	98	98	90
340 (16ppt)	97	95	93	88

April 23, 2008

Sampling Locations	24h	48h	72h	96h
Lab control 1 (0ppt)	100	95	80	75
Lab Control 2 (1ppt)	100	98	93	83
Lab Control 3 (2ppt)	97	93	80	77
Hood (1.5ppt)	12	7	5	5
711 (1ppt)	17	17	17	17
Cache-Lindsey (1ppt)	32	28	28	28
Cache-Ulatis (1.5 ppt)	70	70	70	70
Light55 (0ppt)	48	42	37	33
Rough & Ready (1.5ppt)	98	98	97	97
815 (2ppt)	72	68	63	63
915 (2.5ppt)	85	72	68	65
902 (3ppt)	87	83	77	77
508 (3.5ppt)	100	100	98	95
Lab Control 4 (5ppt)	100	100	88	85
602 (5ppt)	100	95	87	85
609 (5ppt)	100	97	97	92
Suisun (5ppt)	100	98	87	72
Napa (6ppt)	100	100	100	100
405 (7.5ppt)	100	98	87	83
340 (15ppt)	100	100	98	98

May 7, 2008

Sampling Locations	24h	48h	72h	96h
Lab control 1 (0ppt)	97	95	92	82
Lab Control 2 (1ppt)	100	100	95	92
Lab Control 3 (2ppt)	100	100	100	95
Hood (1.5ppt)	57	43	42	42
711 (1.5ppt)	58	37	35	32
Cache-Lindsey (1.5ppt)	63	60	60	60
Cache-Ulatis (0.5 ppt)	88	85	85	85
Light55 (0.5ppt)	78	75	72	70
Rough & Ready (0.5ppt)	93	92	88	82
815 (0ppt)	68	57	53	52
902 (0.5ppt)	53	47	43	43
915 (1.5ppt)	88	70	68	65
508 (4ppt)	93	93	93	88
Lab Control 4 (5ppt)	100	100	100	97
602 (10ppt)	98	98	98	98
609 (5ppt)	98	98	98	98
Suisun (4.5ppt)	100	100	100	97
Napa (6.5ppt)	100	100	100	100
405 (12ppt)	100	100	97	97
340**				

*Parentheses indicate salinity of the water samples. ** Water was not collected by UCD-ATL because of high salinity*

APPENDIX I One-way ANOVA using Tukey HSD procedure to identify the significance at 5% level of *Eurytemora affinia* survival.

April 9, 2008 48hr Survival

Tukey HSD test; variable 48hr (apr9.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 67.917, df = 40.000

	Sites	{1} 88.3	{2} 76.7	{3} 86.7	{4} 81.7	{5} 68.3	{6} 96.7	{7} 96.7	{8} 68.3	{9} 80.0	{10} 86.7	{11} 40.0	{12} 95.0	{13} 98.3	{14} 93.3	{15} 98.3	{16} 100.	{17} 96.7	{18} 88.3	{19} 91.7	{20} 98.3
1	RR		0.9634	1.0000	1.0000	0.2943	0.9991	0.9991	0.2943	0.9991	1.0000	0.0002	1.0000	0.9922	1.0000	0.9922	0.9634	0.9991	1.0000	1.0000	0.9922
2	Hood	0.9634		0.9922	1.0000	0.9991	0.2943	0.2943	0.9991	1.0000	0.9922	0.0006	0.4397	0.1835	0.6063	0.1835	0.1077	0.2943	0.9634	0.7670	0.1835
3	L55	1.0000	0.9922		1.0000	0.4397	0.9922	0.9922	0.4397	1.0000	1.0000	0.0002	0.9991	0.9634	1.0000	0.9634	0.8913	0.9922	1.0000	1.0000	0.9634
4	CU	1.0000	1.0000	1.0000		0.8913	0.7670	0.7670	0.8913	1.0000	1.0000	0.0002	0.8913	0.6063	0.9634	0.6063	0.4397	0.7670	1.0000	0.9922	0.6063
5	CL	0.2943	0.9991	0.4397	0.8913		0.0166	0.0166	1.0000	0.9634	0.4397	0.0166	0.0321	0.0083	0.0600	0.0083	0.0041	0.0166	0.2943	0.1077	0.0083
6	Suisun	0.9991	0.2943	0.9922	0.7670	0.0166		1.0000	0.0166	0.6063	0.9922	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9991	1.0000	1.0000
7	Napa	0.9991	0.2943	0.9922	0.7670	0.0166	1.0000		0.0166	0.6063	0.9922	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9991	1.0000	1.0000
8	SJ815	0.2943	0.9991	0.4397	0.8913	1.0000	0.0166	0.0166		0.9634	0.4397	0.0166	0.0321	0.0083	0.0600	0.0083	0.0041	0.0166	0.2943	0.1077	0.0083
9	SJ902	0.9991	1.0000	1.0000	1.0000	0.9634	0.6063	0.6063	0.9634		1.0000	0.0003	0.7670	0.4397	0.8913	0.4397	0.2943	0.6063	0.9991	0.9634	0.4397
10	SJ915	1.0000	0.9922	1.0000	1.0000	0.4397	0.9922	0.9922	0.4397	1.0000		0.0002	0.9991	0.9634	1.0000	0.9634	0.8913	0.9922	1.0000	1.0000	0.9634
11	SR711	0.0002	0.0006	0.0002	0.0002	0.0166	0.0002	0.0002	0.0166	0.0003	0.0002		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
12	NR340	1.0000	0.4397	0.9991	0.8913	0.0321	1.0000	1.0000	0.0321	0.7670	0.9991	0.0002		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	CS405	0.9922	0.1835	0.9634	0.6063	0.0083	1.0000	1.0000	0.0083	0.4397	0.9634	0.0002	1.0000		1.0000	1.0000	1.0000	1.0000	0.9922	1.0000	1.0000
14	SB508	1.0000	0.6063	1.0000	0.9634	0.0600	1.0000	1.0000	0.0600	0.8913	1.0000	0.0002	1.0000	1.0000		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	GB602	0.9922	0.1835	0.9634	0.6063	0.0083	1.0000	1.0000	0.0083	0.4397	0.9634	0.0002	1.0000	1.0000	1.0000		1.0000	1.0000	0.9922	1.0000	1.0000
16	NS609	0.9634	0.1077	0.8913	0.4397	0.0041	1.0000	1.0000	0.0041	0.2943	0.8913	0.0002	1.0000	1.0000	1.0000	1.0000		1.0000	0.9634	0.9991	1.0000
17	CTR1	0.9991	0.2943	0.9922	0.7670	0.0166	1.0000	1.0000	0.0166	0.6063	0.9922	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000		0.9991	1.0000	1.0000
18	CTR0	1.0000	0.9634	1.0000	1.0000	0.2943	0.9991	0.9991	0.2943	0.9991	1.0000	0.0002	1.0000	0.9922	1.0000	0.9922	0.9634	0.9991		1.0000	0.9922
19	CTR2	1.0000	0.7670	1.0000	0.9922	0.1077	1.0000	1.0000	0.1077	0.9634	1.0000	0.0002	1.0000	1.0000	1.0000	1.0000	0.9991	1.0000	1.0000		1.0000
20	CTR5	0.9922	0.1835	0.9634	0.6063	0.0083	1.0000	1.0000	0.0083	0.4397	0.9634	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9922	1.0000	

April 9, 2008 96hr Survival

Tukey HSD test; variable 96hr (apr9.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 109.58, df = 40.000

	Sites	{1} 81.7	{2} 76.7	{3} 70.0	{4} 75.0	{5} 46.7	{6} 91.7	{7} 95.0	{8} 58.3	{9} 70.0	{10} 73.3	{11} 20.0	{12} 88.3	{13} 90.0	{14} 88.3	{15} 93.3	{16} 100.	{17} 75.0	{18} 78.3	{19} 83.3	{20} 95.0
1	RR		1.0000	0.9970	1.0000	0.0226	0.9996	0.9869	0.4362	0.9970	1.0000	0.0002	1.0000	1.0000	1.0000	0.9970	0.8146	1.0000	1.0000	1.0000	0.9869
2	Hood	1.0000		1.0000	1.0000	0.0978	0.9592	0.8146	0.8146	1.0000	1.0000	0.0002	0.9970	0.9869	0.9970	0.9034	0.4362	1.0000	1.0000	1.0000	0.8146
3	L55	0.9970	1.0000		1.0000	0.4362	0.5666	0.3197	0.9970	1.0000	1.0000	0.0003	0.8146	0.6979	0.8146	0.4362	0.0978	1.0000	1.0000	0.9869	0.3197
4	CU	1.0000	1.0000	1.0000		0.1506	0.9034	0.6979	0.9034	1.0000	1.0000	0.0002	0.9869	0.9592	0.9869	0.8146	0.3197	1.0000	1.0000	1.0000	0.6979
5	CL	0.0226	0.0978	0.4362	0.1506		0.0009	0.0004	0.9970	0.4362	0.2238	0.2238	0.0026	0.0015	0.0026	0.0006	0.0002	0.1506	0.0616	0.0133	0.0004
6	Suisun	0.9996	0.9592	0.5666	0.9034	0.0009		1.0000	0.0378	0.5666	0.8146	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	0.9034	0.9869	1.0000	1.0000
7	Napa	0.9869	0.8146	0.3197	0.6979	0.0004	1.0000		0.0133	0.3197	0.5666	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	0.6979	0.9034	0.9970	1.0000
8	SJ815	0.4362	0.8146	0.9970	0.9034	0.9970	0.0378	0.0133		0.9970	0.9592	0.0077	0.0978	0.0616	0.0978	0.0226	0.0026	0.9034	0.6979	0.3197	0.0133
9	SJ902	0.9970	1.0000	1.0000	1.0000	0.4362	0.5666	0.3197	0.9970		1.0000	0.0003	0.8146	0.6979	0.8146	0.4362	0.0978	1.0000	1.0000	0.9869	0.3197
10	SJ915	1.0000	1.0000	1.0000	1.0000	0.2238	0.8146	0.5666	0.9592	1.0000		0.0002	0.9592	0.9034	0.9592	0.6979	0.2238	1.0000	1.0000	0.9996	0.5666
11	SR711	0.0002	0.0002	0.0003	0.0002	0.2238	0.0002	0.0002	0.0077	0.0003	0.0002		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
12	NR34(	1.0000	0.9970	0.8146	0.9869	0.0026	1.0000	1.0000	0.0978	0.8146	0.9592	0.0002		1.0000	1.0000	1.0000	0.9970	0.9869	0.9996	1.0000	1.0000
13	CS405	1.0000	0.9869	0.6979	0.9592	0.0015	1.0000	1.0000	0.0616	0.6979	0.9034	0.0002	1.0000		1.0000	1.0000	0.9996	0.9592	0.9970	1.0000	1.0000
14	SB508	1.0000	0.9970	0.8146	0.9869	0.0026	1.0000	1.0000	0.0978	0.8146	0.9592	0.0002	1.0000	1.0000		1.0000	0.9970	0.9869	0.9996	1.0000	1.0000
15	GB602	0.9970	0.9034	0.4362	0.8146	0.0006	1.0000	1.0000	0.0226	0.4362	0.6979	0.0002	1.0000	1.0000	1.0000		1.0000	0.8146	0.9592	0.9996	1.0000
16	NS609	0.8146	0.4362	0.0978	0.3197	0.0002	1.0000	1.0000	0.0026	0.0978	0.2238	0.0002	0.9970	0.9996	0.9970	1.0000		0.3197	0.5666	0.9034	1.0000
17	CTR1	1.0000	1.0000	1.0000	1.0000	0.1506	0.9034	0.6979	0.9034	1.0000	1.0000	0.0002	0.9869	0.9592	0.9869	0.8146	0.3197		1.0000	1.0000	0.6979
18	CTR(	1.0000	1.0000	1.0000	1.0000	0.0616	0.9869	0.9034	0.6979	1.0000	1.0000	0.0002	0.9996	0.9970	0.9996	0.9592	0.5666	1.0000		1.0000	0.9034
19	CTR2	1.0000	1.0000	0.9869	1.0000	0.0133	1.0000	0.9970	0.3197	0.9869	0.9996	0.0002	1.0000	1.0000	1.0000	0.9996	0.9034	1.0000	1.0000		0.9970
20	CTR5	0.9869	0.8146	0.3197	0.6979	0.0004	1.0000	1.0000	0.0133	0.3197	0.5666	0.0002	1.0000	1.0000	1.0000	1.0000	1.0000	0.6979	0.9034	0.9970	

April 23, 2008 48hr Survival

Tukey HSD test; variable 48hr (apr23.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 95.417, df = 40.000

	Sites	{1} 95.0	{2} 93.3	{3} 93.3	{4} 100	{5} 98.3	{6} 6.7	{7} 41.7	{8} 70.0	{9} 28.3	{10} 98.3	{11} 100	{12} 16.7	{13} 68.3	{14} 83.3	{15} 71.7	{16} 100	{17} 98.3	{18} 100	{19} 95.0	{20} 96.7
1	CTR0		1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.2176	0.0002	1.0000	1.0000	0.0002	0.1416	0.9934	0.3193	1.0000	1.0000	1.0000	1.0000	1.0000
2	CTR1	1.0000		1.0000	1.0000	1.0000	0.0002	0.0002	0.3193	0.0002	1.0000	1.0000	0.0002	0.2176	0.9990	0.4448	1.0000	1.0000	1.0000	1.0000	1.0000
3	CTR2	1.0000	1.0000		1.0000	1.0000	0.0002	0.0002	0.3193	0.0002	1.0000	1.0000	0.0002	0.2176	0.9990	0.4448	1.0000	1.0000	1.0000	1.0000	1.0000
4	CTR5	1.0000	1.0000	1.0000		1.0000	0.0002	0.0002	0.0536	0.0002	1.0000	1.0000	0.0002	0.0315	0.8430	0.0886	1.0000	1.0000	1.0000	1.0000	1.0000
5	RR	1.0000	1.0000	1.0000	1.0000		0.0002	0.0002	0.0886	0.0002	1.0000	1.0000	0.0002	0.0536	0.9270	0.1416	1.0000	1.0000	1.0000	1.0000	1.0000
6	Hood	0.0002	0.0002	0.0002	0.0002	0.0002		0.0101	0.0002	0.4448	0.0002	0.0002	0.9990	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
7	L55	0.0002	0.0002	0.0002	0.0002	0.0002	0.0101		0.0886	0.9739	0.0002	0.0002	0.2176	0.1416	0.0010	0.0536	0.0002	0.0002	0.0002	0.0002	0.0002
8	CU	0.2176	0.3193	0.3193	0.0536	0.0886	0.0002	0.0886		0.0010	0.0886	0.0536	0.0002	1.0000	0.9739	1.0000	0.0536	0.0886	0.0536	0.2176	0.1416
9	CL	0.0002	0.0002	0.0002	0.0002	0.0002	0.4448	0.9739	0.0010		0.0002	0.0002	0.9934	0.0017	0.0002	0.0006	0.0002	0.0002	0.0002	0.0002	0.0002
10	Suisun	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.0886	0.0002		1.0000	0.0002	0.0536	0.9270	0.1416	1.0000	1.0000	1.0000	1.0000	1.0000
11	Napa	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.0536	0.0002	1.0000		0.0002	0.0315	0.8430	0.0886	1.0000	1.0000	1.0000	1.0000	1.0000
12	SR711	0.0002	0.0002	0.0002	0.0002	0.0002	0.9990	0.2176	0.0002	0.9934	0.0002	0.0002		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
13	SJ815	0.1416	0.2176	0.2176	0.0315	0.0536	0.0002	0.1416	1.0000	0.0017	0.0536	0.0315	0.0002		0.9270	1.0000	0.0315	0.0536	0.0315	0.1416	0.0886
14	SJ902	0.9934	0.9990	0.9990	0.8430	0.9270	0.0002	0.0010	0.9739	0.0002	0.9270	0.8430	0.0002	0.9270		0.9934	0.8430	0.9270	0.8430	0.9934	0.9739
15	SJ915	0.3193	0.4448	0.4448	0.0886	0.1416	0.0002	0.0536	1.0000	0.0006	0.1416	0.0886	0.0002	1.0000	0.9934		0.0886	0.1416	0.0886	0.3193	0.2176
16	NR340	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.0536	0.0002	1.0000	1.0000	0.0002	0.0315	0.8430	0.0886		1.0000	1.0000	1.0000	1.0000
17	CS405	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.0886	0.0002	1.0000	1.0000	0.0002	0.0536	0.9270	0.1416	1.0000		1.0000	1.0000	1.0000
18	SB508	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.0536	0.0002	1.0000	1.0000	0.0002	0.0315	0.8430	0.0886	1.0000	1.0000		1.0000	1.0000
19	GB602	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.2176	0.0002	1.0000	1.0000	0.0002	0.1416	0.9934	0.3193	1.0000	1.0000	1.0000		1.0000
20	NS609	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.0002	0.1416	0.0002	1.0000	1.0000	0.0002	0.0886	0.9739	0.2176	1.0000	1.0000	1.0000	1.0000	

April 23, 2008 96hr Survival

Tukey HSD test; variable 96hr (apr23.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 140.83, df = 40.000

	Sites	{1} 75.0	{2} 75.0	{3} 76.7	{4} 85.0	{5} 96.7	{6} 5.00	{7} 33.3	{8} 70.0	{9} 28.3	{10} 71.7	{11} 100	{12} 16.7	{13} 63.3	{14} 76.7	{15} 65.0	{16} 98.3	{17} 83.3	{18} 95.0	{19} 85.0	{20} 91.7
1	CTR0		1.0000	1.0000	0.9999	0.7629	0.0002	0.0130	1.0000	0.0030	1.0000	0.5358	0.0002	0.9994	1.0000	0.9999	0.6529	1.0000	0.8554	0.9999	0.9660
2	CTR1	1.0000		1.0000	0.9999	0.7629	0.0002	0.0130	1.0000	0.0030	1.0000	0.5358	0.0002	0.9994	1.0000	0.9999	0.6529	1.0000	0.8554	0.9999	0.9660
3	CTR2	1.0000	1.0000		1.0000	0.8554	0.0002	0.0080	1.0000	0.0019	1.0000	0.6529	0.0002	0.9967	1.0000	0.9994	0.7629	1.0000	0.9234	1.0000	0.9879
4	CTR5	0.9999	0.9999	1.0000		0.9994	0.0002	0.0008	0.9879	0.0003	0.9967	0.9879	0.0002	0.7629	1.0000	0.8554	0.9967	1.0000	0.9999	1.0000	1.0000
5	RR	0.7629	0.7629	0.8554	0.9994		0.0002	0.0002	0.4221	0.0002	0.5358	1.0000	0.0002	0.1146	0.8554	0.1661	1.0000	0.9967	1.0000	0.9994	1.0000
6	Hood	0.0002	0.0002	0.0002	0.0002	0.0002		0.3202	0.0002	0.6529	0.0002	0.0002	0.9994	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
7	L55	0.0130	0.0130	0.0080	0.0008	0.0002	0.3202		0.0506	1.0000	0.0327	0.0002	0.9660	0.2343	0.0080	0.1661	0.0002	0.0012	0.0002	0.0008	0.0002
8	CU	1.0000	1.0000	1.0000	0.9879	0.4221	0.0002	0.0506		0.0130	1.0000	0.2343	0.0005	1.0000	1.0000	1.0000	0.3202	0.9967	0.5358	0.9879	0.7629
9	CL	0.0030	0.0030	0.0019	0.0003	0.0002	0.6529	1.0000	0.0130		0.0080	0.0002	0.9994	0.0770	0.0019	0.0506	0.0002	0.0004	0.0002	0.0003	0.0002
10	Suisun	1.0000	1.0000	1.0000	0.9967	0.5358	0.0002	0.0327	1.0000	0.0080		0.3202	0.0004	1.0000	1.0000	1.0000	0.4221	0.9994	0.6529	0.9967	0.8554
11	Napa	0.5358	0.5358	0.6529	0.9879	1.0000	0.0002	0.0002	0.2343	0.0002	0.3202		0.0002	0.0506	0.6529	0.0770	1.0000	0.9660	1.0000	0.9879	1.0000
12	SR711	0.0002	0.0002	0.0002	0.0002	0.0002	0.9994	0.9660	0.0005	0.9994	0.0004	0.0002		0.0030	0.0002	0.0019	0.0002	0.0002	0.0002	0.0002	0.0002
13	SJ815	0.9994	0.9994	0.9967	0.7629	0.1146	0.0002	0.2343	1.0000	0.0770	1.0000	0.0506	0.0030		0.9967	1.0000	0.0770	0.8554	0.1661	0.7629	0.3202
14	SJ902	1.0000	1.0000	1.0000	1.0000	0.8554	0.0002	0.0080	1.0000	0.0019	1.0000	0.6529	0.0002	0.9967		0.9994	0.7629	1.0000	0.9234	1.0000	0.9879
15	SJ915	0.9999	0.9999	0.9994	0.8554	0.1661	0.0002	0.1661	1.0000	0.0506	1.0000	0.0770	0.0019	1.0000	0.9994		0.1146	0.9234	0.2343	0.8554	0.4221
16	NR340	0.6529	0.6529	0.7629	0.9967	1.0000	0.0002	0.0002	0.3202	0.0002	0.4221	1.0000	0.0002	0.0770	0.7629	0.1146		0.9879	1.0000	0.9967	1.0000
17	CS405	1.0000	1.0000	1.0000	1.0000	0.9967	0.0002	0.0012	0.9967	0.0004	0.9994	0.9660	0.0002	0.8554	1.0000	0.9234	0.9879		0.9994	1.0000	1.0000
18	SB508	0.8554	0.8554	0.9234	0.9999	1.0000	0.0002	0.0002	0.5358	0.0002	0.6529	1.0000	0.0002	0.1661	0.9234	0.2343	1.0000	0.9994		0.9999	1.0000
19	GB602	0.9999	0.9999	1.0000	1.0000	0.9994	0.0002	0.0008	0.9879	0.0003	0.9967	0.9879	0.0002	0.7629	1.0000	0.8554	0.9967	1.0000	0.9999		1.0000
20	NS609	0.9660	0.9660	0.9879	1.0000	1.0000	0.0002	0.0002	0.7629	0.0002	0.8554	1.0000	0.0002	0.3202	0.9879	0.4221	1.0000	1.0000	1.0000	1.0000	

May 7, 2008 48hr Survival

Tukey HSD test; variable 48hr (may7.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 46.491, df = 38.000

	Sites	{1} 95.0	{2} 100	{3} 100	{4} 100	{5} 91.7	{6} 43.3	{7} 75.0	{8} 85.0	{9} 60.0	{10} 100	{11} 100	{12} 36.7	{13} 56.7	{14} 46.7	{15} 70.0	{16} 100	{17} 100	{18} 98.3	{19} 98.3
1	CTR0		1.0000	1.0000	1.0000	1.0000	0.0002	0.0768	0.9405	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0075	1.0000	1.0000	1.0000	1.0000
2	CTR1	1.0000		1.0000	1.0000	0.9889	0.0002	0.0075	0.4392	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0007	1.0000	1.0000	1.0000	1.0000
3	CTR2	1.0000	1.0000		1.0000	0.9889	0.0002	0.0075	0.4392	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0007	1.0000	1.0000	1.0000	1.0000
4	CTR5	1.0000	1.0000	1.0000		0.9889	0.0002	0.0075	0.4392	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0007	1.0000	1.0000	1.0000	1.0000
5	RR	1.0000	0.9889	0.9889	0.9889		0.0002	0.2692	0.9991	0.0004	0.9889	0.9889	0.0002	0.0002	0.0002	0.0369	0.9889	0.9889	0.9991	0.9991
6	Hood	0.0002	0.0002	0.0002	0.0002	0.0002		0.0004	0.0002	0.2692	0.0002	0.0002	0.9991	0.6391	1.0000	0.0032	0.0002	0.0002	0.0002	0.0002
7	L55	0.0768	0.0075	0.0075	0.0075	0.2692	0.0004		0.9405	0.4392	0.0075	0.0075	0.0002	0.1497	0.0014	1.0000	0.0075	0.0075	0.0169	0.0169
8	CU	0.9405	0.4392	0.4392	0.4392	0.9991	0.0002	0.9405		0.0075	0.4392	0.4392	0.0002	0.0014	0.0002	0.4392	0.4392	0.4392	0.6391	0.6391
9	CL	0.0002	0.0002	0.0002	0.0002	0.0004	0.2692	0.4392	0.0075		0.0002	0.0002	0.0169	1.0000	0.6391	0.9405	0.0002	0.0002	0.0002	0.0002
10	Suisun	1.0000	1.0000	1.0000	1.0000	0.9889	0.0002	0.0075	0.4392	0.0002		1.0000	0.0002	0.0002	0.0002	0.0007	1.0000	1.0000	1.0000	1.0000
11	Napa	1.0000	1.0000	1.0000	1.0000	0.9889	0.0002	0.0075	0.4392	0.0002	1.0000		0.0002	0.0002	0.0002	0.0007	1.0000	1.0000	1.0000	1.0000
12	SR711	0.0002	0.0002	0.0002	0.0002	0.0002	0.9991	0.0002	0.0002	0.0169	0.0002	0.0002		0.0768	0.9405	0.0002	0.0002	0.0002	0.0002	0.0002
13	SJ815	0.0002	0.0002	0.0002	0.0002	0.0002	0.6391	0.1497	0.0014	1.0000	0.0002	0.0002	0.0768		0.9405	0.6391	0.0002	0.0002	0.0002	0.0002
14	SJ902	0.0002	0.0002	0.0002	0.0002	0.0002	1.0000	0.0014	0.0002	0.6391	0.0002	0.0002	0.9405	0.9405		0.0169	0.0002	0.0002	0.0002	0.0002
15	SJ915	0.0075	0.0007	0.0007	0.0007	0.0369	0.0032	1.0000	0.4392	0.9405	0.0007	0.0007	0.0002	0.6391	0.0169		0.0007	0.0007	0.0014	0.0014
16	CS405	1.0000	1.0000	1.0000	1.0000	0.9889	0.0002	0.0075	0.4392	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0007		1.0000	1.0000	1.0000
17	SB508	1.0000	1.0000	1.0000	1.0000	0.9889	0.0002	0.0075	0.4392	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0007	1.0000		1.0000	1.0000
18	GB602	1.0000	1.0000	1.0000	1.0000	0.9991	0.0002	0.0169	0.6391	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0014	1.0000	1.0000		1.0000
19	NS609	1.0000	1.0000	1.0000	1.0000	0.9991	0.0002	0.0169	0.6391	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0014	1.0000	1.0000	1.0000	

May 7, 2008 96hr Survival

Tukey HSD test; variable 96hr (may7.sta)
Approximate Probabilities for Post Hoc Tests
Error: Between MS = 57.018, df = 38.000

	Sites	{1} 81.7	{2} 91.7	{3} 95.0	{4} 96.7	{5} 81.7	{6} 41.7	{7} 70.0	{8} 85.0	{9} 60.0	{10} 96.7	{11} 100	{12} 31.7	{13} 51.7	{14} 43.3	{15} 65.0	{16} 96.7	{17} 93.3	{18} 98.3	{19} 98.3
1	CTR0		0.9756	0.7852	0.6136	1.0000	0.0002	0.9109	1.0000	0.0920	0.6136	0.2791	0.0002	0.0026	0.0002	0.4335	0.6136	0.9109	0.4335	0.4335
2	CTR1	0.9756		1.0000	1.0000	0.9756	0.0002	0.0920	0.9998	0.0013	1.0000	0.9963	0.0002	0.0002	0.0002	0.0118	1.0000	1.0000	0.9998	0.9998
3	CTR2	0.7852	1.0000		1.0000	0.7852	0.0002	0.0242	0.9756	0.0004	1.0000	1.0000	0.0002	0.0002	0.0002	0.0026	1.0000	1.0000	1.0000	1.0000
4	CTR5	0.6136	1.0000	1.0000		0.6136	0.0002	0.0118	0.9109	0.0003	1.0000	1.0000	0.0002	0.0002	0.0002	0.0013	1.0000	1.0000	1.0000	1.0000
5	RR	1.0000	0.9756	0.7852	0.6136		0.0002	0.9109	1.0000	0.0920	0.6136	0.2791	0.0002	0.0026	0.0002	0.4335	0.6136	0.9109	0.4335	0.4335
6	Hood	0.0002	0.0002	0.0002	0.0002	0.0002		0.0056	0.0002	0.2791	0.0002	0.0002	0.9756	0.9756	1.0000	0.0483	0.0002	0.0002	0.0002	0.0002
7	L55	0.9109	0.0920	0.0242	0.0118	0.9109	0.0056		0.6136	0.9756	0.0118	0.0026	0.0002	0.2791	0.0118	1.0000	0.0118	0.0483	0.0056	0.0056
8	CU	1.0000	0.9998	0.9756	0.9109	1.0000	0.0002	0.6136		0.0242	0.9109	0.6136	0.0002	0.0006	0.0002	0.1658	0.9109	0.9963	0.7852	0.7852
9	CL	0.0920	0.0013	0.0004	0.0003	0.0920	0.2791	0.9756	0.0242		0.0003	0.0002	0.0056	0.9963	0.4335	1.0000	0.0003	0.0006	0.0002	0.0002
10	Suisun	0.6136	1.0000	1.0000	1.0000	0.6136	0.0002	0.0118	0.9109	0.0003		1.0000	0.0002	0.0002	0.0002	0.0013	1.0000	1.0000	1.0000	1.0000
11	Napa	0.2791	0.9963	1.0000	1.0000	0.2791	0.0002	0.0026	0.6136	0.0002	1.0000		0.0002	0.0002	0.0002	0.0004	1.0000	0.9998	1.0000	1.0000
12	SR711	0.0002	0.0002	0.0002	0.0002	0.0002	0.9756	0.0002	0.0002	0.0056	0.0002	0.0002		0.1658	0.9109	0.0006	0.0002	0.0002	0.0002	0.0002
13	SJ815	0.0026	0.0002	0.0002	0.0002	0.0026	0.9756	0.2791	0.0006	0.9963	0.0002	0.0002	0.1658		0.9963	0.7852	0.0002	0.0002	0.0002	0.0002
14	SJ902	0.0002	0.0002	0.0002	0.0002	0.0002	1.0000	0.0118	0.0002	0.4335	0.0002	0.0002	0.9109	0.9963		0.0920	0.0002	0.0002	0.0002	0.0002
15	SJ915	0.4335	0.0118	0.0026	0.0013	0.4335	0.0483	1.0000	0.1658	1.0000	0.0013	0.0004	0.0006	0.7852	0.0920		0.0013	0.0056	0.0006	0.0006
16	CS405	0.6136	1.0000	1.0000	1.0000	0.6136	0.0002	0.0118	0.9109	0.0003	1.0000	1.0000	0.0002	0.0002	0.0002	0.0013		1.0000	1.0000	1.0000
17	SB508	0.9109	1.0000	1.0000	1.0000	0.9109	0.0002	0.0483	0.9963	0.0006	1.0000	0.9998	0.0002	0.0002	0.0002	0.0056	1.0000		1.0000	1.0000
18	GB602	0.4335	0.9998	1.0000	1.0000	0.4335	0.0002	0.0056	0.7852	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0006	1.0000	1.0000		1.0000
19	NS609	0.4335	0.9998	1.0000	1.0000	0.4335	0.0002	0.0056	0.7852	0.0002	1.0000	1.0000	0.0002	0.0002	0.0002	0.0006	1.0000	1.0000	1.0000	