Pelagic Organism Decline (POD)

Acute and Chronic Invertebrate and Fish Toxicity Testing

Progress Report

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This is a draft work in progress subject to review and revision as information becomes available.

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1. Summary

This study was designed as a pilot study aimed at testing water samples from a small number of sites throughout the Delta using standard bioassay invertebrate species (*Hyalella azteca*, *Ceriodaphnia dubia*), and at developing acute and chronic toxicity test with several Delta species of concern, the copepod *Pseudodiaptomus forbesi*, and the pelagic fish species striped bass (*Morone saxatilis)* and delta smelt *(Hypomesus transpacificus*).

Significant acute and chronic toxicity to amphipods was detected at four out of ten sampling sites: the Napa River (340), the Old River (902), the San Joaquin River (910) and the Sacramento River (711). Chronic toxicity to the amphipod *Hyalella azteca* was measured at DFG sites 711, 902 and 910 on June 13/14. Slight (non-significant) growth reduction was also measured at sites 711, 902 and 915 on June 27/28, and at sites 902 and 915 on August 22/23. Site 711 is located in the Sacramento River near Rio Vista, site 902 is in Old River at the mouth of Holland Cut, site 910 is in the San Joaquin River, between Hog and Turner Cut and site 915 is also in the Old River (western arm at Railroad Bridge). Significant mortality of *H. azteca* was observed repeatedly in water samples from DFG site 340 in the Napa River. Survival was reduced to 34% in water collected on August 12, and to 22% in water collected on September 8, 2005. Site 711 and 910 also caused 10% copepod mortality within 24 h (data update at the time when report was submitted).

No significant toxicity to the cladoeran *C. dubia* was observed during the 2005 sampling period. However, survival was slightly reduced in samples taken June 29/July 1 at site 804 (San Joaquin River, 1 km upstream from mouth), and July 25/26 at sites 902 and 910 (Old River, San Joaquin River). These three sites have high densities of *Microcystis* (P. Lehman, pers. commun.). *C. dubia* survival was exclusively reduced in water from these sites, it is possible that the cladoceran is particularly sensitive to *Microcystis*, but less sensitive to contaminants impairing amphipod survival and growth in the Napa and Sacramento Rivers.

No significant toxicity to juvenile striped bass was observed in July 27/28 samples from DFG stations 340, 711, 910 and 915. No significant toxicity to juvenile delta smelt was observed in August 30/31 samples from DFG stations 340, 711, 910 and 915. Survival of fish exposed to water from site 340 was slightly reduced to 85% +/- 2.9%, but the difference to controls was not statistically significant. The analysis of sublethal biomarker endpoints in striped bass and delta smelt is ongoing.

Tests to determine the toxicity of copper to striped bass and delta smelt showed that 3-month old delta smelt (fork length: 3.5-4 cm) were approximately 10-12 times more sensitive to this contaminant than 3-month old striped bass (fork length: 5-5.4 cm). The 96-h and 7-day LC50s for copper are 348 and 301 µg/L (striped bass), and 33.5 and 24.7 µg/L (delta smelt), respectively. This LC50 of juvenile delta smelt for copper is far below the 96-h LC50 value reported by the California Department of Fish and Game (2004) of 1.4 mg/L for larval delta smelt. Our results indicate that delta smelt is one of the most sensitive fish species to copper.

Recommendations: Due to the relatively small number of 2005 sampling sites it is difficult to draw conclusions about the sources and the geographic extent of aquatic toxicity in the Delta. It is therefore recommended to increase in the number of sampling sites to better characterize primary sources as well as the geographic distribution of toxicity. Chemical analyses should be performed on water samples that cause significant toxicity to bioassay organisms, but are not sufficiently toxic for initiating TIEs. In areas, where *Microcystis* toxicity is of special concern, water samples should be collected directly below the water surface and tested with *C. dubia*.

Further routine toxicity testing with copepods is recommended throughout the year. In addition to *P. forbesi*, the native copepod *Eurytemora affinis* should be cultured and a toxicity test developed based on protocols established for *P. forbesi*.

Information on the sensitivity of Delta species of concern to contaminants of concern is extremely scarce. It is recommended to continue laboratory testing to establish LC50 information for species and selected contaminants of concern. As more information on environmental concentrations of specific contaminants emerges, LC50 data will be valuable for focusing future research and monitoring efforts.

It is important to develop field-applicable tools for the detection of *stressor-specific* sublethal effects in Delta species of concern. Future work with delta smelt and striped bass should employ state-of-the-art technology to expand our ability to identify stressor-specific effects in these species, and to understand how these fish respond to changes in their environment. In particular, microarrays for monitoring differential expression of stress-responsive genes could be developed using subtractive hybridization techniques. Altered regulation of thousands of stress genes could thus be measured in tissues from field-collected fish to identify stressors and their chronic effects.

2. Background and Approach

This 4-month project is a pilot-level study intended to investigate toxicity of Delta water samples to invertebrates and fish, and to assess the potential for contaminated water in contributing to the observed declines of pelagic species in the Delta. Water samples for toxicity testing were collected approximately simultaneously with fish sampling at sites characterizing primary inflows to the Delta as well as geographic regions important to pelagic fish of interest. From June through September 2005, samples from 10 selected fish survey sites were collected twice a month in the Delta and the Napa River during the DFG townet fish survey. Water samples were tested for acute and chronic toxicity to the invertebrates *Ceriodaphnia dubia* (Cladocera) and *Hyalella azteca* (Amphipoda), as well as *Pseudodiaptomus forbesi* (Copepoda), and juveniles of the Delta fish species delta smelt (*Hypomesus transpacificus*) and juvenile striped bass (*Morone saxatilis*). Juvenile delta smelt and striped bass are among the rapidly declining Delta fish species. *Ceriodaphnia dubia* is a common invertebrate test organism in biotoxicity studies (e.g. US EPA 2002) and has been used in a published toxicity study conducted in the Delta in 1993-1995 (Werner et al. 2000) as well as in studies conducted by the CA Department of Boating and Waterways as part of their aquatic weed control permit requirements and by the San Francisco Estuary Institute in the San Francisco Bay watershed. Toxicity tests with the amphipod *H. azteca* provided the opportunity to explore toxicity in more saline waters. While *C. dubia* and *H. azteca* occur in the Delta, they are not known to be important food organisms for pelagic fishes. Thus, assays were developed and conducted with the copepod *P. forbesi*, an important Delta fish food organism during summer and fall. In contrast to *C. dubia* and *H. azteca*, standardized assays involving *P. forbesi*, juvenile delta smelt, and striped bass did not exist prior to this project, and protocols were developed at the UC Davis Aquatic Toxicology Lab, during the summer 2005. For delta smelt and striped bass, sublethal effects including inhibition of acetylcholine esterase in the brain (indicative of toxicity due to organophosphate insecticides), and quantification of vitellogenin (indicative of endocrine disruption), stress protein (indicative of cumulative cellular stress) and cytokine (indicative of immune-system effects) m-RNA are being explored as more sensitive, and in part stressor-specific, endpoints than fish mortality and growth.

Questions addressed:

1. Is water in the Delta and the Napa River toxic to pelagic fish and fish food organisms? If yes, where and when?
2. Is there a relationship between toxicity results and fish and zooplankton abundances?
3. Is there a relationship between *Microcystis* blooms and results of the toxicity assays?

3. Methods

Toxicity testing, indigenous species test development and analysis of sublethal toxicity endpoints were/are being performed at the UC Davis Aquatic Toxicology Laboratory (ATL; http://www.vetmed.ucdavis.edu/apc/atl/). Water samples for toxicity testing and potential toxicity identification evaluations (conducted when 50% mortality of the test species occurs within 96 h) were collected twice a month at 10 fish survey sites in the Delta and the Napa River from June through September 2005 during the DFG townet fish survey. Samples were pumped from a depth of approx. 0.5 m, and preserved according to the sampling protocol provided by the UC Davis ATL. The following DFG stations were sampled: 910, 902, 915, 704, 711, 804, 609, 504, 508 and 340. These are the same stations as sampled for the *Microcystis* studies. For toxicity testing with fish, samples were collected on July 27/28 (juvenile striped bass) and August 30/31 (juvenile delta smelt) from DFG stations 340, 711, 910 and 915.

3.1 *Hyalella azteca* (Amphipoda)

Before initiating bioassays, the water samples are mixed rigorously in the original containers, filtered through a 60-µm screen, brought to test temperature and aerated at a rate of 100 bubbles/min until the dissolved oxygen concentration is approximately 8.5 mg/L. The laboratory control water consists of deionized water amended to US EPA standards.

H. azteca are purchased from Aquatic Research Organisms (New Hampshire, MD). The 10-day tests consist of five replicate 300 ml glass beakers each containing 100 ml of sample, a one square inch piece of nitex screen (a substrate for the *H. azteca* to cling to), and 10 organisms. Tests are initiated with 7 to 14 day old *H. azteca*, which are obtained from Aquatic Research Organisms in Hampton, New Hampshire. Each replicate is fed 100 µl of a 2:1 mixture of *S. capricornutum* and YCT (a mixture of yeast, organic alfalfa and trout chow) two hours before renewal on day 5. Approximately 75% of the test solution is renewed on day 5. An additional high EC control test was conducted for *H. azteca* tests. "High EC" control water was reconstituted to EPA moderate hardness and the EC adjusted to match the highest EC of the water samples (typically found at site 340, Napa River) with pre-filtered Pacific Ocean seawater**.** Tests were conducted in a 23 ± 2° C chamber with a 16-hour light: 8-hour dark photoperiod. Mortality was recorded daily. On day 10, the surviving *H. azteca* were dried and weighed to determine dry tissue weight/individual and relative growth.

3.2 *Ceriodaphnia dubia* (Cladocera)

Before initiating bioassays, the water samples are mixed rigorously in the original containers, filtered through a 60-µm screen, brought to test temperature and aerated at a rate of 100 bubbles/min until the dissolved oxygen concentration is approximately 8.5 mg/L. The laboratory control water consists of deionized water amended to US EPA standards.

C. dubia are from an in-house culture maintained at the ATL. The daphnids are maintained at 25±1°C and a 16:8 light:dark cycle. Tests are set up according to US EPA protocols. The *C. dubia* chronic tests (7 days) consist of ten replicate 20 ml glass vials, each containing one organism. Tests are initiated with less than 24-hour-old *C. dubia*, born within an 8-hour period. *C. dubia* are transferred daily into a new vial of fresh solution that has had a mixture of *S. capricornutum* and YCT (a mixture of yeast, organic alfalfa and trout chow) added to it to serve as nourishment for the organisms. Sierra Springs™ water amended to EPA moderately hard (SSEPAMH) is used as the control water for the *C. dubia* test. Tests are conducted at 25 ± 2° C with a 16-hour light: 8-hour dark photoperiod. Mortality is recorded and neonates are counted daily to determine fecundity. Tests are terminated after 7 days.

3.3 Test Development with Delta Resident Species

3.3.1 Striped Bass (*Morone saxatilis*)

This 7-day chronic toxicity test measured the effects of test waters on the survival and growth of juvenile *Morone saxatilis*. Each experimental treatment was comprised of 5 replicates of 5 animals each, and each replicate tank contained 5L of water at 20 C. Fish were fed daily (Silver Cup 2.0 mm pellets). The light:dark cycle was 16h:8h.

Juvenile striped bass (approx. 3 months old, fork length: 5-5.4 cm) were purchased from Professional Aquaculture Services (Chico, CA), and acclimated to laboratory conditions for 2 days before tests were initiated. Upon arrival, fish were placed into 10 gallon aquaria containing dilute well water, which had been brought to a salinity of 8 ppt to match the salinity of the water in which the bass arrived. Approximately 30 to 50 fish were placed in each aquarium. The day after arrival the fish were acclimated once with dilute well water brought to 4 ppt and again with unsalted dilute well water (diluted to an approximate hardness of 200 mg/L $CaCO_3$). This dilute well water was used as control water throughout the experiment.

On the day of test initiation (day 0), replicate tanks filled with test waters were aerated and brought to 20°C. Five fish were transferred into each replicate tank. Approx. 80 percent of the water in each replicate was renewed on days 2, 4, and 6. On days 1, 3, and 5, water was not renewed, but the numbers of live, dead, and missing fish were scored for each replicate. Water temperature, pH, and DO were measured daily. Ammonia nitrogen (NH3-N) was measured prior to each water renewal. At test termination, temperature, pH, DO, EC, and ammonia were measured for each treatment. On Day 7, one fish from each replicate was measured for mass and fork length, and frozen for analysis of tissue chemistry. The remaining 4 fish were measured and individual tissues (brain, kidney, spleen, liver, gonads, muscle, gill) dissected, snap-frozen and stored at –80°C for subsequent analyses of sublethal biomarkers.

We performed this test two times, once using ambient samples as the test waters, and once using CuCl as a reference toxicant in concentrations ranging from 50 ppb to 1000 ppb Cu^+.

3.3.2 Delta Smelt (*Hypomesus transpacificus*)

Delta Smelt (Hypomesus transpacificus) 7-day Holding Conditions Evaluation: Juvenile delta smelt (3-months old, fork length: 3.5-4.0 cm) were obtained from Bradd Bridges (Delta Smelt Hatchery, Tracy, CA). In preparation for conducting toxicity tests using delta smelt, we evaluated the health of delta smelt held for 7 days under three different holding conditions: 5 fish in 5 liters of water, 10 fish in 5 liters, and 10 fish in 7 liters (Appendix, Table 19). Each treatment was comprised of 2 replicate tanks. The water used was the same dilute well water (hardness = 200 mg/L) as in the striped bass tests. Fish were received directly into test tanks on the day of test initiation.

Fish were fed twice per day a small pinch (about 0.07 grams) of a mixture of EPAC and Hikari 400 – 600 um crumble food (2:1 ratio of EPAC:Hikari). 50 percent of the water in each replicate was renewed on days 2, 4, and 6. Temperature, pH, DO, and ammonia nitrogen were measured daily, and dead fish were removed daily.

Delta Smelt (Hypomesus transpacificus) 7-day Toxicity Test: This 7-day chronic toxicity test measured the effects of test waters on the survival and growth of juvenile *Hypomesus transpacificus*. Each experimental treatment was comprised of 4 replicates of 10 animals each, and each replicate tank contained 7 L of water at 20°C. Fish were fed twice daily with artemia (< 48 hrs old). The light:dark cycle was 16h:8h.

Fish were received 2 days prior to test initiation. Upon arrival, fish were placed into dilute well water in gently aerated test tanks, 10 fish in each 7 liter tank. Reserve fish were placed in a 10 gallon aquarium containing dilute well water (< 100 fish). The day after arrival, 80 percent of the water in each tank was replaced with new dilute well water. This dilute well water was used as control water throughout the experiment.

On the day of test initiation (day 0), 80 percent of the water in each replicate tank was replaced with test water. Fish from the reserve tank were transferred to tanks in which mortality had occurred over the 2 day acclimation period to bring the total number of fish in each replicate to 10. 80 percent of the water in each replicate was renewed on days 2, 4, and 6. On days 1, 3, and 5, water was not renewed, but the numbers of live, dead, and missing fish were scored for each replicate. Water temperature, pH, and DO were measured daily. Ammonia nitrogen (NH3-N) was measured prior to each water renewal. On Day 7, 4 fish from each replicate were measured for mass and forklength and individual tissues (brain, kidney, spleen, liver, gonads, muscle, gill) were dissected, snap-frozen and stored at –80°C for subsequent analyses of sublethal biomarkers. The remaining fish from each replicate were measured and frozen for analysis of tissue chemistry. At test termination, temperature, pH, DO, EC, and ammonia were measured for each treatment.

We performed this test three times, once using ambient samples as the test waters, once to find the general range of sensitivity of delta smelt to Cu^{+}, and a third time using CuCl as a reference toxicant in concentrations ranging from 5 ppb to 50 ppb Cu^{+}. The Cu^{+} range finder test differed from the other tests in that each treatment contained only 2 replicates.

3.3.3 Copepods *(Pseudodiaptomus forbesi)*

Copepods were collected 1 day prior to test initiation from the San Joaquin River near the New Bridge Marina. A 147 µm mesh plankton net was held 0.5 to 2 ft under the surface of the water for approximately 2 minutes. The salinity of the site water was measured and a 5-gallon cubitaner was filled with site water to dilute animals and prevent density-caused stress and mortality at the lab. Copepods are maintained in L16 culture medium and fed *Cryptomonas ovata* following the protocol developed by Mueller-Solger (pers. commun.) and Hall et al. (manuscript in preperation).

The *P. forbesi* tests (7 days) consist of ten replicate 20 ml glass vials, each containing one organism (immature) in 15 ml of test solution. Culture medium (L16) is used as the control water. Eighty percent of the exposure water is replaced daily with fresh test solution containing food algae (1 ml of *Cryptomonas* culture per 200 ml sample water). Tests are conducted at 22 ± 2° C with a 16-hour light: 8-hour dark photoperiod. Mortality is recorded daily. Temperature and conductivity are measured at test initiation and termination. Dissolved oxygen and pH are measured at test initiation and daily before and after test water renewal. Tests are terminated after 7 days.

Statistical Analysis: Statistical analysis of toxicity testing results for all species followed EPA standard statistical procedures for static renewal toxicity tests (US EPA, 2002). These analyses were performed using Toxcalc 5.0 software (Tidepool Scientific Software, 1996). In tests comparing greater than two ambient samples to one control treatment, the number of control replicates was doubled to preserve statistical power in the event that it became necessary to perform non-parametric statistics.

US EPA. 2002. Methods for Measuring the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition. Washington, DC 20460: U.S. Environmental Protection Agency, Office of Water.

Internal Quality Assurance: The UCD ATL Quality Assurance Officer (QA Officer) performed an internal quality assurance audit on the following components: reference toxicant control charts for *C. dubia, and H. azteca* from July 2005 and the previous 19 months, staff performance audits, laboratory safety and systems audit. Her findings indicate that UCD ATL is current and in compliance in those aspects of the laboratory. Her audits of these systems did not yield any evidence of deviations or discrepancies.

3.4 Sublethal Indicators of Contaminant Effects in Striped Bass and Delta Smelt

Acetylcholinesterase (AChE) inhibition in brain: AChE activity is quantified using a modification of the method of Ellman et al. (1961). Brain samples are homogenized, and samples are transferred to microplate wells containing enzyme substrate (0.32 mM DTNB and 2 mM AtChI). Samples are run in triplicates and absorbance at 405 nm is measured at 2 min intervals for 10 min at 25°C with an automated microplate reader (Multiskan Ascent, Thermo Electron Inc., Milford, MA, USA). Substrate blanks are included on each plate and all samples are corrected for

background hydrolysis. All activities are calculated as μmol/min/g wet weight, then normalized to protein content (μmol/min/mg protein).

mRNA quantification: Total RNA is extracted (RNeasy Mini Kit, Qiagen Inc.) from individual tissues, and cDNA synthesized according to protocols described in Eder et al. (2004). Primers for the targeted stress-responsive genes (cytokines, stress proteins, vitellogenin) are designed using available DNA/RNA sequence information obtained from internet databases. TaqMan PCR systems are validated as described in Leutenegger et al., (1999). Real-time Taqman PCR analysis is then performed using instrumentation available at the UC Davis Lucy Whittier Molecular and Diagnostic Core Facility (http://www.biotech.ucdavis.edu).

4. Results

4.1 Ambient Toxicity Testing

4.4.1 *Hyalella. azteca* (Amphipoda)

Chronic toxicity to *H. azteca* was observed in water samples collected on June 13/14 from sites 711, 902 and 910 (Appendix, Table 1-1). Relative growth was significantly reduced to 30% (site 711), 52% (site 902) and 51% (site 910) of controls. Site 711 is located in the Sacramento River near Rio Vista, site 902 is in Old River at the mouth of Holland Cut, and site 910 is in the San Joaquin River, between Hog and Turner Cut. No toxicity was observed for C. dubia exposed to these water samples. Reduced growth of *H. azteca* was also observed in water samples collected from sites 711, 902 and 915 (Old River, western arm at Railroad Bridge) on June 27/28 and again in samples collected August 22/23 at sites 902 and 915 (Old River), but these data were not statistically significant (Appendix, Table 3-1).

Acute toxicity to *H. azteca* (significant reduction in survival) was observed repeatedly in water samples from site 340 (Napa River). Survival was reduced to 34% in water collected on August 12 (Appendix, Table 10-1) and to 22% in water collected on September 8. The September sample also reduced relative growth of surviving amphipods to 73% of control (Appendix, Table 13-1). Water from the Napa River had the highest salinity, and toxicity in site water was compared to “high EC” control treatments, which were adjusted to the salinity of the Napa River samples. Tests with *C. dubia* were not performed for site 340 due to the high salinity. Toxicity to *H. azteca* was significant, but not high enough to initiate Toxicity Identification Evaluations (TIEs). The criterion for TIEs is that a sample must cause 50% mortality within 96 h.

4.4.2 *Ceriodaphnia dubia* (Cladocera)

No significant toxicity to *C. dubia* was observed during this sampling period. Survival was slightly reduced in samples taken June 29/July 1 at site 804 (83% survival; San Joaquin River, 1 km upstream from mouth) (Appendix, Table 4-2), and July 25/26 at sites 902 (80% survival) and 910 (90% survival) (Appendix, Table 7-2). Site 902 is in the

Old River at the mouth of Holland Cut, and site 910 is in the San Joaquin River, between Hog and Turner Cut.

4.1.3 Striped Bass (*Morone saxatilis*)

Samples were collected on July 27/28 DFG stations 340, 711, 910 and 915, and 7-d tests were initiated on July 30, 2005. There was 100% survival and no significant effect on body weight and fork length in all treatments with the exception of water from site 711 (Sacramento River near Rio Vista) (Appendix, Table 15-1). These fish had 96% survival, but the effect was not significantly different from controls.

4.1.4 Delta Smelt (*Hypomesus transpacificus*)

Samples were collected on August 30/31 from DFG stations 340, 711, 910 and 915, and 7-d tests were initiated on September 1, 2005. Fish in control water had 95% +/- 2.9% survival, and survival was equal or better at sites 711, 910 and 915 (Appendix, Table 16-1). Survival of fish exposed to water from site 340 was slightly reduced to 85% +/- 2.9%, but the difference to control was not statistically significant. Fork length and wet weight were similar in all treatments. EC of the water from site 340 was 19 mS/cm, which corresponds to a salinity of approximately 11 ppt (Appendix, Table 16-2).

4.1.5 Copepods *(Pseudodiaptomus forbesi)*

Tests developed with the copepod species *P. forbesi* are presently being performed on water samples collected on September 27/29. Control survival is 100%, and so far 10% mortality has been observed after 24 h in water samples from sites 711 and 910.

4.2 Copper Toxicity to Delta Species

4.2.1 Striped Bass (*Morone saxatilis*)

A 7-day test with juvenile striped bass yielded LC50 values for copper ion toxicity of 348 µg/L (96 h) and 301 µg/L (7 d) (Appendix, Table 17-1).

4.2.2 Delta Smelt (*Hypomesus transpacificus*)

Delta smelt juveniles were far more sensitive to copper than striped bass (Appendix, Tables 18-1, 20-1). A 7-day test yielded LC50 values for copper ion toxicity of 33.5 µg/L (96 h) and 24.7 µg/L (7 d).

4.2.2 Copepods *(Pseudodiaptomus forbesi)*

Tests to determine the copper LC50s for *P. forbesi* will be initiated within the next few weeks.

4.2.3 Sublethal Indicators of Contaminant Effects in Delta Species

Brain samples of delta smelt and striped bass from laboratory tests are presently being prepared for acetylcholinesterase enzyme activity assays. In addition, primers for vitellogenin, stress protein and cytokine mRNA analysis are being designed. Almost no sequence information is available for delta smelt, and degenerate primers will be used. This should yield good results, since the selected biomarkers exhibit high degrees of sequence homology across species. For striped bass, sequence information is available for cytokines (IGF-1, TGF-beta, natural resistance-associated macrophage protein) and vitellogenin. Stress proteins are highly conserved and therefore degenerative primers will be used.

5. Conclusions and Recommendations

Significant acute and chronic toxicity to amphipods (*H. azteca*) was detected at four out of ten sampling sites: the Napa River (340), the Old River (902), the San Joaquin River (910) and the Sacramento River (711). Slight (statistically non-significant) toxic effects on cladocerans (*C. dubia*) were observed in the Old River (902), and the San Joaquin River (804, 910). Since the latter three sites are reported to also have high *Microcystis* toxicity and biomass, and *C. dubia* survival was exclusively reduced in these sites, it is possible that the cladoceran is particularly sensitive to *Microcystis*, but less sensitive to contaminants impairing amphipod survival and growth in the Napa and Sacramento Rivers. This study was designed as a pilot study aimed at testing water samples from a small number of sites throughout the Delta. It is now recommended to increase in the number of sampling sites to better characterize primary sources as well as the geographic distribution of toxicity. Chemical analyses should be performed on water samples that cause significant toxicity to bioassay organisms, but are not sufficiently toxic for initiating TIEs. In areas, where *Microcystis* toxicity is of special concern, water samples should be collected directly below the water surface and tested with *C. dubia*.

Toxicity testing protocols for juvenile delta smelt, juvenile striped bass and the copepod *P. forbesi* were successfully developed. However, delta smelt and striped bass only spawn once a year, which limits the period of testing with these species to the spring and summer. Further routine toxicity testing with copepods is recommended throughout the year. In addition to *P. forbesi*, the native copepod *Eurytemora spec.* should be cultured and a toxicity test developed based on protocols established for *P. forbesi*.

Information on the sensitivity of Delta species of concern to contaminants of concern is extremely scarce. Test results for copper LC50 values of delta smelt and striped bass showed, that delta smelt is extremely sensitive to this chemical. It is recommended to continue laboratory testing to establish LC50 information for species and selected contaminants of concern. As more information on environmental concentrations of specific contaminants emerges, LC50 data will be valuable for focusing future research and monitoring efforts.

Our work on striped bass and delta smelt biomarkers is aimed at developing field-applicable tools for the detection of stressor-specific sublethal effects in these species. Vitellogenin is a well-studied indicator of (estrogenic) endocrine disruption. Stress proteins (hsps) signal the cumulative effects of a variety of environmental stressors on cellular integrity and protein function. Lastly, altered expression of specific cytokines helps distinguish the effects of viral infections from the more general immune system effects. Future work with these species should focus on state-of-the-art technology to expand our ability to identify stressor-specific effects in field-collected delta smelt and striped bass, and to understand how these fish respond to changes in their environment. In particular, microarrays for monitoring differential expression of stress-responsive genes could be developed using subtractive hybridization techniques. Altered regulation of thousands of stress genes could thus be measured in tissues from field-collected fish to identify stressors and their chronic effects.

APPENDIX

Table 1-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/13/05 and 6/14/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	89[P]	2.9	0.113	0.009	0.100	0.008
902	96	4.0	0.059	0.005	0.057	0.005
910	98	2.0	0.058	0.010	0.058	0.010
915	90	3.5	0.102	0.009	0.092	0.011
704	96	2.4	0.084	0.009	0.081	0.010
711	86	3.9	0.034	0.007	0.029	0.008

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 6/15/05.

2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 1-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/13/05 and 6/14/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	22.3[P]	1.47	95[P]
902	26.9	1.10	90
910	31.5	0.90	100
915	23.8	2.82	90
704	28.3	0.90	100
711	21.6	3.22	70

P. The laboratory control met all EPA criteria for test acceptability. 90% of the daphnids had a third brood.

1. This test was set up on 6/15/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 1-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG)
for the Department of Water Resources (DWR) on 6/13/05 and 6/14/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	7.89	204	8.2	84	54	NAP
Lab Control (DIEPAMHR)	24	8.04	318	8.5	96	56	NAP
902	24	8.41	153	8.6	112	46	0.06
910	24	7.68	209	8.6	84	46	0.08
915	24	7.85	170	8.5	68	52	0.04
704	24	7.82	159	8.6	76	66	0.13
711	24	7.89	137	8.6	84	62	0.10

Table 2-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/15/05, 6/16/05. and 6/17/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	91.3[P]	4.1	0.017	0.002	0.015	0.002
Lab. Control (DIEPAMHR @ 13.5 ms)	90.3	7.3	0.024	0.003	0.022	0.004
504	100	0.0	0.032	0.002	0.032	0.002
804	94	3.8	0.021	0.003	0.020	0.004
609	100	0.0	0.036	0.003	0.036	0.003
508	100	0.0	0.042	0.002	0.042	0.002
340	92	5.2	0.051	0.002	0.047	0.004

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 6/18/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 2-2. Summary of 10-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/15/05, 6/16/05, and 6/17/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	25.3[P]	0.73	100[P]
504	18.6	4.92	88
804	22.5	4.68	89
609	21.0	2.19	100
508	27.3	1.31	100

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.

1. This test was set up on 6/18/05.

2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 2-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/15/05, 6/16/05, and 6/17/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	8.08	205	8.1	84	54	NAP
Lab Control (DIEPAMHR)	23	8.21	311	8.3	104	40	NAP
Lab Control (DIEPAMHR @ 13.5 ms)	22	7.97	13290	8.1	NAV	NAV	NAP
504	23	8.00	282	8.0	104	60	0.05
804	22	7.95	159	7.9	56	54	0.03
609	22	7.82	559	8.1	136	68	0.04
508	22	7.95	163	8.3	96	62	0.07
340	22	7.57	13860	8.0	1496	86	0.04

Table 3-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/27/05 - 6/28/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	90[P]	2.6	0.022	0.004	0.020	0.004
902	90	3.2	0.012	0.004	0.011	0.004
915	94	4.0	0.012	0.002	0.011	0.002
910	100	0.0	0.036	0.006	0.036	0.006
711	92	3.8	0.017	0.002	0.016	0.002
704	86	6.0	0.022	0.004	0.019	0.004

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 6/29/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 3-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/27/05 and 6/28/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	22.4[P]	1.52	100[P]
902	25.6	2.47	100
915	22.6	1.80	100
910	24.8	1.56	100
711	21.2	2.00	100
704	20.9	2.64	90

P. The laboratory control met all EPA criteria for test acceptability. 89% of the daphnids had a third brood.

1. This test was set up on 6/29/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 3-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/27/05 and 6/28/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	8.07	190	8.3	92	54	NAP
Lab Control (DIEPAMHR)	24	8.09	344	8.0	148	64	NAP
902	24	8.10	144	8.4	48	60	0.01
915	24	8.08	146	8.4	44	52	0.02
910	24	8.08	303	8.5	72	54	0.12
711	24	8.17	150	8.4	52	66	0.13
704	24	8.10	156	8.6	56	64	0.09

Table 4-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/29/05, 6/30/05, and 7/01/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	88[P]	2.9	0.021	0.003	0.018	0.002
Lab. Control (DIEPAMHR @ 16.7 ms)	76	3.7	0.027	0.003	0.021	0.002
804	100	0.0	0.035	0.002	0.035	0.002
504	100	0.0	0.052	0.004	0.052	0.004
609	100	0.0	0.043	0.001	0.043	0.001
508	98	2.0	0.039	0.005	0.038	0.005
340 [(3)]	96	2.3	0.048	0.005	0.047	0.005

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/02/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)
3. Compared to High EC control

Table 4-2. Summary of 10-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/29/05, 6/30/05, 7/01/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	21.9[P]	2.18	100[P]
804	21.0	3.61	83
504	20.0	0.95	100
609	20.7	1.08	100
508	21.5	1.30	100

P. The laboratory control met all EPA criteria for test acceptability. 78% of the daphnids had a third brood.

1. This test was set up on 7/01/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 4-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 6/29/05, 6/30/05, and 7/01/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	25	8.08	210	8.2	104	52	NAP
Lab Control (DIEPAMHR)	24	8.19	345	8.5	104	66	NAP
Lab. Control (DIEPAMHR @ 16.7 ms)	24	8.05	16720	8.4	1800	90	NAP
804	24	8.05	162	8.3	68	56	0.04
504	24	7.97	607	8.4	108	64	0.08
609	24	8.12	946	8.5	100	84	0.09
508	24	8.07	182	8.3	72	68	0.07
340	24	7.88	16210	8.3	1756	90	0.09

Table 5-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/11/05 and 7/12/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	98[P]	1.3	0.053	0.004	0.052	0.005
902	100	0.0	0.053	0.004	0.053	0.005
915	100	0.0	0.053	0.007	0.053	0.007
910	96	2.3	0.070	0.004	0.067	0.004
711	100	0.0	0.064	0.006	0.064	0.006
704	94	4.0	0.066	0.003	0.062	0.004

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/13/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 5-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/11/05 and 7/12/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	16.3[P]	2.25	100[P]
902	23.0	0.83	100
915	26.2	1.07	90
910	23.8	2.73	80
711	26.5	3.08	90
704	22.5	1.59	90

P. The laboratory control met all EPA criteria for test acceptability. 65% of the daphnids had a third brood.

1. This test was set up on 7/13/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 5-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/11/05 and 7/12/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	7.84	198	8.2	96	52	NAP
Lab Control (DIEPAMHR)	24	7.95	335	8.2	108	64	NAP
902	24	8.01	149	8.3	52	58	0.12
915	24	7.87	157	8.3	52	58	0.08
910	24	7.80	294	8.3	64	58	0.15
711	24	7.92	150	8.3	64	70	0.15
704	24	8.01	198	8.3	56	64	0.10

Table 6-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/13/05, 7/14/05, and 7/15/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	100[P]	0.0	0.031	0.002	0.031	0.002
Lab. Control (DIEPAMHR @ 21.22 mS)	80	4.1	0.059	0.006	0.046	0.003
609	100	0.0	0.045	0.009	0.045	0.009
504	98	2.0	0.047	0.006	0.045	0.004
508	100	0.0	0.044	0.002	0.044	0.002
804	100	0.0	0.042	0.004	0.042	0.004
340[(3)]	96	4.4	0.041	0.004	0.039	0.003

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/15/05.

2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

3. Compared to high EC control

Table 6-2. Summary of 7-day *Ceriodaphnia* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/13/05, 7/14/05, 7/15/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	26.0[P]	0.89	100[P]
609	29.7	0.94	100
508	28.0	0.60	100
804	27.0	1.74	100

P. The laboratory control met all EPA criteria for test acceptability. 95% of the daphnids had a third brood.
1. This test was set up on 7/15/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 6-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/13/05, 7/14/05, 7/15/05.

Treatment	Field Salinity (ppt)	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	NAP	25	8.06	187	8.3	96	52	NAP
Lab Control (DIEPAMHR)	NAP	25	8.20	329	8.5	108	64	NAP
Lab Control (DIEPAMHR @ 21.22 ms)	NAP	25	8.02	20900	8.2	2464	86	NAP
609	NAV	25	7.90	1292	8.0	180	90	0.09
504	NAV	24	7.94	4303	8.4	444	68	0.07
508	NAV	25	8.03	550	8.2	88	62	0.08
804	NAV	25	8.04	255	8.2	60	64	0.03
340	NAV	25	7.86	20940	8.2	1404	96	0.08

Table 7-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) on 7/25/05 - 7/26/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	97[P]	1.5	0.025	0.003	0.025	0.003
902	98	1.8	0.036	0.002	0.035	0.002
910	100	0.0	0.054	0.005	0.054	0.005
915	100	0.0	0.033	0.003	0.033	0.003
704	100	0.0	0.038	0.001	0.038	0.001
711	98	2.0	0.024	0.004	0.023	0.004

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/27/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 7-2. Summary of 7-day *C. dubia* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/25/05 - 7/26/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	23.3[P]	1.12	100[P]
902	19.3	3.50	80
910	21.6	2.60	90
915	21.0	2.62	100
704	23.8	1.82	100
711	25.9	1.32	100

P. The laboratory control met all EPA criteria for test acceptability. 85% of the daphnids had a third brood.

1. This test was set up on 7/28/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 7-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/25/06 - 7/26/05.

Treatment	Field Salinity (ppt)	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	NAP	24	8.11	232	8.6	136	68	NAP
Lab Control (DIEPAMHR)	NAP	24	8.01	338	9.0	144	64	NAP
902	NAV	25	8.12	175	8.9	76	60	0.00
910	NAV	25	7.58	418	8.2	172	76	0.22
915	NAV	25	7.83	168	8.6	100	62	0.00
704	NAV	24	7.86	198	9.3	100	60	0.04
711	NAV	24	7.73	140	9.1	84	62	0.06

Table 8-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/27/05, 7/28/05, and 7/29/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	98[P]	1.5	0.050	0.003	0.049	0.003
Lab. Control (DIEPAMHR @ 24.37 ms)	67	4.0	0.083	0.007	0.055	0.006
508	100	0.0	0.039	0.003	0.039	0.003
804	98	2.0	0.055	0.004	0.054	0.004
340 [(3)]	69	4.1	0.068	0.005	0.047	0.002
609	94	2.5	0.066	0.004	0.062	0.004
504	98	2.0	0.071	0.003	0.070	0.003

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/30/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)
3. Compared to High EC Control

Table 8-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/27/05 and 7/29/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	22.9[P]	1.78	100[P]
508	25.3	2.03	100
804	26.5	1.08	100

P. The laboratory control met all EPA criteria for test acceptability. 80% of the daphnids had a third brood.

1. This test was set up on 7/30/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 8-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/27/05, 7/28/05, and 7/29/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	26	8.30	288	7.6	136	68	NAP
Lab Control (DIEPAMHR)	23	8.32	357	8.5	144	64	NAP
Lab Control (DIEPAMHR @ 24.37 ms)	23	7.85	24190	8.5	2916	92	NAP
508	23	8.01	1832	8.5	224	64	0.13
804	23	8.22	651	8.6	108	70	0.06
340	23	7.65	23490	8.0	2792	94	0.11
609	23	7.91	3472	8.5	400	90	0.13
504	23	7.82	9450	8.3	1064	74	0.10

Table 9-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/08/05 and 8/09/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	93.9[P]	2.2	0.022	0.003	0.021	0.003
902	100	0.0	0.036	0.005	0.036	0.005
915	100	0.0	0.035	0.001	0.035	0.001
910	92	3.5	0.057	0.009	0.052	0.007
711	98	2.0	0.052	0.006	0.051	0.005
704	98	2.0	0.042	0.007	0.041	0.007

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 8/10/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 9-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/08/05 and 8/09/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	24.3[P]	1.45	100[P]
902	20.8	2.62	100
915	27.4	1.51	100
910	25.5	3.55	90
711	26.0	2.19	100
704	23.1	2.89	100

P. The laboratory control met all EPA criteria for test acceptability. 70% of the daphnids had a third brood.

1. This test was set up on 8/10/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 9-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/08/05 and 8/09/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	26	7.94	232	8.0	112	68	NAP
Lab Control (DIEPAMHR)	24	7.92	294	8.4	120	56	NAP
902	24	8.19	411	7.9	68	54	0.03
915	24	7.95	231	8.0	68	72	0.03
910	24	7.87	475	7.7	128	82	0.27
711	25	7.71	141	8.0	52	60	0.15
704	25	7.96	201	7.8	68	66	0.08

Table 10-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/10/05, 8/11/05, and 8/12/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	97[P]	2.3	0.033	0.002	0.032	0.003
Lab. Control (DIEPAMHR @ 26.45 ms)	85	4.7	0.038	0.004	0.032	0.004
804	98	2.2	0.035	0.007	0.035	0.007
609	94	4.0	0.057	0.003	0.054	0.003
508	90	4.7	0.050	0.005	0.044	0.002
504	100	0.0	0.033	0.002	0.033	0.002
340 (3)	34	12.9	0.050	0.006	0.017	0.006

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 8/12/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)
3. Compared to high EC control

Table 10-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/10/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	19.4[P]	1.27	100[P]
804	16.0	2.16	100

P. The laboratory control met all EPA criteria for test acceptability. 70% of the daphnids had a third brood.

1. This test was set up on 8/13/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 10-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/10/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	8.15	298	7.5	112	68	NAP
Lab Control (DIEPAMHR)	25	8.06	351	8.0	120	56	NAP
804	25	7.95	1401	8.2	184	66	0.05
609	25	7.90	4172	8.0	468	86	0.03
508	25	7.84	5280	8.1	568	78	0.02
504	25	7.77	7320	8.2	816	76	0.05
340	25	7.73	26010	7.9	4000	400	0.02

Table 11-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/22/05 and 8/23/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	96[P]	1.8	0.033	0.004	0.032	0.004
902	81	9.9	0.023	0.006	0.018	0.005
915	94	4.0	0.023	0.003	0.022	0.003
910	93	4.4	0.045	0.005	0.042	0.002
711	94	4.0	0.032	0.005	0.031	0.006
704	100	0.0	0.048	0.003	0.048	0.003

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 8/24/05.

2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 11-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/22/05 and 8/23/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	28.5[P]	0.71	100[P]
902	34.3	0.71	100
915	27.6	0.76	100
910	30.0	1.41	100
711	29.4	1.40	100
704	25.8	2.17	90

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.

1. This test was set up on 8/24/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 11-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/22/05 and 8/23/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	25	8.08	219	8.0	100	68	NAP
Lab Control (DIEPAMHR)	25	8.01	314	8.3	92	59	NAP
902	25	8.06	427	8.1	84	67	0.00
915	25	8.01	354	8.2	80	64	0.00
910	25	8.05	533	8.0	120	84	0.22
711	25	8.00	172	8.3	68	72	0.05
704	25	8.00	686	8.1	106	78	0.04

Table 12-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/24/05, 8/25/05, and 8/26/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	95[P]	1.7	0.041	0.002	0.039	0.021
Lab. Control (DIEPAMHR @ 26.71 mS)	26	9.9	0.014	0.014	0.006	0.003
804	100	0.0	0.044	0.003	0.044	0.003
504	86	4.9	0.065	0.005	0.055	0.003
609	100	0.0	0.034	0.002	0.034	0.002
340 (3)	37	10.6	0.060	0.011	0.022	0.007
508	96	4.0	0.038	0.003	0.036	0.003

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 8/26/05.

2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

3. Compared to the high EC control

Table 12-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/24/05, 8/25/05, and 8/26/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	24.0[P]	0.84	100[P]
804	27.1	1.76	90

P. The laboratory control met all EPA criteria for test acceptability. 100% of the daphnids had a third brood.

1. This test was set up on 8/27/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 12-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/24/05, 8/25/05, and 8/26/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	8.07	216	8.2	100	68	NAP
Lab Control (DIEPAMHR)	24	8.18	318	8.3	92	59	NAP
804	24	8.16	1588	8.1	204	68	0.04
504	24	7.78	12970	8.4	1504	90	0.12
609	24	7.94	6800	8.5	780	78	0.00
340	24	7.72	24460	8.0	2880	96	0.06
508	24	8.00	5970	8.4	676	72	0.03

Table 13-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 9/07/05 and 9/08/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	99[P]	1.0	0.041	0.002	0.039	0.002
Lab. Control (DIEPAMHR @ 27 mS)	80	12.6	0.033	0.005	0.024	0.003
340 (3)	22	10.2	0.024	0.008	0.004	0.002
504 (3)	96	2.4	0.044	0.003	0.042	0.003
508 (3)	94	4.0	0.038	0.002	0.036	0.002
609 (3)	96	2.4	0.046	0.004	0.044	0.004

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 9/09/05.
2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)
3. All samples compared to high EC control

Table 13-2. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 9/07/05 and 6/08/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (DIEPAMHR)	23	8.28	403	8.8	104	46	NAP
Lab Control (DIEPAMHR @ 27 mS)	25	8.28	28230	8.2	NAP	NAP	NAP
340	25	7.63	27450	8.3	3080	156	0.08
504	25	7.79	10860	8.4	1224	86	0.04
508	25	7.81	7660	8.3	896	78	0.05
609	25	7.79	7340	8.4	1012	88	0.03

Table 14-1. Summary of 10-day *Hyalella* water column toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 9/12/05, 9/13/05, and 9/14/05.[1]

Treatment	Survival (%)[2]		Growth[2] (mg/individual)		Biomass[2] (mg/individual)	
	x	se	x	se	x	se
Laboratory Control (DIEPAMHR)	99[P]	1.0	0.059	0.002	0.058	0.002
902	100	0.0	0.078	0.003	0.078	0.003
915	98	1.8	0.092	0.005	0.090	0.003
910	96	4.0	0.156	0.004	0.149	0.006
711	100	0.0	0.083	0.005	0.083	0.005
704	98	2.0	0.082	0.003	0.080	0.002
804	100	0.0	0.086	0.004	0.086	0.002

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 9/14/05.

2. Highlighted areas indicate a significant reduction in survival, growth, or biomass when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 14-2. Summary of 7-day *Ceriodaphnia* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 9/12/05 and 9/14/05.[1]

Treatment	Reproduction[2] (neonates/adult)		Survival[2] (%)
	x	se	
Laboratory Control (SSEPAMH)	24.4[P]	1.35	90[P]
902	31.1	1.24	100
915	31.9	1.02	100
910	30.6	1.20	100
711	28.3	0.76	100
704	27.6	1.71	100
804	23.0	2.84	100

P. The laboratory control met all EPA criteria for test acceptability. 95% of the daphnids had a third brood.

1. This test was set up on 9/14/05.
2. Highlighted cells indicate a significant reduction in reproduction or survival relative to the laboratory control water. Both endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 14-3. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 9/12/05, 9/13/05, and 9/14/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	24	7.99	200	8.4	92	50	NAP
Lab Control (DIEPAMHR)	24	8.11	331	8.5	108	62	NAP
902	24	8.35	455	8.6	100	68	0.07
915	24	8.08	416	8.5	92	68	0.07
910	24	7.74	547	8.4	140	88	0.14
711	24	7.99	214	8.2	76	72	0.16
704	24	7.91	1002	8.4	156	72	0.11
804	24	7.90	1923	8.4	248	70	0.09

Striped Bass Ambient Water Testing

Table 15-1. Summary of 7-day *Morone saxatilis* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 7/27/05 and 7/28/05.[1]

Treatment	Survival (%)[2]		Length (cm)[2]		Weight (g)[2]	
	x	se	x	se	x	se
Laboratory Control (Dilute Well Water)	100[P]	0.0	5.2	0.3	1.4	0.1
915	100	0.0	5.3	0.1	1.5	0.1
711	96	4.0	5.3	0.1	1.4	0.1
609	100	0.0	5.4	0.1	1.7	0.1
340	100	0.0	5.2	0.1	1.5	0.1

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 7/30/05.
2. Highlighted areas indicate a significant reduction in survival, length, or weight when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 15-2. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) for striped bass testing on 7/27/05and 7/28/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (SSEPAMH)	26	8.30	288	7.6	136	68	NAP
Lab Control (DIEPAMHR)	23	8.32	357	8.5	144	64	NAP
Lab Control (DIEPAMHR @ 24.37 mS)	23	7.85	24190	8.5	2916	92	NAP
Lab Control (Dilute Well Water)	21	7.98	414	10.2	208	222	NAP
915	19	8.03	157	8.8	96	70	0.00
711	20	7.89	132	8.8	92	78	0.07
609	20	7.63	2740	8.4	376	92	0.10
340	19	7.58	7640	8.8	188	144	0.01

Delta Smelt Ambient Water Testing

Table 16-1. Summary of 7-day *Hypomesus transpacificus* toxicity test conducted on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) on 8/30/05.[1]

Treatment	Survival (%)[2] x	se	Length (cm)[2] x	se	Weight (g)[2] x	se
Laboratory Control (Dilute Well Water)	95[P]	2.9	3.79	0.06	0.29	0.01
711	98	2.5	3.87	0.09	0.29	0.02
915	92	4.9	3.94	0.08	0.34	0.03
609	100	0.0	3.91	0.02	0.32	0.00
340	85	2.9	3.97	0.06	0.32	0.02

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 9/01/05.
2. Highlighted areas indicate a significant reduction in survival, length, or weight when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 16-2. Summary of water chemistry measurements on samples collected by the California Department of Fish and Game (CDFG) for the Department of Water Resources (DWR) for delta smelt testing on 8/30/05.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (μmhos/cm)	Lab DO (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	Ammonia (mg/L)
Lab Control (Dilute Well Water)	23	8.16	470	8.7	212	200	NAP
711	21	7.91	169	9.1	68	78	0.13
915	21	8.04	360	9.1	740	70	0.07
609	22	7.58	6460	8.2	2236	100	0.08
340	22	7.55	19050	8.4	80	138	0.03

Striped Bass: Copper Toxicity

Table 17-1. Summary of 7-day *Morone saxatilis* Cu^+ reference toxicant test conducted using dilute well water spiked with copper chloride.[1]

Treatment	Survival (%)[2] x	se	Length (cm)[2] x	se	Weight (g)[2] x	se
Laboratory Control (Dilute Well Water)	100[P]	0.0	5.48	0.15	1.73	0.18
50 ppb Cu^+	100	0.0	5.41	0.13	1.58	0.14
200 ppb Cu^+	92	8.0	5.42	0.18	1.66	0.22
500 ppb Cu^+	0	0.0	--	--	--	--
1000 ppb Cu^+	0	0.0	--	--	--	--

Survival:	96 hr	7 day
NOEC	200	200
LOEC	500	500
LC50	348	301

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 8/11/05.
2. Highlighted areas indicate a significant reduction in survival, length, or weight when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 17-2. Summary of water chemistry measurements taken on termination of *Morone saxatilis* Cu^+ reference toxicant test.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Ammonia (mg/L)
Lab. Control (Dilute Well Water)	21	8.57	257	8.7	1.03
50 ppb Cu^+	22	8.34	282	8.2	0.81
200 ppb Cu^+	21	8.46	245	8.6	0.95
500 ppb Cu^+	22	8.62	272	8.5	0.10
1000 ppb Cu^+	20	8.43	254	8.5	0.25

Delta Smelt: Copper Toxicity

Table 18-1. Summary of 7-day *Hypomesus transpacificus* Cu^+ reference toxicant test conducted using dilute well water spiked with copper chloride.[1]

Treatment	Survival (%)[2] x	se	Length (cm)[2] x	se	Weight (g)[2] x	se
Laboratory Control (Dilute Well Water)	100[P]	0.0	3.42	0.04	0.24	0.00
5 ppb Cu^+	93	6.7	3.53	0..05	0.24	0.01
10 ppb Cu^+	95	2.9	3.49	0.04	0.23	0.00
25 ppb Cu^+	40	4.1	3.57	0.11	0.26	0.02
50 ppb Cu^+	23	4.7	3.52	0.08	0.26	0.02

Survival:	96 hr	7 day
NOEC	10	10
LOEC	25	25
LC50	33.5	24.7

P. The laboratory control met the criteria for test acceptability.

1. This test was set up on 9/14/05.
2. Highlighted areas indicate a significant reduction in survival, length, or weight when compared to the laboratory control. All endpoints were analyzed according to EPA standard methods. (1-tailed test, $P < 0.05$)

Table 18-2. Summary of water chemistry measurements taken on termination of *Hypomesus transpacificus* Cu^+ reference toxicant test.

Treatment	Lab Temp (^oC)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Ammonia (mg/L)
Lab. Control (Dilute Well Water)	21	8.40	431	8.8	0.28
5 ppb Cu^+	21	8.49	456	8.7	0.24
10 ppb Cu^+	21	8.48	461	9.0	0.23
25 ppb Cu^+	21	8.46	455	8.8	0.37
50 ppb Cu^+	21	8.39	457	8.9	0.14

Delta Smelt: Test Development - Water Volume

Table 19-1: DWR POD Delta Smelt -Water Volume
Field Date: NAP
Test Setup Date: 8/11/05

		# Surviving Fish by Test Day						
Treatment	**Rep**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5 fish in 5 Liters	1	4	4	4	4	4	3	3
	2	4	3	3	3	3	3	3
Ammonia		0.19	0.94	1.14	0.39	1.24	1.87	0.79
10 fish in 5 Liters	1	7	7	7	7	7	7	7
	2	10	9	9	9	9	9	9
Ammonia		0.34	1.27	1.42	0.42	1.78	2.75	1.30
10 fish in 8 Liters	1	10	10	10	10	10	10	10
	2	10	9	9	9	9	9	9
Ammonia		0.25	0.91	1.05	0.38	1.21	2.15	0.72
% Renewed		50	50	80	50	50	80	

Table 19-2. Summary of water chemistry measurements taken on termination of *Hypomesus transpacificus* holding conditions test.

Treatment	Lab Temp (^{o}C)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Ammonia (mg/L)
5 fish in 5 liters	21	8.29	456	8.4	0.79
10 fish in 5 liters	21	8.42	458	8.9	1.30
10 fish in 5 liters	20	8.34	451	8.9	0.72

Delta Smelt: Test Development – Copper Toxicity Range Finder Test

Table 20-1: DWR POD Delta Smelt Cu^+ Range Finder
Field Date: NAP
Test Setup Date: 9/01/05

		# Surviving Fish by Test Day						
Treatment	**Rep**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
0 ppb Control	1	5	4	4	4	4	4	4
(Dilute Well Water)	2	5	5	5	4	4	4	4
50 ppb	1	4	3	3	2	2	2	2
	2	0	0	0	0	0	0	0
200 ppb	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0
500 ppb	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0
1000 ppb	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0

Table 20-2. Summary of water chemistry measurements taken on termination of *Hypomesus transpacificus* Cu+ range finder test.

Treatment	Lab Temp (^{o}C)	Lab pH	Lab EC (µmhos/cm)	Lab DO (mg/L)	Ammonia (mg/L)
Lab Control (Dilute Well Water)	20	8.52	507	9.2	0.15
50 ppb Cu^{+}	20	8.46	440	9.1	0.09
200 ppb Cu^{+}	21	8.43	266	8.7	0.10
500 ppb Cu^{+}	21	8.46	235	9.0	0.08
1000 ppb Cu^{+}	21	8.46	325	9.1	0.10