Appendix A
Supporting Biological Data

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**Figure A-6. Phytoplankton Biomass by Major Algal Groups at the Three Sampling Sites in Lake Elsinore during 2010 (Tobin 2011)**

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**Figure A-7. Species Sensitivity Distribution (SSD) of Fish Species, Plotting the Species Mean Acute Value (SMAV) Relative to Un-ionized Ammonia. Those highlighted in red and green are species found in the lakes (red), or closely related species (green).**



**Figure A-8. SSD of Various Aquatic Invertebrate Species, Plotting the Species Mean Acute Value (SMAV) Relative to Un-ionized Ammonia. Those highlighted in red are species either found in the lakes or closely related species (i.e., same genus).**



**Figure A-9. Historical Un-ionized Ammonia Concentrations for Lake Elsinore (Site LEE2) Calculated from Depth Integrated Total Ammonia, pH, Temperature, and Salinity.**

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| **Table A-1. Hydroacoustic Fish Survey Results from Lake Elsinore Comparing Most Current Survey (April 2015) with Surveys Conducted in 2008 and 2010 (Anderson 2016).** |
| **Date** | **Population (fish/acre)** | **Mean Sizea****(cm)** | **Size Rangea (cm)** | **Fish >20 cma (fish/acre)** |
| April 24, 2008 | 18,090 | 4.7 | 0.5 - 100 | 1,050 (5.8%) |
| March 15, 2010b | 2,867 | 4.0 | 0.5 – 29 | 6 (0.2%) |
| December 1, 2010 | 27,720 | 4.3 | 0.5 – 61 | 273 (1.0%) |
| April 2, 2015 | 56,600 | 1.8 | 0.5 - 30 | 12 (0.02%) |
| a Based on Loves’ equation.b March 2010 survey was conducted after fish kill in summer of 2009. |

| **Table A-2. Summary of Historic Fish Kills in Lake Elsinore** (*Additional references to be added))* |
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| **Date** | **Dissolved Oxygen (mg/L)** | **Duration of Fish Kill (days)** | **Lake Water Surface Elevation (ft)** | **Lake Volume (acre-ft)** | **Fish Species** | **Estimated Weight of Fish (tons)** | **Probable Cause** | **Reference** |
| **Initial** | **Final** |
| 1883\*\* |  |  |  |  |  |  |  | “fish died in the lake and their stench filled the air” | Hudson |
| Circa 18861 |  |  |  |  |  | Arroyo chub |  |  | Couch (1952) |
| Circa 1898 |  |  |  |  |  |  |  | Attributed to a sulfurous gas released from the lake bottom | Couch (1952) |
| January 1906 |  |  |  |  |  |  |  |  | Couch (1952) |
| 1915 |  |  |  | ~1,243 | 48,200 | Black Bass |  | Low lake level and “salty” water | Couch (1952) |
| 19172 |  |  |  | ~1,258 | 116,000 |  |  | High water temperature | Couch (1952) |
| September 13, 1927 |  |  | 10 | ~1,253 | 90,000 |  |  |  | Elsinore Valley News (September 22, 927) |
| April 7, 1933\* |  |  | 6 | ~1,242 | 45,000 | Mostly carp and a few “minnows,” i.e., arroyo chub |  | Lake turnover3: chlorides = 1,540 mg/L, TDS = 4,386 mg/L, dissolved oxygen at the surface at the shoreline at 25% saturation on April 13. High algal density. *Oscillatoria* about 30% of phytoplankton sample. | Elsinore Leader Press (May 4, 1933) |
| 1936 |  |  |  | 1,227 | 5,400 |  |  | Tons of algae reported | Bovee (1989) |
| August 15, 1940\* |  |  |  | 1,252 | 85,500 | Arroyo chub; Small/young fish | Heavy Kill | Sudden change in the mineral content of the lake | Bovee (1989), Couch (1952) |
| 1941 |  |  |  |  |  |  | Heavy Kill |  | See Footnote 3 |
| August 27, 1948\*4 |  |  | 6 | 1,232 | 16,200 | Carp | 300-5005 | (1) Increased alkalinity and mineral concentrations; (2) Over-abundance of algae coupled with high water temperaturesresulting in oxygen reduction6 | Couch (1952);Hudson (1978);Bovee (1989) |
| 1950\* |  |  |  | 1,230 | 12,000 |  |  | No fish in the lake7 | Bovee (1989) |
| 1954 |  |  |  | 1,223 | 0 |  |  | Lake dried up8 | Bovee (1989) |
| 1966\* |  |  |  | 1,229 | 9,600 |  | Heavy kill | Dissolved oxygen reduction | Bovee (1989) |
| August 31, 1972\* |  |  | 8 | 1,235 | 24,000 | Primarily threadfin shad | 800 | Water temperatures ranged from 27.2 to 29.5ºC | Bovee (1989) |
| August 6, 1975 |  |  | ~2 | 1,230 | 12,000 |  | Dump Truck Loads |  | Bovee (1989) |
| Fall 1976 |  |  |  | 1,229 | 9,600 |  | 41 |  | Bovee (1989) |
| August 1987 |  |  |  | 1,240 | 39,000 | Threadfin shad | Minor kill |  | Bovee (1989) |
| October 1988 |  |  |  | 1,233 | 18,700 |  | Minor; 300 lbs |  | Bovee (1989) |
| July/August 1990 | 6 | 0 | 609 | 1,237 | 28,400 |  | 1500 |  | MWH (2002) |
| 1991 |  |  |  |  |  |  |  | “120 thousand tons of fish killed by algae” | Press Enterprise |
| July/August 1992 | 6.5 | 2 | 6010 | 1,231 | 14,000 |  |  |  | MWH (2002) |
| 1993 |  |  |  |  |  |  |  | More than 100,000 tons of fish died | Black and Veatch |
| June/July 1995 | 9 | 3 | 6011 | 1,254 | 95,000 | Various species | 200 | Low dissolved oxygen | North County Times (August 22, 2002); MWH(2002) |
| 1996 |  |  |  |  |  |  |  | “in August, smaller fish die off” | Press Enterprise |
| 1997 |  |  |  |  |  |  |  | On April, 7 tons of shad died of oxygen depletion | Press Enterprise |
| November 11, 1998\* |  |  |  | ~1,250 | 76,000 | Threadfin shad | 240 | Migratory birds stressing high density shad population during period of low dissolved oxygen | Kilroy (1998) |
| August 2001 |  |  |  | 1,239 | 35,000 | Carp |  |  | LESWA (2002) |
| August 22, 2002 |  |  | 2 | 1,236 |  | Primarily Carp | 50 | Low dissolved oxygen | North County Times (August 24, 2002) |
| 1 Based on the memory of Jessie Stephens. Unreliable record.2 Letter from James Gyger, Fish and Game warden, written in 1919 and published in the Lake Elsinore Valley Press on June 13, 1919. States: “About every 15 or 20 years it [Lake Elsinore] gets so low that everything in it dies.”3 Fish kill observed to have begun over the deep part of the lake.4 Letter from the California Department of Fish and Game to the U.S. Department of the Interior states “… fish losses in Lake Elsinore have occurred to a varying degree almost annually for the past 10-15 years.” Quoted by Bovee (1989).5 Estimated at 1,000 tons in Hudson (1978).6 Letter from the California Department of Fish and Game to the U.S. Department of the Interior quoted by Bovee (1989). 7 The lake dried up in 1951. Probably few to no fish in the lake since the fish kill in August/September 1948.8 Lake partially refilled in 1952 to about 11 feet deep.9 Fish mortality occurred over this period of time.10 Fish mortality occurred over this period of time.11 Fish mortality occurred over this period of time.\* In both FMP and Water Board Staff Report\*\* In “Lake Elsinore Valley its Story 1776-1977” by Tom Hudson |

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| **Table A-3. Conductivity Thresholds of Common Fish Taxa found in Lake Elsinore and Canyon Lake.** |
| **Common Name** | **Species** | **Endpoint** | **Salinity Threshold (ppt)** | **Conductivity Threshold (µS/cm)** |
| Black Crappie | *Pomoxis nigromaculatus* | Presence | Up to 4.7 | Up to 8,457 |
| Channel Catfish | *Ictalurus punctatus* | No effect | Up to 8 | 13,855 |
| Common Carp | *Cyprinus carpio* | Lethality | 7.2 | 12,568 |
| Common Carp | *Cyprinus carpio* | LD50 | 12.8 | 21,356 |
| Gizzard shad | *Dorosoma cepedianum*\* | No effect | 2.0 – 34 | 4,130 – 51,714 |
| Striped Bass | *Morone saxatilis* | LC50 | > 22 | > 34,981 |
| Largemouth Bass | *Micropterus salmoides* | Decline in abundance | > 4.0 | > 7,276 |
| **\***Same genus as the Threadfin Shad, *Dorosoma petenense* |

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| **Table A-4. Conductivity Thresholds of Common Invertebrate Taxa found in Lake Elsinore and Canyon Lake.** |
| **Common Name** | **Species** | **Survival Conductivity Threshold (LC50 µS/cm)** | **Reproduction Conductivity Threshold (EC50 µS/cm)** | **Comment** |
| Water flea | *Daphnia pulex* | 1,820 | < 1,070 < 2,680 | 10-day LC50, tiered reproduction response. |
| Water flea | *Diaphanosoma brachyurum* | < 1,968 |  | 48-hr LC50 |
| Water flea | *Daphnia pulex* | 2,480 < 3,280 | 2,480 < 3,280 | 17-day LC50/EC50 |
| Water flea | *Daphnia middendorffiana* | 2,856 |  | 96-hr LC50, field collected organisms |
| Water flea | *Moinodaphnia macleayi* | 2,893 |  | 48-hr LC50 |
| Water flea | *Ceriodaphnia rigaudii* | 3,075 |  | 48-hr LC50 |
| Water flea | *Daphnia magna* | 3,120 |  | No *Daphnia* in lakes > 3,120 µS/cm |
| Water flea | *Daphnia pulex* | 3,318 |  | 96-hr LC50, field collected organisms |
| Water flea | *Ceriodaphnia dubia* | 3,350 | 2,890 | 7-day chronic LC50, EC50 not reported for reproduction  |
| Water flea | *Daphnia magna* | 4,284 |  | 96-hr LC50, field collected organisms |
| Water flea | *Ceriodaphnia dubia* | 4,620 | 3,830 | 7-day chronic |
| Water flea | *Simocephalus sp.* | 4,900 |  | 48-hr LC50 |
| Water flea | *Daphnia longispina* | 5,384 | 4,153 | 48-hr LC50; 21-day EC50 reproduction |
| Water flea | *Chydoridae* | 6,000 |  | 24-hr LC50 |
| Rotifer | *Epiphanes macrourus* | 6,100 | 2,000 < 4,000 | 96-hr LC50, EC50 120-hrs population growth |
| Calanoid Copepod | *Leptodiaptomus tyrelli* | 8,591 |  | 96-hr LC50, field collected organisms |
| Water flea | *Daphnia magna* | 9,125 |  |  |
| Water flea | *Daphnia magna* | 10,449 | 8,959 | 48-hr LC50; 21-day EC50 reproduction |
| Cyclopoid Copepod | *Eucyclops sp.* | 12,000 |  | 72-hr LC50 |
| Calanoid Copepod | *Hesperodiaptomus arcticus* | 12,332 |  | 96-hr LC50, field collected organisms |
| Cyclopoid Copepod | *Acanthocyclops sp.* | > 15,000 |  | 72-hr LC50 |

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| **Table A-5. Dissolved Oxygen (DO) Thresholds of Common Fish Taxa found in Lake Elsinore and Canyon Lake.** |
| **Common Name** | **Species** | **Endpoint** | **DO Threshold (mg/L)** | **Comment** |
| Largemouth Bass | *Micropterus salmoides* | distress | 5.0 | adults |
| Black Crappie | *Pomoxis nigromaculatus* | lethality | 4.3 | caged at 26 degrees |
| Common Carp | *Cyprinus carpio* | increased respiration | 4.2 | at 10 degrees |
| Common Carp | *Cyprinus carpio* | reduced metabolic rate | 3.4 | at 10 degrees |
| Channel Catfish | *Ictalurus punctatus* | retarded growth | 3.0 |  |
| Striped Bass | *Morone saxatilis* | lethality | 3.0 | juvenile |
| Striped Bass | *Morone saxatilis* | lethality | 3.0 | at 16 degrees, juvenile |
| Largemouth Bass | *Micropterus salmoides* | lethality | 2.5 | larval |
| Largemouth Bass | *Micropterus salmoides* | reduced metabolic rate | 2.3 | adults at 20 degrees |
| Gizzard Shad | *Dorosoma cepedianum* | lethality | 2.0 |  |
| White Bass | *Morone chrysops* | distress | 2.0 | at 24 degrees |
| White Bass | *Morone chrysops* | reduced survival | 1.8 | larvae at 16 degrees |
| American Shad | *Alosa sapidissima* | lethality | 1.6 | juvenile at 23 degrees |
| Striped Bass | *Morone saxatilis* | LC50 | 1.6 | juvenile & adult |
| Bluegill | *Lepomis macrochirus* | avoidance | 1.5 | adults |
| Largemouth Bass | *Micropterus salmoides* | avoidance | 1.5 | adult |
| Black Crappie | *Pomoxis nigromaculatus* | lethality | 1.4 |  |
| Largemouth Bass | *Micropterus salmoides* | lethality | 1.2 | at 25 degrees |
| Gizzard Shad | *Dorosoma cepedianum* | lethality | 1.0 | at 16 degrees |
| White Bass | *Morone chrysops* | lethality | 1.0 | at 24 degrees |
| Bluegill | *Lepomis macrochirus* | LC50 | 0.9 | at 30 degrees |
| Channel Catfish | *Ictalurus punctatus* | lethality | 0.9 | juvenile at 25-35 degrees |
| Common Carp | *Cyprinus carpio* | lethality | 0.7 | juveniles at 18 degrees |
| Common Carp | *Cyprinus carpio* | gulping air at surface | 0.5 |   |

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| **Table A-6. Un-ionized Ammonia Thresholds of Common Fish Taxa Observed in Lake Elsinore and Canyon Lake.** |
| **Common Name** | **Species** | **Endpoint** | **Un-ionized Ammonia as N Threshold (mg/L)** |
| White Perch | *Morone americana* | Species Mean Acute Value (LC50) | 0.27 |
| Hybrid Striped Bass | *Morone saxatilis x chrysops* | 0.43 |
| Pumpkinseed | *Lepomis gibbosus* | 0.52 |
| Guadalupe bass | *Micropterus treculii* | 0.54 |
| White Bass | *Morone chrysops* | 0.61 |
| Smallmouth bass | *Micropterus dolomieu* | 0.94 |
| Green sunfish | *Lepomis cyanellus* | 0.98 |
| Bluegill | *Lepomis macrochirus* | 0.99 |
| Steelcolor shiner | *Cyprinella whipplei* | 1.01 |
| Largemouth Bass | *Micropterus salmoides* | 1.09 |
| Spotfin shiner | *Cyprinella spiloptera* | 1.13 |
| Channel Catfish | *Ictalurus punctatus* | 1.43 |
| Common Carp | *Cyprinus carpio* | 1.44 |
| Striped Bass | *Morone saxatilis* | 1.78 |
| Rainbow dace | *Cyprinella lutrensis* | 2.42 |

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| **Table A-7. Un-ionized Ammonia Thresholds of Common Invertebrate Taxa Observed in Lake Elsinore and Canyon Lake (or those closely related).** |
| **Common Name** | **Species** | **Endpoint** | **Unionized Ammonia as N Threshold (mg/L)** |
| Water flea | *Ceriodaphnia acanthina* | Species Mean Acute Value (LC50) | 0.6 |
| Water flea | *Daphnia pulicaria* | 0.9 |
| Water flea | *Simocephalus vetulus* | 1.0 |
| Water flea | *Ceriodaphnia dubia* | 1.3 |
| Water flea | *Chydorus sphaericus* | 1.4 |
| Water flea | *Daphnia magna* | 1.6 |
| Oligochaete Worm | *Lumbriculus variegatus* | 1.7 |
| Midge | *Chironomus tentans* | 4.0 |