**APPENDIX 1-10: Summary of Diazinon Monitoring Data**

There are a large number of studies and data available on diazinon residues in air, surface water, drinking water, ground water, tissue (fish, mussel, clam, and crab), rain, and snow. Most of the available monitoring studies include samples collected at sites that were not chosen based on proximity (spatial or temporal) to pesticide usage and are thus referred to in this document as ‘non-targeted’ monitoring studies. Generally, ‘targeted’ monitoring would refer to data collected in a sampling program designed to correspond, both spatially and temporally, with a high likelihood of detection of a particular pesticide. Typically, sampling frequencies employed in monitoring studies are insufficient to ensure high probability that peak concentrations are captured. The limited amount of targeted data (which is discussed in the Environmental Fate Characterization in the section on dissipation studies), coupled with the fact that available data are not temporally or spatially correlated with known pesticide application times and/or areas, limit the utility of these data as indications of reasonably upper end exposure concentrations for risk assessment purposes. Therefore, in this assessment model-generated values are used for estimating acute and chronic exposure concentrations and monitoring data are used for characterization purposes. A lack of detections or low detected concentrations should not be interpreted as a reason to dismiss potential risk.

# Clean Water Act Programs

Diazinon is identified as a cause of impairment for 59 water bodies listed as impaired under section 303(d) of the Clean Water Act in California, Kansas, Oklahoma, and Washington (**Table B 1-10.3**).[[1]](#footnote-2) Impaired waters include rivers, creeks, drains, sloughs, channels, lakes, harbors, and drainage ditches. There are 107 Total Maximum Daily Loads (TMDL) listed for diazinon, and all of them are in California[[2]](#footnote-3). Section 304(a) ambient water quality criteria[[3]](#footnote-4), Aquatic life benchmarks, and Health Advisory levels[[4]](#footnote-5), have been established for diazinon (**Table B 1-10.1**). Monitoring data, impaired waters, and TMDLs for diazinon, demonstrate that the use of diazinon may result in transport of diazinon to surface water at levels that may cause risk to human health or the environment.

**Table B 1-10.1. Office of Water health advisories for diazinon1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Health Advisories** | | | | | |
| **10-kg Child** | | **70-kg Adult** | | | |
| **1-day (µg/L)** | **10-day**  **(µg/L)** | **RfD**  **(mg/kg/day)** | **DWEL1**  **(µg/L)** | **Life-time (µg/L)** | **mg/L at 10-4 Cancer Risk** |
| 20 | 20 | 0.0002 | 7 | 1 | NA |

DWEL=Drinking Water Equivalent Level

RfD=Reference Dose  
1 The 2012 Edition of the Drinking Water Standards and Health Advisories are available at <http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf> (accessed 2/28/2015)

**Table B 1-10.2. OPP aquatic life benchmarks and Office of Water aquatic life criteria for diazinon**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **OPP Aquatic Life Benchmarks** | | | | | | **Office of Water**  **Aquatic Life Criteria** | |
| **Fish** | | **Invertebrates** | | **Nonvascular Plants** | **Vascular Plants** |
| Acute1 | Chronic2 | Acute3 | Chronic4 | Acute5 | Acute6 | Maximum  Concentration | Continuous Concentration |
| 45 | <0.55 | 0.105 | 0.17 | 3700 | Not available | 0.17 | 0.17 |

1. Benchmark = Toxicity value x LOC. For acute fish, toxicity value is generally the lowest 96-hour LC50 in a standardized test (usually with rainbow trout, fathead minnow, or bluegill), and the LOC is 0.5.
2. Benchmark = Toxicity value x LOC. For chronic fish, toxicity value is usually the lowest NOEAC from a life-cycle or early life stage test (usually with rainbow trout or fathead minnow), and the LOC is 1.
3. Benchmark = Toxicity value x LOC. For acute invertebrate, toxicity value is usually the lowest 48- or 96-hour EC50 or LC50 in a standardized test (usually with midge, scud, or daphnid), and the LOC is 0.5.
4. Benchmark = Toxicity value x LOC. For chronic invertebrates, toxicity value is usually the lowest NOAEC from a life-cycle test with invertebrates (usually with midge, scud, or daphnids), and the LOC is 1.
5. Benchmark = Toxicity value x LOC. For acute nonvascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (usually with green algae or diatoms), and the LOC is 1.
6. Benchmark = Toxicity value x LOC. For acute vascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (usually with duckweed) and the LOC is 1.

**Table B 1-10.3. Summary of waters listed as impaired due to diazinon**

| **State** | **Waterbody** | **River basin** |
| --- | --- | --- |
| CA | [ALAMO RIVER](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR7231000019990205093023&p_cycle=&p_report_type=) | COLORADO RIVER BASIN |
| [ARROYO PAREDON](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3153401019990222143223&p_cycle=&p_report_type=) | CENTRAL COAST |
| [ARROYO TRABUCO CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR9012000020011025103603&p_cycle=&p_report_type=) | NR |
| [BEAR CREEK (SAN JOAQUIN AND CALAVERAS COUNTIES; PARTLY IN DELTA WATERWAYS, EASTERN PORTION)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5312000020080709162556&p_cycle=&p_report_type=) | NR |
| [BEAR RIVER, LOWER (BELOW CAMP FAR WEST RESERVOIR)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5151000020000208113114&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [BLANCO DRAIN](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101019981209161509&p_cycle=&p_report_type=) | CENTRAL COAST |
| [BUTTE SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5203000020011128163228&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [CHUALAR CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091900020080604161337&p_cycle=&p_report_type=) | CENTRAL COAST |
| [COLUSA BASIN DRAIN](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5202100019980813170249&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [COYOTE CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR4051501019980917123914&p_cycle=&p_report_type=) | LOS ANGELES |
| [DEL PUERTO CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5411000020011212111305&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [DOMINGUEZ CHANNEL (LINED PORTION ABOVE VERMONT AVE)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR4051200019980918161017&p_cycle=&p_report_type=) | LOS ANGELES |
| [DRY CREEK (TRIBUTARY TO TUOLUMNE RIVER AT MODESTO, E STANISLAUS COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5354001120080623180014&p_cycle=&p_report_type=) | NR |
| [ESPINOSA LAKE](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAL3091900020020117151744&p_cycle=&p_report_type=) | CENTRAL COAST |
| [ESPINOSA SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101019981230135152&p_cycle=&p_report_type=) | CENTRAL COAST |
| [FRENCH CAMP SLOUGH (CONFLUENCE OF LITTLEJOHNS AND LONE TREE CREEKS TO SAN JOAQUIN RIVER, SAN JOAQUIN CO; PARTLY IN DELTA WATERWAYS, EASTERN PORTION)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5314000020020702142222&p_cycle=&p_report_type=) | NR |
| [GILSIZER SLOUGH (FROM YUBA CITY TO DOWNSTREAM OF TOWNSHIP ROAD, SUTTER COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5203000020080702172323&p_cycle=&p_report_type=) | NR |
| [INGRAM CREEK (FROM CONFLUENCE WITH SAN JOAQUIN RIVER TO CONFLUENCE WITH HOSPITAL CREEK)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5411000020011211113332&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [JACK SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5154000020011211114128&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [LIVE OAK SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5203000020070511150326&p_cycle=&p_report_type=) | NR |
| [LOS ANGELES RIVER REACH 1 (ESTUARY TO CARSON STREET)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR4051200019990202083037&p_cycle=&p_report_type=) | LOS ANGELES |
| [MAIN DRAINAGE CANAL](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5204000020041130180509&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [MAIN STREET CANAL](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3121003020020819110803&p_cycle=&p_report_type=) | CENTRAL COAST |
| [MERCED RIVER, LOWER (MCSWAIN RESERVOIR TO SAN JOAQUIN RIVER)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5357000019980817154245&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [MORRISON SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5203000020070511132905&p_cycle=&p_report_type=) | NR |
| [MOSS LANDING HARBOR](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAB3060001419981214121135&p_cycle=&p_report_type=) | CENTRAL COAST |
| [MUSTANG CREEK (MERCED COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5356000020080808193633&p_cycle=&p_report_type=) | NR |
| [NATOMAS EAST MAIN DRAINAGE CANAL (AKA STEELHEAD CREEK, DOWNSTREAM OF CONFLUENCE WITH ARCADE CREEK)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5192100020021209150207&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [NEW RIVER (IMPERIAL COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR7231000019990205102948&p_cycle=&p_report_type=) | COLORADO RIVER BASIN |
| [OLD SALINAS RIVER](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101020080611145518&p_cycle=&p_report_type=) | CENTRAL COAST |
| [ORCUTT CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3121003020011129154708&p_cycle=&p_report_type=) | CENTRAL COAST |
| [ORESTIMBA CREEK (ABOVE KILBURN ROAD)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5422003219990126113826&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [ORESTIMBA CREEK (BELOW KILBURN ROAD)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5355000020021209154446&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [PETALUMA RIVER](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR2063002019980928165716&p_cycle=&p_report_type=) | SAN FRANCISCO BAY |
| [PETALUMA RIVER (TIDAL PORTION)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR2063004020020916200425&p_cycle=&p_report_type=) | SAN FRANCISCO BAY |
| [PIXLEY SLOUGH (SAN JOAQUIN COUNTY; PARTLY IN DELTA WATERWAYS, EASTERN PORTION)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5312000020080803212723&p_cycle=&p_report_type=) | NR |
| [QUAIL CREEK](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091900020011227140647&p_cycle=&p_report_type=) | CENTRAL COAST |
| [REDHAWK CHANNEL](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR9025100020080904171327&p_cycle=&p_report_type=) | NR |
| [SALINAS RECLAMATION CANAL](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101019980828112229&p_cycle=&p_report_type=) | CENTRAL COAST |
| [SALINAS RIVER (LOWER, ESTUARY TO NEAR GONZALES RD CROSSING, WATERSHEDS 30910 AND 30920)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101020021007193102&p_cycle=&p_report_type=) | CENTRAL COAST |
| [SANTA CLARA RIVER REACH 6 (W PIER HWY 99 TO BOUQUET CYN RD) (WAS NAMED SANTA CLARA RIVER REACH 8 ON 2002 303(D) LIST)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR4035100019990204123459&p_cycle=&p_report_type=) | LOS ANGELES |
| [SPRING CREEK (COLUSA COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5612002020070510165737&p_cycle=&p_report_type=) | NR |
| [STANISLAUS RIVER, LOWER](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5353000019980817151834&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [TEMBLADERO SLOUGH](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR3091101019981209131830&p_cycle=&p_report_type=) | CENTRAL COAST |
| [TUOLUMNE RIVER, LOWER (DON PEDRO RESERVOIR TO SAN JOAQUIN RIVER)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5355000019980817143435&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [ULATIS CREEK (SOLANO COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5601001220080801154307&p_cycle=&p_report_type=) | NR |
| [WADSWORTH CANAL](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5203000020041130173733&p_cycle=&p_report_type=) | CENTRAL VALLEY |
| [WINTERS CANAL (YOLO COUNTY)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=CAR5112000020080801150313&p_cycle=&p_report_type=) | NR |
| KS | [LABETTE CR](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_21&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [LABETTE CR](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_22&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [LITTLE LABETTE CR](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_23&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [TOLEN CR](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_39&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [UNNAMED STREAM](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_298&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [UNNAMED STREAM](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_303&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [UNNAMED STREAM](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_304&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| [UNNAMED STREAM](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=KS-NE-05-564_305&p_cycle=&p_report_type=) | NEOSHO RIVER BASIN |
| OK | [Haikey Creek](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=OK120410010210_00&p_cycle=&p_report_type=) | NR |
| WA | [GRAYS HARBOR COUNTY DRAINAGE DITCH NO. 1 (GHCDD-1)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=WA1240884468222_0%2E052&p_cycle=&p_report_type=) | NR |
| [PACIFIC COUNTY DRAINAGE DITCH NO. 1 (PCDD-1)](http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=WA1240478467266_0%2E998&p_cycle=&p_report_type=) | NR |

NR=not reported.

# Surface Water

## USGS NAWQA Surface Water Data (1992 – 2014)

Surface water data from the USGS NAWQA program were obtained on December 30, 2014 (USGS, 2015). A total of 30,297 water samples across 2,206 sites throughout the United States were analyzed for diazinon between 1993 and 2014. There were 8,313 detections (27% of samples) of diazinon in the United States and concentrations ranged from not detectable to 3.8 µg/L. Forty-six states had detections of diazinon in surface water. After 2004, the highest detected concentration was 0.359 µg/L. The long term method detection level is 0.003 µg/L (Gilliom *et al.*, 2007). As expected, higher numbers of samples collected within a given state tended to correspond with higher maximum concentrations detected (**Figure B 1-10.1**). Eleven states[[5]](#footnote-6) had detections at 0.9 µg/L or greater and 34 states had detections above 0.1 µg/L (**Table B 1-10.4**). Detections above 0.1 µg/L occurred in creeks and storm drains, as well as in major rivers.

**Figure B 1-10.1. Number of surface water samples analyzed for diazinon in each state and the maximum diazinon concentration in surface water detected in that state**

**Table B 1-10.4. Summary of NAWQA monitoring results for diazinon by state**

| **State/Tribal Area** | **Detections** | **Samples** | **Frequency** | **Maximum Diazinon Concentration Detected (µg/L)** | **Sample Years** |
| --- | --- | --- | --- | --- | --- |
| Alabama | 197 | 881 | 22% | 1.01 | 1998-2008 |
| Alaska | 5 | 47 | 11% | 0.0427 | 1999 |
| Arizona | 95 | 265 | 36% | 0.207 | 1996-2010 |
| Arkansas | 55 | 404 | 14% | 0.0328 | 1994-2010 |
| California | 1602 | 2442 | 66% | 3.8 | 1992-2012 |
| Colorado | 298 | 848 | 35% | 0.66 | 1993-2010 |
| Connecticut | 116 | 406 | 29% | 0.21 | 1993-2010 |
| Delaware | 1 | 5 | 20% | 0.007 | 1999 |
| District of Columbia | 6 | 6 | 100% | 0.21 | 1994 & 2000 |
| Florida | 116 | 618 | 19% | 0.276 | 1993-2005 |
| Georgia | 441 | 1696 | 26% | 2.8 | 1993-2010 |
| Hawaii | 23 | 57 | 40% | 0.293 | 1999-2001 |
| Idaho | 17 | 485 | 4% | 0.093 | 1994-2004 |
| Illinois | 434 | 1421 | 31% | 0.224 | 1996-2009 |
| Indiana | 669 | 1801 | 37% | 1.1 | 1991-2010 |
| Iowa | 28 | 1169 | 2% | 0.095 | 1996-2011 |
| Kentucky | 11 | 151 | 7% | 0.0067 | 1997-2008 |
| Louisiana | 347 | 1664 | 21% | 0.978 | 1995-2009 |
| Maine | 0 | 4 | 0% | Not detected | 2000 |
| Maryland | 50 | 393 | 13% | 0.1 | 1994-2004 |
| Massachusetts | 117 | 293 | 40% | 0.4 | 1994-2011 |
| Michigan | 68 | 227 | 30% | 0.197 | 1996-2006 |
| Minnesota | 121 | 655 | 18% | 0.19 | 1996-2010 |
| Mississippi | 29 | 513 | 6% | 0.025 | 1996-2007 |
| Missouri | 49 | 383 | 13% | 0.114 | 1994-2005 |
| Montana | 1 | 224 | 0% | 0.003 | 2000 |
| Nebraska | 123 | 927 | 13% | 0.184 | 1992-2009 |
| Nevada | 190 | 465 | 41% | 0.46 | 1993-2008 |
| New Hampshire | 5 | 32 | 16% | 0.006 | 1994 & 2000 |
| New Jersey | 216 | 704 | 31% | 0.47 | 1996-2009 |
| New Mexico | 28 | 122 | 23% | 0.21 | 1993-1996 |
| New York | 135 | 663 | 20% | 0.697 | 1994-2007 |
| North Carolina | 246 | 973 | 25% | 0.315 | 1992-2009 |
| North Dakota | 1 | 162 | 1% | 0.004 | 1995 |
| Ohio | 336 | 842 | 40% | 0.564 | 1996-2008 |
| Oklahoma | 2 | 13 | 15% | 0.017 | 1994-1995 |
| Oregon | 320 | 1053 | 30% | 1.28 | 1992-2011 |
| Pennsylvania | 235 | 1095 | 21% | 0.436 | 1993-2010 |
| Rhode Island | 0 | 1 | 0% | Not Detected | 1999 |
| South Carolina | 94 | 526 | 18% | 0.323 | 1996-2005 |
| Tennessee | 97 | 537 | 18% | 1.05 | 1996-2004 |
| Texas | 661 | 1547 | 43% | 1.2 | 1993-2013 |
| Utah | 166 | 354 | 47% | 1.22 | 1999-2010 |
| Vermont | 0 | 9 | 0% | Not detected | 1994-1995 |
| Virginia | 213 | 886 | 24% | 1.4 | 1993-2010 |
| Washington | 210 | 1487 | 14% | 0.501 | 1993-2012 |
| West Virginia | 4 | 84 | 5% | 0.338 | 1994 & 1996 |
| Wisconsin | 148 | 673 | 22% | 0.98 | 1993-2011 |
| Wyoming | 2 | 84 | 2% | 0.0474 | 2003 |
| United States | |  |  |  |  | | --- | --- | --- | --- | | 8328 | 30297 |  | 27% | | 30297 | 27% | 3.80 | 1993-2014 |

A total of 1,499 surface water samples across sites throughout the United States were analyzed for diazoxon between 2002 and 2014. Detections occurred in 2004 in California and Texas. Concentrations ranged from not detected to 0.06 µg/L with the highest detection occurring in 2004. The limit of quantitation ranged from 0.006 to 0.045 µg/L based on the range of less than values reported in the dataset. Diazinon and diazoxon were analyzed in these samples and the ratio of the concentration of the oxon to the diazinon concentration ranged from 0.11 to 0.25.

## Pesticide Concentrations in Drinking Water USGS and USEPA in (1999-2000)

In 1999 and 2000, the United States Geological Survey (USGS) and USEPA collaborated in examining concentrations of pesticides in twelve small drinking-water supply reservoirs in areas of high pesticide use. The reservoirs range in size from 120 to 92,600 acre-feet with contributing watersheds ranging in size from 3.3 to 784 square miles and (Blomquist *et al.*, 2001). Water samples were collected from raw-water intake, finished drinking water, and some reservoir outflows. Samples were collected quarterly throughout the year and at weekly or biweekly intervals following the primary pesticide application periods. Diazinon was detected in 35% (114 of 323) of raw water samples and was one of the most frequently detected insecticides at a maximum concentration of 0.11 µg/L detected in Lake Arcadia, Oklahoma. This was the reservoir with the smallest capacity of 120 acre-feet and a high sampling frequency and had both urban and agriculture areas in the counties intersecting the watershed. Diazinon was not detected in finished water samples. Diazoxon was not included as an analyte in the study. Studies have shown that organophosphorus compounds are readily oxidized in the presence of chlorine and ozone, and could form diazoxon. While diazinon was not observed in finished water samples, it is possible that diazoxon was present in the samples.

## Drinking Water Monitoring in 44 Community Water Systems (MRID 45513501, 45526200, 46626201)

This monitoring study was conducted on behalf of five companies for supporting the registration of organophosphates. This study was initiated voluntarily by a consortium of registrants, not in response to an EPA Data-Call-In. Residues of six organophosphate insecticides were monitored at finished drinking water collected from 44 community water systems near areas where a high percentage of the sales of the pesticide were made.

The study collected and analyzed 1103 samples from 44 surface-water-sourced CWS's, 73 1 of these were from 27 agriculturally influenced CWS's and 372 were from 17 urban influenced CWS's. All of these samples were taken from finished water. In addition 12 samples were taken from raw water, 6 from each of two sites. (The collection of these samples was not indicated in the protocol, and the purpose of collecting them is not clear.) There were a total of 77 detections during the study. However, 64 of the detections were attributed to laboratory cross-contamination and 6 were due to matrix interference. The remaining 7 detects represent actual occurrence of the analyte in the samples. Each of the 7 detections represents the occurrence of one pesticide in a sample.

Diazinon was not found in any sample collected during the study; however, diazoxon was found in three samples, each from a different water supply. The detections are summarized in **Table B 1-10.5**.

**Table B 1-10.5. Detections of diazoxon in drinking water**

| **Location** | **Water Body** | **Date** | **Concentration (µg/L)** |
| --- | --- | --- | --- |
| York, PA | Codorus Creek | June 21, 1999 | 0.15 |
| Atlanta, GA | Cattahoochie River | April 4, 2000 | 0.131 |
| Philadelphia Suburban Water Co., PA | Nashaminy Creek | August 16, 1999 | 0.055 |

## Pesticide Data Program (PDP) Surface Water (2001-2013)

The Pesticide Data Program (PDP) is a national pesticide residue database program that examines pesticide residues in agricultural commodities and drinking water in the United States food supply to support pesticide dietary exposure assessments (USDA, 2013). Finished drinking water monitoring in California and New York began in 2001. In 2002, the program was expanded to Colorado, Kansas, and Texas. In 2004, the program began examining paired raw and finished drinking water samples sourced from surface water. The survey ended in 2013. The limit of detection ranged from 3.3 to 30 ng/L.

Diazinon was detected in 0.10% of surface water source water samples (six of 5,921 samples) at a maximum diazinon concentration of 0.133 µg/L (**Table B 1-10.6**). Detections occurred in 2001, 2002, 2003, 2007, and 2010. Most detections occurred in raw water; however, there were also detections in finished water.

**Table B 1-10.6. Summary of surface water sourced drinking water monitoring data from the PDP**

| **Year** | **Detects** | **Number of Samples** | **Frequency of Detects** | **Diazinon Maximum Concentration (µg/L)** | **Detect(s) in** |
| --- | --- | --- | --- | --- | --- |
| 2001 | 1 | 283 | 0.35% | 0.010 | Finished Water |
| 2002 | 1 | 657 | 0.15% | 0.010 | Finished Water |
| 2003 | 1 | 794 | 0.13% | 0.133 | Finished Water |
| 2004 | 0 | 239 | 0.00% | NA | Paired raw and finished water |
| 2005 | 0 | 232 | 0.00% | NA | Paired raw and finished water |
| 2006 | 0 | 368 | 0.00% | NA | Paired raw and finished water |
| 2007 | 1 | 733 | 0.14% | 0.0164 | Paired raw and finished water |
| 2008 | 1 | 619 | 0.16% | 0.1 | Paired raw and finished water |
| 2009 | 0 | 612 | 0.00% | NA | Paired raw and finished water |
| 2010 | 1 | 559 | 0.18% | 0.059 | Paired raw and finished water |
| 2011 | 0 | 240 | 0.00% | NA | Paired raw and finished water |
| 2012 | 0 | 485 | 0.00% | NA | Paired raw and finished water |
| 2013 | 0 | 100 | 0.00% | NA | Paired raw and finished water |
| Total | 6 | 5921 | 0.10% | 0.133 | Raw and finished water |

NA=not applicable

## STORET/WQX Data Warehouse (1986-2012)

STORET/Water Quality Exchange (WQX) is a repository for water quality, biological, and physical data maintained by the USEPA. Data are submitted by states, tribes, and others. Data were downloaded on February 15, 2015 (USEPA, 2015). Data were available from several states and are summarized in **Table B 1-10.7**. This summary includes data that are reported elsewhere for California but were also submitted to STORET. There were 29 samples with diazinon concentrations above 1 µg/L. Most of these higher detections occurred in California and Alabama but some also occurred in Minnesota, Missouri, and Florida in samples collected between 1993 and 2003.

Surface water samples were collected and analyzed for diazoxon. In 2009 in Washington State, 10 samples were collected in Callam County and diazoxon was present in all samples above the method detection limit, but below an unreported quantitation limit. Diazoxon was not detected in 2,890 samples collected in Minnesota between 2012 and 2013 with a method detection limit ranging from 0.075 to 0.15 µg/L.

**Table B 1-10.7. Summary of STORET surface water monitoring data by State**

| **State** | **Detections** | **Total Samples** | **Frequency of Detections** | **Maximum Diazinon Concentration µg/L** |
| --- | --- | --- | --- | --- |
| Alabama | 24 | 474 | 5.06% | 4.2 |
| Arizona | 47 | 846 | 5.56% | 0.697 |
| Arkansas | 40 | 545 | 7.34% | 0.38732 |
| Californiaa | 415 | 683 | 60.76% | 6.7 |
| Colorado | 0 | 127 | 0.00% | -- |
| Florida | 374 | 4864 | 7.69% | 1.8 |
| Idaho | 0 | 19 | 0.00% | -- |
| Illinois | 161 | 1318 | 12.22% | 0.48 |
| Iowa | 28 | 3970 | 0.71% | 0.46 |
| Kansas | 50 | 262 | 19.08% | 0.85 |
| Kentucky | 6 | 277 | 2.17% | 0.0501 |
| Louisiana | 1 | 18 | 5.56% | 0.0569 |
| Minnesota | 134 | 6628 | 2.02% | 1.66 |
| Missouri | 20 | 110 | 18.18% | 1.5 |
| Montana | 0 | 2 | 0.00% | -- |
| New Mexico | 0 | 91 | 0.00% | -- |
| North Carolina | 0 | 1135 | 0.00% | -- |
| North Dakota | 20 | 247 | 8.10% | Detections below quantitation Level of (MDL=0.1 µg/L) |
| Oklahoma | 32 | 39 | 82.05% | 0.03035 |
| South Dakota | 251 | 251 | 100.00% | Detections below quantitation Level (MDL=0.25 µg/L) |
| Tennessee | 0 | 5 | 0.00% | -- |
| Texas | 0 | 1 | 0.00% | -- |
| Spirit Lake (Tribal Data) | 1 | 1 | 100.00% | Detections below quantitation Level of (MDL=0.1 µg/L) |
| Utah | 32 | 513 | 6.24% | 0.6 |
| Washington | 79 | 116 | 68.10% | 0 |
| Wisconsin | 69 | 69 | 100.00% | 0.5 |
| Wyoming | 0 | 5 | 0.00% | -- |
| All States | 1784 | 22616 | 7.89% | 6.7 |

MDL=method detection limit

a Some values reported in California were duplicates. These duplicates were not removed for this analysis.

## South Florida Water Management District (1992 – 2007)

The south Florida Water Management District is responsible for management of water quality in 16 counties from Orlando to the Florida Keys. The area includes management of canals, levees, water control structures, and pump stations. Monitoring for 80 pesticides and degradation products was conducted at 34 aquatic sampling sites in South Florida. Sampling sites covered the area from Lake Okeechobee south into the Everglades National Park. Water samples are collected four times a year and sediment samples are collected twice a year from each designated site. Diazinon was one of the most frequently detected insecticides and was observed in 21% of surface water samples (15 out of 71). The maximum concentration detected was 1.9 µg/L. Diazinon was not observed in sediment samples. Sediment samples were collected from the same sites as water samples, but not as many samples were collected.

## Oregon Laboratory Analytical Storage and Retrieval Database (LASAR)

The Oregon Laboratory Analytical Storage and Retrieval Database (LASAR) was searched on February 23, 2015 (Oregon Department of Environmental Quality, 2015). Diazinon was not detected in 190 surface water samples collected between 1999 and 2002 or in 71 groundwater samples collected in 1993, 1994, and 1999. The limit of detection for surface water ranged from 0.01 to 0.2 µg/L based on less-than values reported in the dataset. Diazinon was detected in 20% (1 of 5) of sediment samples collected in 1998 at a maximum concentration of 8 µg/kg-dry weight. The limit of detection in sediment was 5 µg/kg-dry weight.

## Washington Monitoring Data

# State of Washington Environmental Information Management System

The Washington Environmental Information Management System (Washington State Department of Ecology, 2015) is a repository of data for air, water, soil, sediment, aquatic animals, and plants for the state of Washington. Data were downloaded from the site on February 23, 2015. Data from this database were submitted to the Water Quality Exchange System (STORET) and in the cranberry monitoring summary. The limit of detection for different methods ranged from 0.024 to 0.3 µg/L. Diazinon was detected in 233 of 4667 surface water samples (5.0%). There were 11 surface water samples with diazinon concentrations above 1 µg/L (maximum of 5.7 µg/L) that were collected in the Grayland Ditch System in 1996 and 2002. There were 161 surface water samples with diazinon concentrations ranging from 0.1 to 0.9 µg/L and 183 surface water samples between 0.05 and 0.099 µg/L.

## Washington State Cranberry Bog

Diazinon has been detected above state water quality criteria over the previous 17 years in water draining from cranberry bogs into the Grays Harbor County Drainage Ditch and Pacific County Drainage Ditch (Baker, 2014). Exceedances of water quality criteria requires the Washington State Department of Agriculture to follow guidance in pesticide management. Under this plan, sampling in the ditches draining from cranberry bogs is monitored.

In June and July of 1998, the Washington State Department of Ecology collected water samples at three sites in surface drainage ditches from cranberry-growing areas near Grayland, Washington (Anderson and Davis, 2000). Two sites were test sites, and a third location was a control site. Samples were collected to evaluate whether implemented best management practices resulted in lower pesticide concentrations in the ditches. Water draining from cranberry bogs and residential property in the Grayland/North Cove area south of Westport is collected in a ditch system that discharges into Willapa Bay to the north and in the south bay of Grays Harbor. Both ditches receive water from small streams that run down the hills east of the cranberry bogs and directly from shallow groundwater within bogs. Water samples were collected pre and post-spray and analyzed for diazinon, chlorpyrifos, and azinphos-methyl. Diazinon was detected in all but two samples (8 of 10 samples) and concentrations ranged from 0.033 µg/L to 7.0 µg/L. Anderson and Davis (2000) summarized results from previous years (**Table B 1-10.7**), and results indicated that the best management practices that were implemented did not result in decreased diazinon concentrations in the ditches. The limit of quantitation for diazinon was 0.06 µg/L.

A report in 2014 (Baker, 2014) updated the analysis with monitoring data collected in 2002 and 2012. Additional sites were added in each drainage ditch. Samples were collected one week prior to pesticide application, during the week of peak application, and two weeks following application. These results are also summarized in **Table B 1-10.8**. Diazinon was detected in up to 100% of samples in at least one site every year. The maximum detected concentration in 2002 was 5.7 µg/L and 2.2 µg/L in 2009.

**Table B 1-10.8. Summary of diazinon concentrations in water**

| **Parameter** | **Diazinon Concentration in Water µg/L** | | | |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **1994** | **1995** | **1996** | **1998** | **2002** | **2009** |
| Grays Harbor County Drainage Ditch No. 1 | | | | |  |  |
| Frequency | NR | NR | 100% (26/26) | 100%  (5/5) | 100%  (9/9) | 56%  (5/9) |
| Mean | 0.20 | 0.24 | 0.86 | 1.13 | 0.96 | 0.281 |
| Max | 0.029 | 0.68 | 5.4 | 4.4 | 5.7 | 2.2 |
| Pacific County Drainage Ditch No. 1 | | | | |  |  |
| Frequency | NR | NR | 96%  (25/26) | 100%  (5/5) | 100%  (12/12) | 100%  (9/9) |
| Mean | No data | No data | 0.3 | 2.4 | 0.31 | 0.180 |
| Range | No data | No data | 1.7 | 7.0 | 0.71 | 0.42 |

NR=Not reported

## California Monitoring Data

Since 2000, USGS, in cooperation with the CADPR, has published several reports involving monitoring of California water bodies for diazinon. These studies are briefly described below. Several mitigations resulting from the registration review of diazinon were implemented between 2004 and 2008. These include cancellation of all granular formulations, residential uses (excluding use in nurseries), and aerial applications to all crops except lettuce. Hall and Anderson (2014) evaluated toxicity and pesticide monitoring data in the California central valley in 2004 to 2009 and noted that “regression analysis of the annual percent of diazinon samples exceeding the water quality objective of 100 ng/L showed a significant decline in exceedances from 2004 to 2009.” Several of California waters on are on the 303(d) list of impaired waters due to contamination with diazinon. These include waters in the San Francisco Bay region, Central Coast region, Los Angeles region, Central Valley region, Colorado River Basin, and San Diego region.

### California Department of Pesticide Regulation (CADPR) Data (1990-2012)

CADPR maintains a database of monitoring data on pesticides in CA surface waters (California Department of Pesticide Regulation, 2015). The sampled water bodies include rivers, creeks, urban streams, agricultural drains, the San Francisco Bay delta region, and storm water runoff from urban areas. The database contains data from 51 different studies by federal (including the USGS NAWQA program), state and local agencies as well as groups from private industry and environmental interests. Data are available from 1990-2012 for several pesticides and degradates. Data on diazinon and diazoxon are included in this database. For the purpose of this assessment, diazinon and diazoxon monitoring data from 1991-2012 were accessed from the CADPR database and are discussed below. Data on diazinon are also available after 2012; however, they are not included in the numbers here because these data are not in the database.[[6]](#footnote-7) Additionally, the detections are within the range of detections reported in earlier years. Concentrations of diazinon in surface waters measured in California are shown in **Figure B 1-10.2**. From 2004 to 2012, 13,620 samples from CA surface waters were analyzed for diazinon. Of these, diazinon was detected in 33% of samples, at a maximum concentration of 61.9 µg/L in a creek in an agricultural area[[7]](#footnote-8) in 2009. Detections greater than 10 µg/L occurred when more than 500 samples were collected in a year in creeks, large rivers, and artificial drains. The month in which peak concentrations occurred varied by site with peaks occurring somewhere in almost every month of the year. Several mitigations were implemented on use of diazinon between 2004 and 2008 including cancelling residential uses (except nurseries), granular formulations, and seed treatment uses.[[8]](#footnote-9),[[9]](#footnote-10) Additionally, aerial applications were only allowed for use on lettuce. It is not possible to draw conclusions on the impact of these mitigations on monitoring results as the frequency of sampling and locations of sampling have changed over time; however, there have been only two detections above 15 µg/L since 2007. Detections between 1 and 10 µg/L (15 detections between 2008 and 2012) occur up to the last year sampled, and detections below 1 µg/L are common (307 detections between 2008 and 2012).

**Figure B 1-10.2. CADPR reported concentrations of diazinon in surface waters in CA (includes detections only) between 1991 and 2012. The same data are shown in two figures, with and without log transformation of the y-axis.**

In California, 773 samples were analyzed to determine whether they contained diazoxon between 1991 and 1995. Diazoxon was detected in five samples at 0.06, 0.08, 0.21, 0.39, and 0.43 µg/L. The limit of quantitation ranged from 0.05 to 0.1 µg/L. Detections occurred in Merced and San Joaquin counties in Spillways, wasteways[[10]](#footnote-11), and a slough.

Data were also collected for both diazinon and diazoxon at a number of sites in California on the same date. For four of the diazoxon detections, the ratio of the concentration of diazoxon to the concentration of diazinon was below 8%. For one diazoxon detection, the ratio was 51%.

### CEDEN

Surface water and sediment monitoring data from the California Environmental Data Exchange Network (CEDEN) were obtained on January 19, 2015 (State Water Resources Control Board, 2015). These data are also included in the STORET summary. A total of 3,563 water samples across 8,165 sites throughout the California were analyzed for diazinon between 1993 and 2014. There were 1,680 detections (47% of samples) of diazinon in the California and concentrations ranged from not detected to 6.7 µg/L. After 2007, the highest detection was 1.15 µg/L. The method detection limit ranged from 0.0001 to 0.05 µg/L. There were 23 detects at 1 µg/L and above and they occurred in the Alamo River, New River, Bouquet Canyon creek, river outlets, and Strong Ranch slough between 2001 and 2012.

### Regions of California with Frequent Detections (2005 – 2010)

Zhang *et al.* (2012) analyzed monitoring results and diazinon usage data collected between 2005 and 2010 in five agricultural regions in California with the objective of identifying diazinon use scenarios that contribute to frequent detections in surface water in California (**Table B 1-10.9**). Diazinon usage decreased 75% between 2005 and 2010 in California. The Salinas Valley had the highest amount of diazinon used and the greatest area treated. The Sacramento valley ranked second. The San Joaquin, Imperial, and Santa Maria Valleys had lower amounts of diazinon applied. Use on lettuce accounted for 77% of the diazinon used in California. The Salinas Valley had detections in 91% of samples collected and the maximum diazinon concentration detected was 24.47 µg/L. Zhang *et al.* (2012) noted that the high frequency of detection and high maximum concentration detected were likely due to the large amount of diazinon used in a relatively small watershed.

**Table B 1-10.9. Summary of monitoring results for regions with high detection frequency of diazinon**

| Region | Sites | # of Samples | Frequency of Detections | Max Diazinon Concentration µg/L | Lbs Diazinon Applied | Major Crops |
| --- | --- | --- | --- | --- | --- | --- |
| Sacramento | 73 | 850 | 30.2% | 2.5 | 152,557 | Prune, tomatoes, peach, walnut |
| San Joaquin | 121 | 2465 | 10.0% | 1.2 | 46,272 | Cherry, peach, almond, corn |
| Salinas | 33 | 244 | 91.0% | 24.465 | 380,508 | Lettuce, Broccoli, Cauliflower and Spinach |
| Santa Maria | 12 | 21 | 90.5% | 0.977 | 27,700 | Lettuce, broccoli, cauliflower |
| Imperial | 12 | 58 | 51.7% | 3.240 | 105,761 | Sugar beet, lettuce, broccoli |

### Irrigation-Season Use in California (2003-2008)

California monitoring data collected between 2003 to 2008 were evaluated to better understand the extent to which diazinon moves offsite into surface water after irrigation season use (Starner, 2009). Monitoring data from samples sites that could potentially receive runoff from dormant spray applications of diazinon, or from urban sources, were identified and eliminated from the analysis to focus the analysis on irrigation seasons uses and sources. Samples that were included in the analysis were collected in the Central Valley (Sacramento Valley, San Joaquin Valley, and Tulare), areas along the Central Coast (including Salinas Valley, Pajaro, and Santa Maria) and southeastern California (Imperial Valley). Overall, diazinon was detected in 637 of 2,635 samples (24 percent) and concentrations exceeded 0.16 µg/L in nine percent of all samples. Frequencies of detections exceeding 0.16 µg/L were up to 65% in some areas. Crops grown in high frequency/high detection areas included cool weather crops such as lettuce, spinach and broccoli.

### San Joaquin River Basin

The San Joaquin River Basin drains an area in Sierra Nevada Mountains and the San Joaquin Valley, and the Pacific Coast. Relevant diazinon usage for this basin included dormant season applications (December – February) to stone fruits and almonds (Kratzer *et al.*, 2002; Zamora *et al.*, 2003) and field crops and orchards during the April to August 2001 time frame (Domagalski and Munday, 2003).

In January-February 2000, USGS sampled 13 sites within the San Joaquin River Basin, on a weekly basis during non-storm periods, and more frequently during storm events (Kratzer *et al.*, 2002). These sampling periods coincided with dormant season applications of diazinon to orchards (mainly stone fruit and nuts). Applications may have also occurred in urban areas. In 2000, five major river (Tuolumne River and San Joaquin River) and eight minor tributary sites were sampled. In January-February 2001, 16 sites (7 rivers, 8 precipitation, and one urban storm drain) were sampled, with some overlap between the sites from one year to the next. During both time periods and for the majority of the sample sites, the highest concentrations of diazinon were observed during storm runoff events. Samples were collected weekly during non-storm periods and several times during storm runoff from one or two storms in 2000, and during four storm events in 2001. In the 2000 study, diazinon was detected in 82-100% of samples per site with a maximum observed concentration of 1.06 µg/L at Del Puerto Creek at Vineyard Road, near Patterson (Kratzer *et al.*, 2002)[[11]](#footnote-12). In the 2001 study, diazinon was detected in 95-100% of samples per site with a maximum observed concentration of 0.435 µg/L in the Merced River (Zamora *et al.*, 2003).

During April to August 2001, 12 sites within the San Joaquin Valley were sampled weekly for diazinon (Domagalski and Munday, 2003). Some of the sites sampled during this study overlapped with those studied in previous USGS studies. During April-August, diazinon was detected in 10% of samples at some sites and 100% of samples at other sites. Median concentrations at the sample sites ranged from <0.005 to 0.011 µg/L, with 90 percent of all measured concentrations <0.06 µg/L. The maximum measured concentration for all sites was 0.325 µg/L. **Figure B 1-10.3** provides an example of measured diazinon concentrations at the San Joaquin River near Vernalis with frequent diazinon detections. This is provided to give an example of what chemographs in the San Juaquin Valley look like, and times of year when diazinon residues are found.

**Figure B 1-10.3. Diazinon concentration in the San Joaquin River near Vernalis in 2001 (data from CADPR database)**

### Sacramento River and Tributaries

*Dormant Season (2000-2001)*

The Sacramento River and its tributaries drain land in northern California. Two studies were completed by the USGS to monitor water concentrations of diazinon resulting from dormant season applications of diazinon to orchards. The first study was targeted to monitor diazinon concentrations in runoff resulting from three winter storms which occurred during January 30-February 25, 2000 (Dileanis *et al.*, 2002). Sites (n=17) on the Sacramento River and its tributaries that were located upstream of orchards, were sampled for five consecutive days for each of the three storms and after diazinon had been applied to orchards in the basin. The peak measured concentration of diazinon was 2.89 µg/L, while the median (n=138) was 0.044 µg/L. The method detection limit was 0.02 µg/L and there were 106 detections. Thirty percent of samples had concentrations greater than 0.08 µg/L. Observed diazinon concentrations were greatest in samples collected from small streams draining areas with agricultural or urban landcovers.

The second study was targeted to monitor diazinon concentrations in runoff resulting from two winter storms during January 24-February 14, 2001 (Dileanis *et al.*, 2003). These storms occurred after dormant spray applications of diazinon to orchards located within the Sacramento Valley. Different sized tributaries as well as portions of the Sacramento River (21 sites total) were sampled. The sites received runoff from areas with both agricultural and urban land uses. The maximum observed concentration of diazinon was 1.38 µg/L, with median concentrations for the first and second storms of 0.055 and 0.026 µg/L, respectively. Observed diazinon concentrations were greatest in samples collected from small streams draining areas with agricultural landcovers.

### Santa Clara River Watershed and Callequas Creek watershed

Paired surface water and sediment samples were collected from 14 sites in the Santa Clara River and Callequas creek watersheds in California in 2009 (Delgado-Moreno *et al.*, 2011). Sites received runoff from agricultural and urban areas. Wet season samples were collected after major rain events in December and February and dry season samples were collected in May and September during periods with no measureable precipitation. Limits of detection ranged from 0.5 ng/L in water and 0.1 to 0.5 ng/g sediment. In general, pesticide concentrations in surface water were higher during the wet season. Diazinon was one of the most frequently detected pesticides[[12]](#footnote-13) and was observed in 82% of samples collected during the wet season and 44% during the dry season. Diazinon was detected at a maximum concentration of 0.172 µg/L in water. Diazinon was detected in 60% of sediment samples during the wet and dry seasons and the median concentration was 1 ng/g sediment during the wet season and <0.5 ng/g during the dry season.

### Salinas River

Anderson *et al.* (2003) measured pesticide (diazinon and chlorpyrifos) concentrations in the Salinas River at four sites. The sites were located upstream from where two agricultural drains join the river, between the two drains, where the section drain enters the river, and about 50 m downstream from both drainage inputs. The drains are approximately 60 km upstream of the point where the river enters Monterrey Bay. Water and sediment samples were collected on April 12, May 15, September 5, 2000, and May 14, 2001. Diazinon was detected in 44% (17 of 39) samples at a maximum concentration of 3.340 µg/L. The limit of detections was 0.03 to 0.04 µg/L (depending on the method used). Diazinon was also detected in pore-water in 3 of 9 sites (33%) at a maximum concentration of 0.46 µg/L. The Salinas River is one of the largest rivers of the central coast of California. Toxicity testing and macro invertebrate community structure were also examined.

### TMDL monitoring in California’s Central Valley

Additional water monitoring data are available in a study entitled “*Results of the TMDL Monitoring of Pesticides in California’s Central Valley Waterways*” (Regional Water Quality Control Board, 2006) (**Table B 1-10.10**). This study was conducted by the Aquatic Ecosystems Laboratory of the John Muir Institute at UC-Davis under a contract from the Regional Water Quality Control Board, Central Valley Region (NMFS, 2008; Regional Water Quality Control Board, 2006). The purpose of the study was “to monitor selected sites in the Sacramento River Basin, the eastern Sacramento-San Joaquin Delta tributary area, and the San Joaquin River Basin over two storm events during the winter of 2005-06 to further characterize and define sources of diazinon, chlorpyrifos, and other pesticides that may cause surface water contamination and toxic conditions to aquatic life.” In part, the results of the study would be used by the study sponsor to support development of Total Maximum Daily Loads (TMDLs) for pesticides in Central Valley watersheds.

Locations for sample collection were taken from three general regions in the Sacramento-San Joaquin Watershed, the Sacramento River and its tributaries, the San Joaquin and its tributaries, and the Sacramento-San Joaquin Delta. The sites in the Sacramento River Watershed were located in Sutter, Butte, and Sacramento Counties, those for the Delta in San Joaquin and those in the San Joaquin River Watershed are in Stanislaus and Merced Counties. Some sites were chosen based on documented pesticide use in the watershed, pesticide-caused toxicity observed in the stream or river, and the inclusion of targeted pesticide on a 303(d) impaired water body lists. Data were reported for concentrations of diazinon in surface water at 12 sites. The detection frequency ranged 50-100% and 6 of the 12 sites had detections over 0.1 µg/L (NMFS, 2008).  Sites were sampled daily for a 2 to 8 days following two storm events. The method detection limit was 0.003 µg/L.

**Table B 1-10.10. Results from monitoring for diazinon in the Central Valley of California in the winter of 2006 (NMFS, 2008)**

| **Site** | **Number of Samples** | **Percent Detections** | **Maximum Concentration (μg/L)** |
| --- | --- | --- | --- |
| **Sacramento River Watershed Sites** | | | |
| Angel Canal/Commanche Creek | 4 | 100 | 0.360 |
| Gilsizer Slough | 4 | 100 | 0.778 |
| Live Oak Slough | 4 | 100 | 0.738 |
| Morrison Slough | 4 | 100 | 0.294 |
| Sacramento River (Alamar) | 9 | 56 | 0.009 |
| Sacramento River (Freeport) | 9 | 56 | 0.003 |
| **Delta Sites** | | | |
| Littlejohn Creek | 4 | 100 | 0.044 |
| Lone Tree Creek | 4 | 100 | 0.246 |
| Mormon Sough | 4 | 50 | 0.014 |
| Pixley Slough | 4 | 100 | 0.116 |
| **San Joaquin River Watershed Sites** | | | |
| Del Puerto Creek | 4 | 50 | 0.015 |
| Orestimba Creek | 2 | 50 | 0.009 |

Available county level pesticide use data for California were employed to infer the predominant uses of diazinon in the counties sampled. Data for 2005 provide information on the extent of use in the counties where monitoring data were collected in this study. All six counties in the study showed considerable amounts of diazinon applied during January and February, which is considered the dormant spray season as the trees are leafless at this time of year. In addition to the crops identified in **Table B 1-10.11**, there were small amounts of diazinon applied in these six counties to apricots, pears, and walnuts (total <350 lbs). Other diazinon uses in these six counties include: 3 lbs used for ‘landscape maintenance’, 24 lbs used in green houses, 33 lbs for outdoor nursery plants, and 91 lbs used around structures. Consequently, the CDPR usage data suggest that the occurrence of diazinon in this monitoring study is associated with the dormant spray application to deciduous orchard crops.

**Table B 1-10.11. Pounds diazinon applied in January and February in six counties in California in 2005 using CDPR pesticide use reporting data**

| **County** | **Pounds Diazinon Applied** | | | | |
| --- | --- | --- | --- | --- | --- |
| **Almonds** | **Apples** | **Cherries** | **Peaches and nectarines** | **Prunes and plums** |
| Butte | 2409 | 4510 | 961 | 1822 | 2177 |
| Merced | 1218 | 0 | 16 | 16 | 83 |
| Sacramento | 0 | 4566 | 116 | 20 | 16 |
| San Joaquin | 12022 | 8 | 1408 | 0 | 4 |
| Sutter | 14080 | 0 | 102 | 1666 | 184 |
| Stanislaus | 12 | 0 | 0 | 10687 | 14396 |

### Central Coast Monitoring Data

Monitoring data were sent from the Central Valley Regional Water Quality Control Board.[[13]](#footnote-14) Data reported in one file cover 2006 through 2013 and include data from the Irrigated Lands Program[[14]](#footnote-15) and the California Surface Water Ambient Monitoring Program[[15]](#footnote-16) (SWAMP). These data may already be summarized in the CEDEN summary; however, the sender indicated that not all of the data were included in the CEDEN database. The method detection limit ranged from 0.0005 to 0.03 µg/L. Diazinon was detected in 37% of samples (80 of 216 samples) at a maximum concentration of 24.46 µg/L in Quail creek in 2007. There were seven detections at 1 µg/L and above in creeks, sloughs, and canals. Diazinon was detected in 2.5% (3 of 119) of sediment samples at a maximum concentration of 4.72 µg/kg-dry weight sediment in Monterey Drainage ditch. The limit of detection ranged from 2 to 14.3 µg/kg-dry weight. Sediment detections also occurred in Salinas River and Orcutt Creek.

Another monitoring data file was received from the Central Valley Regional Water Quality Control.[[16]](#footnote-17) These data summarize data from a number of different agencies. The water bodies sampled include 7728 receiving waters, 840 agricultural drains, 127 urban storm drain, and 268 waste water treatment plant effluent. Diazinon was detected in 34% (3024 out of 8963) samples collected between 2000 and 2011 at a maximum concentration of 40.8 µg/L in 2006 in Strong Ranch slough in an urban area. The next highest detected concentrations were also detected in Strong Ranch slough at 24.40 and 18.60 µg/L in 2006. The highest detected concentration after 2007 was 4.29 µg/L in 2008. There were 18 detections between 1 and 4.4 µg/L collected between 2000 and 2008. These detections occurred in creeks, the Calusa Basin Drain, canals, drains, and a slough. There were 43 detections between 0.5 and 1.0 µg/L between 2000 and 2009. These detections occurred in creeks, canals, storm drains, sloughs, canals, and Calaveras River. There were 438 detections between 0.1 and 0.50 µg/L at the same type of sites previously mentioned but also large rivers such as the San Joaquin River and Stanislaus River. The detection limits reported ranged from 0.002 to 0.032 µg/L.

### Nursery Growers Association, Los Angeles County Irrigated Lands Group

The LA Water Quality Control Board is a State of California Agency that regulates water quality within the coastal watershed of Ventura and Los Angeles Counties (Nursery Growers Association, 2014). Irrigated crops are the dominant agricultural land use. When water quality benchmarks[[17]](#footnote-18) were established several waterbodies in the area were found to exceed them. Water quality monitoring was implemented in the Los Angeles region to help to mitigate these exceedances. When exceedances occur a Water Quality Management plan is implemented. Data are available from 2007 to 2013. These sampling sites were mostly collected from runoff from nurseries that runoff into storm drains. Diazinon is detected in runoff from nurseries. The maximum concentration detected was 6.06 µg/L in August 2008. This demonstrates that use of diazinon on nurseries may result in residues of diazinon being transported to surface water.

# Groundwater

## USGS NAWQA Ground Water Data

Diazinon was detected in 0.86% (105/12,640) of ground water samples between 1992 and 2014 in the NAWQA program. Diazinon was detected at a maximum concentration of 19 µg/L occurring in 1996 in Minnesota. Three samples ranged from 0.16 to 0.38 µg/L collected in 1994, 1996, and 2002 in Minnesota, Florida, and North Carolina. All other detections were 0.098 µg/L and below. Detections occurred in Colorado, Idaho, Iowa, California, Connecticut, Florida, Illinois, Indiana, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Mexico, New York, North Carolina, Pennsylvania, South Carolina, and Virginia.

## PDP Groundwater Data

In 2007, a groundwater survey was started to test drinking water wells at farms and private residences in agricultural areas (**Table B 1-10.12**). In 2009, the program began including wells at schools and daycare centers across the nation. Samples were collected from 1,495 wells in 45 states plus the District of Columbia. This program ended in 2013. From 2010 to 2012, water samples were also collected from municipal water facilities that draw from groundwater sources. Water was collected from 16 facilities in 13 states. Diazinon was detected in 0.16% (three of 1,915 samples) at a maximum concentration of 0.081 µg/L.

**Table B 1-10.12. Summary of ground water sourced drinking water monitoring data from the PDP**

| **Year** | **Detects** | **Number of Samples** | **Frequency of Detects** | **Max Concentration (µg/L)** |
| --- | --- | --- | --- | --- |
| 2007 | 0 | 272 | 0 | NA |
| 2008 | 2 | 250 | 0.80% | 0.05 |
| 2009 | 0 | 278 | 0 | NA |
| 2010 | 0 | 248 | 0 | NA |
| 2011 | 0 | 603 | 0 | NA |
| 2012 | 0 | 164 | 0 | NA |
| 2013 | 1 | 100 |  | 0.081 |
| All Years | 3 | 1915 | 0.16% | 0.081 |

NA=not applicable

## New York Ground Water Monitoring

A study was conducted on behalf of the New York Department of Environmental Conservation to survey representative areas in Upstate New York to determine the occurrence and extent of pesticide contamination in groundwater by sampling rural water systems (domestic and farm) (Richards *et al.*, 2012). Single groundwater samples were collected in 2007 to 2009 from 80 vulnerable private wells (40 in each county) in Cayuga and Orange counties in New York. Water was collected from the tap closest to the well and preceding (where possible) water treatment. Water was run for several minutes to purge the lines prior to collection of the samples. Samples were analyzed for 93 different compounds, including diazinon. Vulnerability was evaluated based on information on local groundwater knowledge, risk modeling, aerial photo assessments, and pesticide use mapping[[18]](#footnote-19). Diazinon was detected in two wells at a maximum concentration of 0.1 µg/L in Orange County (detection frequency = 3%). The method detection limit ranged from 0.03 (Orange County) to 0.7 µg/L (Cayuga County).

## Oregon Laboratory Analytical Storage and Retrieval Database (LASAR)

The Oregon Laboratory Analytical Storage and Retrieval Database (LASAR) was searched on February 23, 2015 (Oregon Department of Environmental Quality, 2015). Diazinon was not detected in 71 groundwater samples collected in 1993, 1994, and 1999. The limit of detection ranged from 0.01 to 0.2 µg/L based on less than values reported in the dataset.

# Sediment Data

## USGS NAWQA Sediment

A total of 242 bottom sediment samples across sites throughout the United States were analyzed for diazinon, and it was detected in three samples at a maximum concentration of 3.5 µg/kg-sediment dry weight. Detections occurred in samples collected in 1992 and 1995 in creeks in Indiana and Texas. The limit of quantitation ranged from 0.1 to 80 µg/kg-sediment dry-weight based on the range of less than values reported in the dataset.

A total of four sediment samples collected in Georgia were analyzed for diazoxon in 2010. Diazoxon was not detected. The limit of quantitation was 3 µg/kg sediment dry weight based on the less-than values reported in the dataset.

## Oregon Laboratory Analytical Storage and Retrieval Database (LASAR)

The Oregon Laboratory Analytical Storage and Retrieval Database (LASAR) was searched on February 23, 2015 (Oregon Department of Environmental Quality, 2015). Diazinon was detected in 20% (1 of 5) of sediment samples collected in 1998 at a maximum concentration of 8 µg/kg-dry weight. The limit of detection in sediment was 5 µg/kg-dry weight.

# Tissue Data

Tissue data were obtained from CEDEN on January 10, 2015. Data on tissue containing residues of diazinon were reported by the Surface Water Ambient Monitoring Program, the Regional Monitoring Program for Water Quality, and the Newport Bay Watershed Biotrend Monitoring Program.

Twenty detections were reported between 1984 and 1989 on residues in freshwater clam (*Corbicula fluminea*) and the California Mussel (*Mytilus californianus*). Diazinon was present at concentrations ranging from 1,060 ng/g-lipid to 13,853.4 ng/g-lipid. Samples were collected from rivers, creeks, harbors, canals, and sloughs.

There were 166 detections reported on a wet weight and dry weight for freshwater clam, California Mussel, Sailfin Molly (*Poecilia latipinna*), Asiatic clam (*Corbicula manilensis*), Channel catfish *(Ictalurus punctatus*), Common carp (*Cyprinus carpio*), Fathead minnow (*Pimephales promelas*), goldfish (*Carassius auratus*), red shiner (*Cyprinella lutrensis*), Treespine stickleback (*Gasterosteus aculeatus*), longjaw mudsucker (*Gillichthys mirabilis*), Tilapia spp., mosquitofish (*Gambusia affinis*), white croaker (*Genyonemus lineatus*), red rock crab (*Cancer productus*), and Jacksmelt (*Atherinopsis californiensis*). Detected concentrations were a maximum of 1100 ng/g dry-weight (usually whole organisms without gut but some soft tissue) and 1050 ng/g wet-weight whole organism. The highest concentration reported in fillet was 140 ng/g wet-weight.

# Atmospheric Monitoring

## Atmospheric Monitoring Data

Diazinon is one of the most frequently detected organophosphate pesticides in air and in precipitation. The majority of monitoring studies involving diazinon have been in California; however, diazinon has been detected throughout the United States. Available air and precipitation monitoring data for diazinon are reported in **Table B 1-10.13**.

**Table B 1-10.13. Diazinon detections in air and precipitation**

| **Location** | **Year** | **Sample type** | **Maximum Conc.\*** | **Detection frequency** | **Source** |
| --- | --- | --- | --- | --- | --- |
| CA, MD | 1970s-1990s | Air | 0.306 | NA | (Majewski and Capel, 1995) |
| Sequoia National Park, CA | 1996 | Air | 0.00024 | 41.7% | (LeNoir *et al.*, 1999) |
| Sacramento, CA  (Franklin Field Airport) | 1996-1997 | Air | 0.0191 | 37.1 % | (Majewski and Baston, 2002) |
| Sacramento, CA (Sacramento Metropolitan Area) | 1996-1997 | Air | 0.0122 | 46.5 % | (Majewski and Baston, 2002) |
| Sacramento, CA (Sacramento International Airport) | 1996-1997 | Air | 0.112 | 38.5 % | (Majewski and Baston, 2002) |
| Fresno County, CA | 1997 | Air | 0.290 | NA | (State of California, 1998a) |
| Fresno County, CA | 1998 | Air | 0.160 | NA | (State of California, 1998b) |
| Mississippi River from New Orleans, LA to St. Paul MN | 1994 | Air | 0.00036 | 100% | (Majewski *et al.*, 1998) |
| Central Valley, CA | 1990-1991 | Air | 0.01 (parent)  0.003 (diazoxon) | 100% | (Zabik and Seiber, 1993) |
| 3 California Agricultural Communities (Salinas, Shafter, Ripon) | 2014 | Air | 0.0057 (diazoxon) | 0%(parent)  1%(diazoxon) | (Tuli *et al.*, 2015) |
| 3 California Agricultural Communities (Salinas, Shafter, Ripon) | 2013 | Air | 0.0487 (parent)  0.0258 (diazoxon) | 4% (parent)  1% (diazoxon) | (Vidrio *et al.*, 2014) |
| 3 California Agricultural Communities (Salinas, Shafter, Ripon) | 2012 | Air | 0.0052 (parent)  0.0101 (diazoxon) | 3% (parent)  3% (diazoxon) | (Vidrio *et al.*, 2013b) |
| 3 California Agricultural Communities (Salinas, Shafter, Ripon) | 2011 | Air | 0.0596 (parent)  0.036 (diazoxon) | 13% (parent)  8% (diazoxon) | (Vidrio *et al.*, 2013a) |
| Sequoia national Park, CA | 1995-1996 | Rain | 0.019 | 57 % | (McConnell *et al.*, 1998b) |
| San Joaquin River Basin, CA | 2001 | Rain | 0.908 | 100% | (Zamora *et al.*, 2003) |
| San Joaquin Valley, CA | 2002-2004 | Rain | 2.22 | 93% | (Majewski *et al.*, 2006) |
| Central Valley, CA | 1990-1991 | Rain | 6.1 (parent)  2.3 (diazoxon) | 100% | (Zabik and Seiber, 1993) |
| CA, MD | 1970s-1990s | Fog | 76.3 | NA | (Zhang *et al.*, 2012) |
| Parlier, CA | 1986 | Fog | 18.0 | NA | (Glotfelty *et al.*, 1990) |
| Monterey, CA | 1987 | Fog | 4.80 | NA | (Schomburg *et al.*, 1991) |
| Sequoia national Park, CA | 1995-1996 | Snow | 0.014 | 62.5 % | (McConnell *et al.*, 1998a) |
| \*For Air, µg/m3; for rain, snow and fog, µg/L | | | | | |

The magnitude of detected concentrations of diazinon in air and in precipitation can vary based on several factors, including proximity to use areas and timing of applications. In air, diazinon has been detected at concentrations up to 0.306 µg/m3. Measured concentrations of diazinon in rain in California have been detected at concentrations up to 2.22 µg/L. In fog, diazinon has been detected up to 76.3 µg/L (Majewski and Capel, 1995). Diazoxon has also been detected in air but is generally present at lower concentrations than parent diazinon (Zabik and Seiber, 1993).

## Deposition Data

In a study of diazinon loads in winter precipitation and runoff to the San Joaquin River Basin, precipitation samples were collected from a January 2001 storm event. In order to observe the influences of dormant season applications of diazinon, four sampling sites were placed near areas dominated by orchards. Concentrations of diazinon measured in rainfall ranged from 0.175 to 0.870 µg/L. The authors concluded that diazinon in precipitation could contribute significantly to the overall diazinon load entrained in runoff (Zamora *et al.*, 2003).

In a 3.5 year study (from 2001-2004) in the central San Joaquin Valley, wet and dry deposition of pesticides, including diazinon, were monitored at six sites, including some with agricultural and urban land uses. When comparing wet and dry deposition, wet deposition represented a larger source of diazinon. Diazinon was detected in 93% of rain samples (n=137), with mean and maximum concentrations of 0.149 and 2.220 µg/L, respectively (Majewski *et al.*, 2006).

## Monitoring data from lakes assumed to only receive atmospheric deposition

Studies are available involving monitoring of diazinon concentrations in California lakes which are removed from agricultural areas and are presumed to receive inputs of diazinon from atmospheric deposition only. Two 1997 studies (Fellers *et al.*, 2004; LeNoir *et al.*, 1999) measured diazinon concentrations in lake water in Kings Canyon and Sequoia National Parks (located in the Sierra Nevada Mountains in California). Fellers *et al*. (2004) reported a maximum concentration of 0.0034 µg/L, and LeNoir *et al.* (1999) reported a maximum concentration of 0.0741 µg/L in lake water. The authors attributed these detections to dry deposition and/or gas exchange from air samples of diazinon originating from agricultural sites located in California’s Central Valley, which is upwind of the lakes.

# Literature Cited

Anderson, B. S., Hunt, J. W., Phillips, B. M., Nicely, P. A., Vlaming, V., Connor, V., et al. 2003. Integrated assessment of the impacts of agricultural drainwater in the Salinas River (California, USA). *Environmental Pollution, 124*, 523-532.

Anderson, P., & Davis, D. 2000. *Evaluation of Efforts to Reduce Pesticide Contamination in Cranberry Bog Drainage*. Publication No. 00-03-041. September 2000. Washington State Department of Ecology. Available at <http://longbeach.wsu.edu/cranberries/documents/evaluationofeffortstoreducepesticidesinbogdrainage.pdf> (Accessed February 21, 2015).

Baker, R. 2014. *The Grayland Ditch*. AGR Pub 102-401. March 31, 2014. Washington State Department of Agriculture. Natural Resource Assessment Section. Available at <http://agr.wa.gov/FP/Pubs/docs/401-2013CranberryReportFinal.pdf> (Accessed February 23, 2015).

Blomquist, J. D., Denis, J. M., Cowles, J. L., Hetrick, J. A., Jones, R. D., & Birchfield, N. 2001. *Pesticides in Selected Water-Supply Reservoirs and Finished Drinking Water, 1999-2000: Summary of Results from a Pilot Monitoring Program*. Open-File Report 01-456. United States Geological Survey. Available at <http://md.water.usgs.gov/nawqa/> (Accessed January 2, 2015).

California Department of Pesticide Regulation. 2015. Surface Water Protection Program Database. Available at <http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm> (Accessed February 15, 2015).

Delgado-Moreno, L., Lin, K., Veiga-Nascimento, R., & Gan, J. 2011. Ocurrence and toxicity of three classes of insecticides in water and sediment in two southern California coastal watersheds. *Journal of Agricultural and Food Chemistry, 59*, 9448-9456.

Dileanis, P. D., Bennett, K. P., & Domagalski, J. L. 2002. *Occurence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January - February 2000*. W.-R. I. R. 02-4101. U.S. Geological Survey. Available at <http://pubs.usgs.gov/wri/wri02-4101/wri02-4101.pdf> (Accessed February 17, 2015).

Dileanis, P. D., Brown, D. L., Knifong, D. L., & Saleh, D. 2003. *Occurence and Transport of Diazinon in the Sacramento River and Selected Tributaries, California, During Two Winter Storms, January - February 2001*. Water-Resources Investigations Report 03-4111. U.S. Geological Survey. Available at <http://pubs.usgs.gov/wri/wri034111/wrir_034111.pdf> (Accessed February 17, 2015).

Domagalski, J. L., & Munday, C. 2003. *Evaluation of Diazinon and Chlorpyrifos Concentrations and Loads, and Other Pesticide Concentrations, at Selected Sites in te San Joaquin Valley, California, April to August 2001*. W.-R. I. R. 03-4088. U.S. Geological Survey. Available at <http://pubs.usgs.gov/wri/wri034088/pdf/wri03_4088.pdf> (Accessed February 17, 2015).

Fellers, G. M., McConnell, L. L., Pratt, D., & Datta, S. 2004. Pesticides in Mountain Yellow-Legged Frogs (*Rana Mucosa*) from the Sierra Nevada Mountains of California. *Environmental Toxicology and Chemistry, 23*(9), 2170-2177.

Gilliom, R. J., Barbash, J. E., Crawford, C. G., Hamilton, P. A., Martin, J. D., Nakagaki, N., et al. 2007. *The quality of Our Nation's Waters. Pesticides in the Nation's Streams and Ground Water, 1992-2001*. C. 1291. February 15, 2007. United States Department of Interior. United States Giological Survey. National Water-Quality Assessment Program. Available at <http://pubs.usgs.gov/circ/2005/1291/pdf/circ1291.pdf> (Accessed September 21, 2009).

Glotfelty, D. E., Majewski, M. S., & Seiber, J. N. 1990. Distribution of several organophosphorus insecticides and their oxygen analogues in a foggy atmosphere. *Environemntal Science and Technology, 24*(3), 353-357.

Hall Jr, L., & Anderson, R. D. 2014. Historical trends analysis of 2004 to 2009 toxicity and pesticide data for California's central valley. *Journal of Environmental Science and Health Part A: Toxic/Hazardous Substances and Environmental Engineering, 47*, 801-811.

Kratzer, C. R., Zamora, C., & Knifong, D. L. 2002. *Diazinon and Chlorpyrifos Loads in the San Joaquin River Basin, California, January and February 2000*. Water Resources Investigations Report 02-4103. U.S. Geological Survey. Available at <http://pubs.usgs.gov/wri/wri02-4103/wri024103.pdf> (Accessed February 15, 2015).

LeNoir, J. S., McConnell, L. L., Fellers, G. M., Cahill, T. M., & Seiber, J. N. 1999. Summertime Transport of Current-use pesticides from California’s Central Valley to the Sierra Nevada Mountain Range, USA. *Environmental Toxicology and Chemistry, 18*(12), 2715-2722.

Majewski, M. S., & Baston, D. S. 2002. *Atmospheric transport of pesticides in the Sacramento, California, Metropolitan Area, 1996-1997*. W. R. I. R. 02-4100. National Water-Quality Assessment Program. U.S. Geological Survey. Available at <http://pubs.usgs.gov/wri/wri024100/wri02-4100.pdf> (Accessed February 28, 2015).

Majewski, M. S., & Capel, P. D. 1995. *Pesticides in the Atmosphere: Distribution, Trends, and Governing Factors*. Chelsea, MI: Ann Arbor Press.

Majewski, M. S., Foreman, W. T., Goolsbey, D. A., & Nakagaki, N. 1998. Airborne pesticide residues along the Mississippi River. *Environmental Science & Technology, 32*, 3689-3698.

Majewski, M. S., Zamora, C., Foreman, W. T., & Kratzer, C. R. 2006. *Contribution of atmospheric deposition to pesticide loads in surface water runoff*. O.-f. R. 2005-1307. United States Geological Survey. Available at <http://pubs.usgs.gov/of/2005/1307/> (Accessed January 20, 2011).

McConnell, L. L., LeNoir, J. S., Datta, S., & Seiber, J. N. 1998a. Wet deposition of current-use pesticides in the Sierra Nevada mountain range, California, USA. *Environmental Toxicology and Chemistry, 17*(10), 1908-1916.

McConnell, L. L., LeNoir, J. S., Datta, S., & Seiber, J. N. 1998b. Wet deposition of current-use pesticides in the Sierra Nevada Mountain Range, USA. *Environmental Toxicology and Chemistry, 17*(10), 1908-1916.

NMFS. 2008. *National Marine Fisheries Service Endangered Species Action 7 Consultation. Biological Opinion. Environmental Protection Agency Registration of Pesticides Containing Chlorpyrifos, Diazinon, and Malathion*. November 2008. National Marine Fisheries Service. National Oceanic and Atmospheric Administration. U.S. Department of Commerce. Available at <http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biop.pdf> (Accessed November 13, 2015).

Nursery Growers Association. 2014. *Annual Monitoring Report- Year Three Under Order # R4-2010-0186*. December 23, 2014. Nursery Growers Association. Los Angeles County. Irrigated Lands Group.

Oregon Department of Environmental Quality. 2015. *Laboratory Analytical Storage and Retrieval Database (LASAR)*. Available at <http://www.deq.state.or.us/lab/lasar.htm> (Accessed February 23, 2015).

Regional Water Quality Control Board. 2006. *Results of the 2006 TMDL Monitoring of Pesticides in California's Central Valley Waterways January - March 2006*. October 2006. John Muir Institute of the Environment. Aquatic Ecosystems Analysis Laboratory. University of California, Davis. California Regional Water Quality Control Board. Central Valley Region. Available at <http://www.swrcb.ca.gov/centralvalley/water_issues/water_quality_studies/2006-tmdl-winter-storm-report-dfg.pdf> (Accessed January 20, 2015).

Richards, B. K., Pacenka, S., Salvucci, A. E., Saia, S. M., Whitbeck, L. F., Furdyna, P. M., et al. 2012. Surveying Upstate NY Well Water for Pesticide Contamination: Cayuga and Orange Counties. *Ground Water Monitoring and Remediation, 32*(1), 73-82.

Schomburg, C. J., Glotfelty, D. E., & Seiber, J. N. 1991. Pesticide occurence and distribution in fog collected near Monterrey California. *Environmental Science & Technology, 25*, 155-160.

Starner, K. 2009. *Spatial and temperal analysis of diazinon irrigation-season use and monitoring data*. October 8, 2009. California Environmental Protection Agency. California Department of Pesticide Regulation. Environmental Monitoring Branch. Available at <http://www.cdpr.ca.gov/docs/emon/surfwtr/policies/starner_sw08.pdf> (Accessed January 17, 2015).

State of California. 1998a. *Report for the Ambient Air Monitoring of Diazinon in Fresno County During Winter, 1997*. P. N. C96-036. April 6, 1998. California Environmental Protection Agency. . Available at <http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/diaamb.pdf> (Accessed February 28, 2015).

State of California. 1998b. *Report for the Application (Kings County) and Ambient (Fresno County) Air Monitoring of Diazinon During Winter, 1998*. Available at <http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/diamapl.pdf> (Accessed February 28, 2015).

State Water Resources Control Board. 2015. California Environmental Data Exchange Network. California State Water Resources Control Board. Available at <http://www.ceden.org/> (Accessed January 17, 2015).

Tuli, A., Vidrio, E., Wofford, P., & Segawa, R. 2015. *Air Monitoring Network Results for 2014. Volume 4*. R. A. 15-02. May 2015. California Department of Pesticide Regulatrion. California Environmental Protection Agency. Available at <http://www.cdpr.ca.gov/docs/emon/airinit/air_network_results.htm> (Accessed

USDA. 2013. Pesticide Data Program. U.S. Department of Agriculture. Agricultural Marketing Service. Available at <http://www.ams.usda.gov/datasets/pdp> (Accessed November 13, 2015).

USEPA. 2015. Storet Data Warehouse. U.S. Environmental Protection Agency. Available at <http://www.epa.gov/storet/dw_home.html> (Accessed January 15, 2015).

USGS. 2015. National Water-Quality Assessment Program. U.S. Geological Survey. Available at <http://water.usgs.gov/nawqa/> (Accessed February 15, 2015).

Vidrio, E., Wofford, P., Segawa, R., & Schreider, J. 2013a. *Air Monitoring Network Results for 2011*. R. A. 13-01. March 2013. California Department of Pesticide Regulation. California Environmental Protection Agency. Available at <http://www.cdpr.ca.gov/docs/emon/airinit/air_network_results.htm> (Accessed November 19, 2015).

Vidrio, E., Wofford, P., Segawa, R., & Schreider, J. 2013b. *Air Monitoring Network Results for 2012*. R. A. 13-02. October 2013. California Department of Pesticide Regulation. California Environmental Protection Agency. Available at <http://www.cdpr.ca.gov/docs/emon/airinit/air_network_results.htm> (Accessed

Vidrio, E., Wofford, P., Segawa, R., & Schreider, J. 2014. *Air Monitoring Network Results for 2013*. R. A. 14-01. December 2014. California Department of Pesticide Regulation. California Environmental Protection Agency. Available at <http://www.cdpr.ca.gov/docs/emon/airinit/air_network_results.htm> (Accessed November 19, 2015).

Washington State Department of Ecology. 2015. [*http://www.ecy.wa.gov/eim/index.htm*](http://www.ecy.wa.gov/eim/index.htm). Washington State Department of Ecology. Available at <http://www.ecy.wa.gov/eim/index.htm> (Accessed February 23, 2015).

Zabik, J. M., & Seiber, J. N. 1993. Atmospheric transport of organophosphate pesticides from California's Central Valley to the Sierra Nevada Mountains. *Journal of Environmental Quality, 22*, 80-90.

Zamora, C., Kratzer, C. R., Majewski, M. S., & Knifong, D. L. 2003. *Diazinon and chlropyrifos loads precipitation and urban and agricultural runoff during January and February 2001 in the San Joaquin River Basin, California.* W. R. I. R. 03-4091. United States Geological Survey. Available at <http://pubs.usgs.gov/wri/wri034091/wrir034091.pdf> (Accessed February 17, 2015).

Zhang, X., Starner, K., & Goh, K. S. 2012. Analysis of diazinon agricultural use in regions of frequent surface water detections in California, USA. *Bulletin of Environmental Contamination and Toxicology, 88*, 333-337.

1. Specific state causes of impairment that make up the national pesticides cause of impairment group are listed at http://iaspub.epa.gov/tmdl\_waters10/attains\_nation\_cy.cause\_detail\_303d?p\_cause\_group\_id=885. [↑](#footnote-ref-2)
2. Documents describing the TMDLs are available at: <http://iaspub.epa.gov/tmdl_waters10/attains_impaired_waters.tmdls?p_pollutant_id=400>. The TMDLs are listed for Callequas creek, Chicken Ranch slough, Chollas creek, Elder creek, Elk Grove creek, Feather river, Lower Salinas River Watershed, Morrison creek, Pajaro river, Sacramento river, Sacramento urban creeks, Sacramento and San Juaquin Delta Waterways and tributaries, San Diego creek, San Francisco Bay Area and Urban creeks, San Juaquin River Strong Ranch Slough, Arroyo Paredon Watershed, Upper Newport Bay, and San Diego creek. [↑](#footnote-ref-3)
3. Specific state pollutants that make up the National Pesticides Pollutant Group and have TMDLs are listed at http://iaspub.epa.gov/tmdl\_waters10/attains\_nation.tmdl\_pollutant\_detail?p\_pollutant\_group\_id=885&p\_pollutant\_group\_name=PESTICIDES. [↑](#footnote-ref-4)
4. <http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf> [↑](#footnote-ref-5)
5. California, Georgia, Virginia, Oregon, Utah, Texas, Indiana, Tennessee, Alabama, Wisconsin, and Louisiana. [↑](#footnote-ref-6)
6. <http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps.htm?filter=surfwater> [↑](#footnote-ref-7)
7. The detection occurred in Alisal creek at Hartnel Road. [↑](#footnote-ref-8)
8. <http://www.epa.gov/pesticides/reregistration/diazinon/> [↑](#footnote-ref-9)
9. While the cancellations were implemented between 2004 and 2008, it would take some time between the implementation and when all products were finally off of the market. [↑](#footnote-ref-10)
10. A wasteway is a channel for carrying off superfluous water. [↑](#footnote-ref-11)
11. The method detection limit for diazinon was 0.002 µg/L for samples collected in 2000 and 0.005 µg/L for samples collected in 2001. [↑](#footnote-ref-12)
12. Diazinon, chlorpyrifos, fipronil, and pyrethroids were monitored in the study. [↑](#footnote-ref-13)
13. Received data in an email from Karen Worcester to Charles Peck dated 2/25/2015, filename rb3\_selected\_Ops\_2015\_02\_26\_v01.xls and Sites\_list\_region\_3.xls (replaces filename CentralCoastOPdata.xlsx). The senders indicated that these data may not be in CEDEN. [↑](#footnote-ref-14)
14. The irrigated lands regulatory program works to prevent agricultural discharges from impairing waters receiving discharges from irrigated lands. Water discharge requirements are issues that may require water quality monitoring of discharges and corrective action if impairment is found. [↑](#footnote-ref-15)
15. Information on the SWAMP program is available at: <http://www.waterboards.ca.gov/water_issues/programs/swamp/about.shtml> [↑](#footnote-ref-16)
16. Received data in an email from Daniel McClure to Rochelle Bohaty on 1/27/2015. Filename CV\_DNC\_BPA\_Conc\_Data\_2012\_03\_02.xlsx The senders indicated that these data may not be in CEDEN. [↑](#footnote-ref-17)
17. The water quality benchmarks were derived, “of the Waiver, along with the Water Quality Control Plan Los Angeles Region (Basin Plan) objectives, California Toxics Rule benchmarks, USEAP ALB guidelines, and CCR Title 22 maximum contamination levels for municipal water (organic chemicals).” The Diazinon water quality benchmark was 0.10 µg/L based on the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Order # R4-2010-0186). [↑](#footnote-ref-18)
18. Based on data from the Pesticide Sales and Use Reporting (PSUR) database (<http://www.dec.ny.gov/chemical/27506.html>). [↑](#footnote-ref-19)