**APPENDIX 2-9: Diazinon Species Sensitivity Distribution Analysis for Birds**

**Summary**

SSDs were fit to LD50 test results for birds exposed to TGAI diazinon. Five distributions were tested, including: gumbel, normal, logistic, triangular, and burr. For this dataset, the gumbel distribution provided the best fit, and is the recommended distribution for inference of the hazard concentrations and quantiles. **Table B 2-9.1** includes the summary statistics for this SSD and the resulting thresholds for direct and indirect effects.

**Table B 2-9.1. Summary statistics for SSDs fit to diazinon test results for birds**

|  |  |
| --- | --- |
| Statistic | Value |
| Best distribution (per AICc) | Log-gumbel |
| Goodness of fit P-value | 0.70 |
| CV of the HC05 | 0.39 |
| HC05 | 0.43 |
| HC10 | 0.54 |
| HC50 | 1.51 |
| HC90 | 7.63 |
| HC95 | 14.15 |
| 1 Mortality Threshold | 0.019 |
| 1Indirect Effects Threshold | 0.187 |

1Slope of dose-response curve = 3.53

**Data**

The data included in **Table B 2-9.2** was used to develop SSDs for diazinon. These data comprised 19 LD50 estimates from 7 bird species. Replicate estimates within species were first summarized into a geometric mean estimate for the species prior to analysis.

**Table B 2-9.2. LD50 values for birds exposed to technical grade diazinon. Data used to generate species sensitivity distribution for birds.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Common Name** | **Species Name** | **Mean LD50 (mg a.i./kg)** | **Slope** | **Test Substance (% a.i.)** | **citation** |
| Mallard Duck | *Anas platyrhynchos* | 1.44 | 2.9 | 88.2 | MRID 40895301 |
| Mallard Duck | *Anas platyrhynchos* | 3.54 | none | 89.0 | MRID 160000, ECOTOX 50386 |
| Ring-necked pheasant | *Phasianus colchicus* | 4.33 | none | 89.0 | MRID 160000, ECOTOX 50386 |
| Northern bobwhite quail | *Colinus virginianus* | 5.2 | none | 89.0 | MRID 109015 |
| Canada goose | *Branta canadensis* | 6.16 | 2.4 | 86.6 | MRID unknown (FEODIA08) |
| Mallard Duck | *Anas platyrhynchos* | 6.38 | 3.89 | 97.0 | MRID 40922902 |
| Mallard Duck | *Anas platyrhynchos* | 6.66 | 3.9 | 86.6 | MRID 40922901 |
| Red-winged blackbird | *Agelaius phoeniceus* | 9.1 | none | TGAI | ECOTOX 55700 |
| Northern bobwhite quail | *Colinus virginianus* | 10 | 6.5 | 99.0 | ECOTOX 37111 |
| Northern bobwhite quail | *Colinus virginianus* | 13 | 6.5 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 13 | 6.4 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 14 | 4 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 15 | 4 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 15 | 4.2 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 16 | 7.1 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 16 | 7 | 99.0 | ECOTOX 37112 |
| Northern bobwhite quail | *Colinus virginianus* | 17 | 9 | 99.0 | ECOTOX 37112 |
| Brown headed cowbird | *Molothrus ater* | 69 | none | 88.2 | MRID 40895303 |
| Starling | *Sturnus vulgaris* | 602 | none | TGAI | ECOTOX 55700 |

**Methods**

SSDs were fit using five distributions (normal, logistic, triangular, gumbel, and burr) and three methods (maximum likelihood, graphical, and moment estimator). Data were first standardized to 100g body weight using Eq (1):

1. 

In Eq. (1), *AT* = adjusted toxicity value, *AW* = mean weight of the assessed birds, *TW* = the mean weight of the tested birds (i.e., from which the LD50 estimate was derived), and x = 0.63 = Mineau scaling factor (Mineau et al. 1996[[1]](#footnote-1)) for diazinon.

**Results**

AICc suggested that the gumbel distribution provided the best fit to the diazinon bird data, followed by the logistic, normal and triangular distributions (Table B 2-9.3). The Burr distribution was not competitive relative to the other four distributions.

**Table B 2-9.3. AICc model selection results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distribution | HC05 | AICc | ΔAICc | Wt |
| gumbel | 0.43 | 37.9 | 0 | 0.59 |
| logistic | 0.18 | 40.6 | 2.67 | 0.16 |
| normal | 0.20 | 41.1 | 3.19 | 0.12 |
| triangular | 0.22 | 41.2 | 3.29 | 0.11 |
| burr | 0.43 | 44.9 | 7.00 | 0.02 |

HC05 estimates ranged from 0.07 ug/L to 0.43 ug/L (Table B 2-9.4), with relatively large uncertainty. In many cases the upper confidence limit on the HC05 was higher than the 30th percentile of the fitted distribution. No distribution showed significant lack of fit under 5,000 replicates of parametric bootstrap sampling. **Table B 2-9.5** provides estimates of the HC05 as well as other quantiles of the fitted SSDs. **Table B 2-9.6** includes the direct and indirect effects thresholds that may be derived from the HC05 values from **Table B 2-9.5**. No slope estimate was available for the species closest to the 5th percentile of the distribution (red-winged blackbird). Therefore, the next closest species was chosen (mallard, ~25th percentile) for which three slope estimates were available (2.9, 3.89, and 3.9). The geometric mean of these (3.53) was used for the slope of dose response for the purpose of estimating mortality and indirect thresholds.

**Table B 2-9.4. HC05 estimates and diagnostic statistics for all distributions and methods**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Distribution | Method | HC05 | SE | CV | LCx | UCx | LCp | UCp | P |
| normal | ML | 0.20 | 0.16 | 0.81 | 0.04 | 0.97 | 0.003 | 0.31 | 0.64 |
| normal | MO | 0.17 | 0.27 | 1.65 | 0.03 | 0.99 | 0.003 | 0.32 | 0.59 |
| normal | GR | 0.09 | 0.16 | 1.91 | 0.00 | 0.51 | 0.000 | 0.24 | 0.47 |
| logistic | ML | 0.18 | 0.14 | 0.78 | 0.04 | 0.84 | 0.006 | 0.30 | 0.45 |
| logistic | MO | 0.17 | 0.28 | 1.66 | 0.02 | 1.08 | 0.004 | 0.33 | 0.61 |
| logistic | GR | 0.07 | 0.16 | 2.37 | 0.00 | 0.48 | 0.001 | 0.22 | 0.45 |
| triangular | ML | 0.22 | 0.25 | 1.17 | 0.02 | 2.15 | 0.000 | 0.47 | 0.80 |
| triangular | MO | 0.16 | 0.27 | 1.71 | 0.03 | 0.98 | 0.000 | 0.33 | 0.58 |
| triangular | GR | 0.10 | 0.19 | 1.96 | 0.01 | 0.59 | 0.000 | 0.26 | 0.48 |
| gumbel | ML | 0.43 | 0.17 | 0.39 | 0.20 | 0.93 | 0.001 | 0.30 | 0.70 |
| gumbel | MO | 0.28 | 0.24 | 0.88 | 0.09 | 1.01 | 0.001 | 0.37 | 0.61 |
| gumbel | GR | 0.16 | 0.17 | 1.03 | 0.01 | 0.59 | 0.000 | 0.27 | 0.40 |
| burr | ML | 0.43 | 0.17 | 0.39 | 0.07 | 0.76 | 0.000 | 0.21 | 0.49 |

**Table B 2-9.5. Estimated quantiles of the fitted SSDs for Diazinon LD50s for birds, standardized to 100 g body weight.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Distribution | Method | HC05 | HC10 | HC50 | HC90 | HC95 |
| normal | ML | 0.20 | 0.33 | 1.98 | 11.85 | 19.69 |
| normal | MO | 0.17 | 0.29 | 1.98 | 13.68 | 23.67 |
| normal | GR | 0.09 | 0.17 | 1.98 | 22.76 | 45.50 |
| logistic | ML | 0.18 | 0.31 | 1.53 | 7.52 | 12.92 |
| logistic | MO | 0.17 | 0.32 | 1.98 | 12.30 | 22.91 |
| logistic | GR | 0.07 | 0.16 | 1.98 | 24.22 | 56.79 |
| triangular | ML | 0.22 | 0.34 | 2.38 | 16.54 | 26.18 |
| triangular | MO | 0.16 | 0.26 | 1.98 | 15.26 | 24.77 |
| triangular | GR | 0.10 | 0.17 | 1.98 | 22.45 | 39.92 |
| gumbel | ML | 0.43 | 0.54 | 1.51 | 7.63 | 14.15 |
| gumbel | MO | 0.28 | 0.38 | 1.54 | 14.16 | 33.03 |
| gumbel | GR | 0.16 | 0.24 | 1.66 | 33.55 | 105.92 |
| burr | ML | 0.43 | 0.54 | 1.51 | 7.63 | 14.15 |

**Table B 2-9.6. Thresholds for a hypothetical 100g bird for diazinon bird data estimated for all distributions and methods fit.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Distribution | Method | Direct effects threshold  (1 in a million) | | | Indirect effects threshold  (10% mortality) | | |
| median | lower | upper | median | lower | upper |
| normal | ML | 0.009 | 0.0008 | 0.059 | 0.086 | 0.045 | 0.143 |
| normal | MO | 0.007 | 0.0007 | 0.049 | 0.072 | 0.038 | 0.119 |
| normal | GR | 0.004 | 0.0004 | 0.026 | 0.037 | 0.020 | 0.062 |
| logistic | ML | 0.008 | 0.0008 | 0.054 | 0.078 | 0.041 | 0.130 |
| logistic | MO | 0.008 | 0.0007 | 0.051 | 0.074 | 0.039 | 0.123 |
| logistic | GR | 0.003 | 0.0003 | 0.020 | 0.030 | 0.016 | 0.050 |
| triangular | ML | 0.010 | 0.0009 | 0.064 | 0.094 | 0.050 | 0.156 |
| triangular | MO | 0.007 | 0.0007 | 0.047 | 0.069 | 0.036 | 0.114 |
| triangular | GR | 0.004 | 0.0004 | 0.029 | 0.043 | 0.022 | 0.071 |
| gumbel | ML | 0.019 | 0.0018 | 0.128 | 0.187 | 0.099 | 0.310 |
| gumbel | MO | 0.012 | 0.0012 | 0.082 | 0.120 | 0.063 | 0.199 |
| gumbel | GR | 0.007 | 0.0007 | 0.047 | 0.069 | 0.037 | 0.115 |
| burr | ML | 0.019 | 0.0018 | 0.128 | 0.187 | 0.098 | 0.310 |

1. Mineau, P., Collins, B.T., and A. Baril. 1996. On the use of scaling factors to improve interspecies extrapolation of acute toxicity in birds. Regulatory Toxicology and Pharmacology, 24: 24-29 [↑](#footnote-ref-1)