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

**Summary**

SSDs were fit to LD50 test results for birds exposed to TGAI chlorpyrifos. Five distributions were tested, including: gumbel, normal, logistic, triangular, and burr. For this dataset, the triangular 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 SSD fit to Chlorpyrifos test results for birds**

|  |  |
| --- | --- |
| Statistic | 1LD50s |
| Goodness of fit P-value | 1 |
| CV of the HC05 | 0.16 |
| HC05 | 6.6 |
| HC10 | 8.4 |
| HC50 | 23.4 |
| HC90 | 65.3 |
| HC95 | 83.3 |
| Mortality Threshold (slope = 4.5) | 0.58 |
| Indirect Effects Threshold (slope = 4.5) | 3.4 |

1Mg/Kg body weight, standardized to a 100g bird.

2mg a.i/kg diet

**Data**

The data included in the SSD analysis are included in **Table 5-3** in the effects characterization for chlorpyrifos. These data comprised 25 LD50 estimates from 14 bird species. Replicate estimates within species were first summarized into a geometric mean estimate for the species prior to analysis. Very few slope values were provided in the available studies; therefore, the default slope (4.5) was used for threshold calculations.

**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 100 g 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 = 1.1573 = Mineau scaling factor (Mineau *et al*. 1996[[1]](#footnote-1)) for chlorpyrifos.

**Results**

AICc suggested that the triangular distribution provided the best fit to the chlorpyrifos LD50 bird data, followed by the normal, logistic, gumbel and burr distributions (**Table B 2-9.2**).

**Table B 2-9.2. AICc model selection results for LD50 data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| distribution | HC05 | AICc | ∆AICc | Weight |
| triangular | 6.5589 | 126.9751 | 0 | 1.0165 |
| normal | 6.3451 | 128.2234 | 1.2484 | 2.1191 |
| logistic | 5.8103 | 129.0242 | 2.0491 | 2.2042 |
| gumbel | 7.0727 | 129.3169 | 2.3418 | 1.5761 |
| burr | 6.7212 | 132.1071 | 5.132 | 2.4515 |

HC05 estimates ranged from 4.61 to 8.29 mg a.i./kg-bw (**Table B 2-9.3**), with relatively large uncertainty. **Table B 2-9.4** provides estimates of the HC05 as well as other quantiles of the fitted SSDs. **Table B 2-9.5** includes the direct and indirect effects thresholds that may be derived from the HC05 values from **Table B 2-9.4** based on a default slope of 4.5. Confidence bounds around these thresholds are also provided in **Table B 2-9.5**.

**Table B 2-9.3. HC05 estimates and diagnostic statistics for all LD50 distributions and methods**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| distribution | method | HC05 | SE | CV | LCx | UCx | LCp | UCp | P |  |
| Normal | ML | 6.35 | 2.12 | 0.33 | 3.30 | 12.21 | 0.007 | 0.201 | 0.80 |  |
| Normal | MO | 6.03 | 2.39 | 0.40 | 2.96 | 11.79 | 0.006 | 0.197 | 0.72 |  |
| Normal | GR | 4.84 | 1.90 | 0.39 | 1.54 | 8.95 | 0.002 | 0.155 | 0.44 |  |
| Logistic | ML | 5.81 | 2.20 | 0.38 | 2.76 | 12.22 | 0.011 | 0.199 | 0.54 |  |
| Logistic | MO | 6.14 | 2.42 | 0.39 | 2.98 | 12.19 | 0.011 | 0.187 | 0.59 |  |
| Logistic | GR | 4.47 | 2.01 | 0.45 | 0.84 | 8.36 | 0.003 | 0.136 | 0.32 |  |
| triangular | ML | 6.56 | 1.02 | 0.16 | 4.84 | 8.89 | 0.012 | 0.115 | 1.00 |  |
| triangular | MO | 5.88 | 2.32 | 0.40 | 3.19 | 12.39 | 0.0002 | 0.229 | 1.00 |  |
| triangular | GR | 5.09 | 1.89 | 0.37 | 2.09 | 9.51 | 0.0000 | 0.174 | 0.99 |  |
| Gumbel | ML | 7.07 | 1.58 | 0.22 | 4.57 | 10.95 | 0.0047 | 0.187 | 0.77 |  |
| Gumbel | MO | 8.03 | 2.12 | 0.26 | 4.92 | 13.45 | 0.0018 | 0.254 | 0.87 |  |
| Gumbel | GR | 6.62 | 2.03 | 0.31 | 2.65 | 10.47 | 0.0001 | 0.183 | 0.57 |  |
| Burr | ML | 6.72 | 2.45 | 0.36 | 1.30 | 11.53 | 0.0003 | 0.179 | 0.97 |  |

**Table B 2-9.4. Estimated quantiles of the fitted SSDs for Chlorpyrifos LD50s for birds, standardized to 100 g body weight**

| Dist | method | HC05 | HC10 | HC50 | HC90 | HC95 |
| --- | --- | --- | --- | --- | --- | --- |
| Normal | ML | 6.35 | 8.53 | 24.18 | 68.55 | 92.12 |
| Normal | MO | 6.03 | 8.20 | 24.18 | 71.30 | 96.89 |
| Normal | GR | 4.84 | 6.90 | 24.18 | 84.67 | 120.79 |
| Logistic | ML | 5.81 | 8.31 | 23.79 | 68.12 | 97.42 |
| Logistic | MO | 6.14 | 8.70 | 24.18 | 67.20 | 95.14 |
| Logistic | GR | 4.47 | 6.86 | 24.18 | 85.24 | 130.84 |
| triangular | ML | 6.56 | 8.37 | 23.37 | 65.30 | 83.30 |
| triangular | MO | 5.88 | 7.71 | 24.18 | 75.80 | 99.37 |
| triangular | GR | 5.09 | 6.86 | 24.18 | 85.25 | 114.92 |
| Gumbel | ML | 7.07 | 8.62 | 21.30 | 88.02 | 151.36 |
| Gumbel | MO | 8.03 | 9.55 | 21.05 | 72.70 | 116.75 |
| Gumbel | GR | 6.62 | 8.19 | 21.54 | 98.24 | 175.44 |
| Burr | ML | 6.72 | 8.84 | 22.87 | 73.17 | 111.16 |

**Table B 2-9.5. Thresholds for a hypothetical 100 g bird for chlorpyrifos LD50 bird data estimated for all distributions and methods fit for slope from study (slope =4.5)**

|  |  |  |  |
| --- | --- | --- | --- |
| Distribution | Method | Direct effects threshold(1 in a million) | Indirect effects threshold(10% mortality) |
| median | lower | upper | median | lower | upper |
| Normal | ML | 0.56 | 0.03 | 1.88 | 3.29 | 1.45 | 4.57 |
| Normal | MO | 0.53 | 0.03 | 1.79 | 3.13 | 1.38 | 4.35 |
| Normal | GR | 0.43 | 0.02 | 1.43 | 2.51 | 1.11 | 3.49 |
| Logistic | ML | 0.51 | 0.02 | 1.72 | 3.02 | 1.33 | 4.19 |
| Logistic | MO | 0.54 | 0.03 | 1.82 | 3.19 | 1.40 | 4.43 |
| Logistic | GR | 0.39 | 0.02 | 1.32 | 2.32 | 1.02 | 3.22 |
| triangular | ML | 0.58 | 0.03 | 1.94 | 3.40 | 1.50 | 4.73 |
| triangular | MO | 0.52 | 0.02 | 1.74 | 3.05 | 1.35 | 4.24 |
| triangular | GR | 0.45 | 0.02 | 1.51 | 2.64 | 1.16 | 3.66 |
| Gumbel | ML | 0.62 | 0.03 | 2.10 | 3.67 | 1.62 | 5.10 |
| Gumbel | MO | 0.71 | 0.03 | 2.38 | 4.17 | 1.84 | 5.79 |
| Gumbel | GR | 0.58 | 0.03 | 1.96 | 3.44 | 1.51 | 4.77 |
| Burr | ML | 0.59 | 0.03 | 1.99 | 3.49 | 1.54 | 4.84 |

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)