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

**Summary**

SSDs were fit to test results for birds exposed to Malathion. Five distributions were used and the triangular distribution provided the best fit. Summary statistics from the fitted SSDs are provided below in **Table** **B 2-9.1**. Detailed results follow.

**Table B 2-9.1** **Summary statistics for SSDs fit to Malathion test results**

|  |  |
| --- | --- |
| Statistic | Birds |
| Best Distribution (by AICc) | Triangular |
| Goodness of fit P-value | 1.0 |
| CV of the HC05 | 0.5476 |
| HC05 | 107.97 |
| HC10 | 133.82 |
| HC50 | 331.1 |
| HC90 | 819.1 |
| HC95 | 1015 |
| Mortality Threshold (slope = 6.6)1 | 20.6 |
| Indirect Effects Threshold (slope = 6.6) | 69.0 |

1 Dose-response slope for study near the HC05 (MRID 48963305). 95% Confidence Intervals were not reported in study DER.

**Data**

Available bird toxicity data for SSDs included studies standard test duration (typically around 14 days) and used technical grade active ingredient. The dataset contained 7 test results on 6 species. 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 = 1.15 = default Mineau scaling factor (Mineau et al. 1996). Toxicity data are presented in **Table** **B 2-9.2**.

**Table B 2-9.2 Acute LD50 values for birds**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Acute LD50 (from study)(mg a.i./kg-bw) | Adjusted LD50 (adjusted to 100g)(mg a.i./kg-bw) | Slope | Reference |
| Ring-necked pheasant (*Phasianus colchicus*)  | 136 | 94.47 | 6.6 | MRID 48963305 |
| Ring-necked pheasant (*P. colchicus*)  | 167 | 116.0 | NA | MRID 00160000/ E50386 |
| Northern Bobwhite Quail (*Colinus virginianus*) | 361 | 331.1 | 9.42 | MRID48153114 |
| Horned Lark(*Eremophila alpestris*) | 403 | 479.5 | NA | MRID 00160000/ E50386 |
| Mallard Duck(*Anas platyrhynchos*) | 1485 | 1039 | NA | MRID 00160000/ E50386 |
| Sharp tailed Grouse(*Typanuchus phasianellus*) | 220 | 158.6 | NA | Crabtree, 1965 |
| Domestic Chicken(*Gallus domesticus*) | 524.8 | 377.2 | NA | E36916 |

Five potential distributions for the Malathion data were considered (log-normal, log-logistic, log-triangular, log-gumbel, and Burr). To fit each of the first four distributions, the toxicity values were common log (log10) transformed. A comparison of the separate distributions using Akaike’s information criterion (AICc) was conducted. Finally, direct and indirect effect thresholds and report five quantiles from the fitted SSDs (HC05, HC10, HC50, HC90, HC95) were calculated.

**Comparison of distributions using AICc**

AICc was used to compare the five distributions for the avian dataset and for this comparison the SSD was fit using maximum likelihood.

For birds, AICc suggested that the triangular distribution provided the best fit (**Table** **B 2-9.3**).

**Table** **B 2-9.3**. **Comparison of distributions for avian toxicity data for Malathion**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| distribution | HC05 | AICc | ∆AICc | Weight |
| Triangular | 107.9764 | 89.7592 | 0 | 0.3689 |
| Normal | 93.5473 | 90.6179 | 0.8587 | 0.2401 |
| Logistic | 87.4570 | 91.0199 | 1.2607 | 0.1964 |
| Gumbel | 104.1528 | 91.0516 | 1.2925 | 0.1933 |
| burr | 91.1602 | 101.0161 | 11.2570 | 0.0013 |

**Goodness of fit and the importance of fitting method**

To test goodness-of-fit, all five distributions for the avian toxicity data for Malathion were fit and ran bootstrap goodness-of-fit tests with 10,000 bootstrap replicates. Maximum likelihood (ML) was used. None of the distributions showed a significant lack of fit. The best distribution, as determined by AICc, also had a lower coefficient of variation for the HC05 (**Table** **B 2-9.4**).

**Table** **B 2-9.4. Range of HC05 values for Malathion SSDs fit to bird dataset.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| distribution | method | HC05 | SE | CV | LCL | UCL | P |
| Triangular | ML | 107.9764 | 59.1306 | 0.5476 | 72.9875 | 284.2096 | 1 |
| Normal | ML | 93.5473 | 60.4611 | 0.6463 | 2.4731 | 267.3054 | 0.9980 |
| Logistic | ML | 87.4570 | 57.2776 | 0.6549 | 33.6570 | 245.6303 | 0.9950 |
| Gumbel | ML | 104.1528 | 46.0393 | 0.4420 | 63.9591 | 236.4019 | 1 |
| Burr | ML | 91.1602 | 74.6627 | 0.8190 | 0 | 275.1692 | 0.7592 |

A plot of the data is shown in **Figure B 2-9.1.**



**Figure B 2-9.1**. **Log-triangular SSD for Malathion LC50s for birds. Red points indicate single toxicity values. Black points indicate multiple toxicity values. Blue line indicates full range of toxicity values for a given species.**

**Calculation of other quantiles**

**Table** **B 2-9.5** provides estimates of the HC05 as well as other quantiles of the fitted SSDs.

**Table** **B 2-9.5.**  **Estimated quantiles of the fitted SSDs for avian tests for Malathion**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| dist | method | HC05 | HC10 | HC50 | HC90 | HC95 |
| Triangular | ML | 107.97 | 133.8 | 331.1 | 819.1 | 1015 |
| Normal | ML | 93.54 | 122.5 | 317.94 | 824.7 | 1080 |
| Logistic | ML | 87.45 | 121.6 | 320.5 | 845.0 | 1175 |
| Gumbel | ML | 104.1 | 124.5 | 281.4 | 1012 | 1650 |
| Burr | ML | 91.16 | 123.2 | 314.7 | 867.5 | 1234 |

**Calculation of thresholds**

Thresholds were calculated using a probit curve with the HC05 as the mean and three different slopes (2, 4.5, and 9). Calculated thresholds are provided in **Table** **B 2-9.6**.

**Table** **B 2-9.6.**  **Thresholds for determination of action area for Malathion avian test results**

|  |  |  |  |
| --- | --- | --- | --- |
| distrib. | method | Mortality Threshold (10-6) | Indirect Effects Threshold (10-1) |
| slope = 6.6 | slope = NA | slope = NA | slope = 6.6 | slope = NA | slope = NA |
| Triangular | ML | 20.6 | -- | -- | 69.0 | -- | -- |