SUPPLEMENTARY INFORMATION

Toxicity of Pine Monoterpenes to Mountain Pine Beetle

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Table S1. Monoterpenes used in toxicity bioassays

Compound	CAS	Purity	Supplier	Catalog #	Lot #
(1*R*)-(+)-α-Pinene	7785-70-8	98%	Sigma Aldrich	P45680	08926AE
(1*S*)-(-)-α-Pinene	7785-26-4	99%	Sigma Aldrich	274399	09409MS
(1*S*)-(-)-β-Pinene	18172-67-3	99%	Sigma Aldrich	112089	00307LG
(1*R*)-(+)-β-Pinene	19902-08-0	98%	Fluka	80607	BCBK2147V
(1*S*)-(+)-3-Carene	498-15-7	99%	Sigma Aldrich	441619	0531PH
Terpinolene	586-62-9	85%	Fluka	86485	1401137
(1*S*)-(-)-Limonene	5989-54-8	96%	Sigma Aldrich	21836-7	14105EU
(1*R*)-(+)-Limonene	5989-27-5	~90%	Fluka	62122	BCBH9990V
Myrcene	123-35-3	99%	Sigma Aldrich	M100005	BCBD7911V
(-)-β-Phellandrene	555-10-2	84%	Synergy Semiochemicals	Custom	Custom

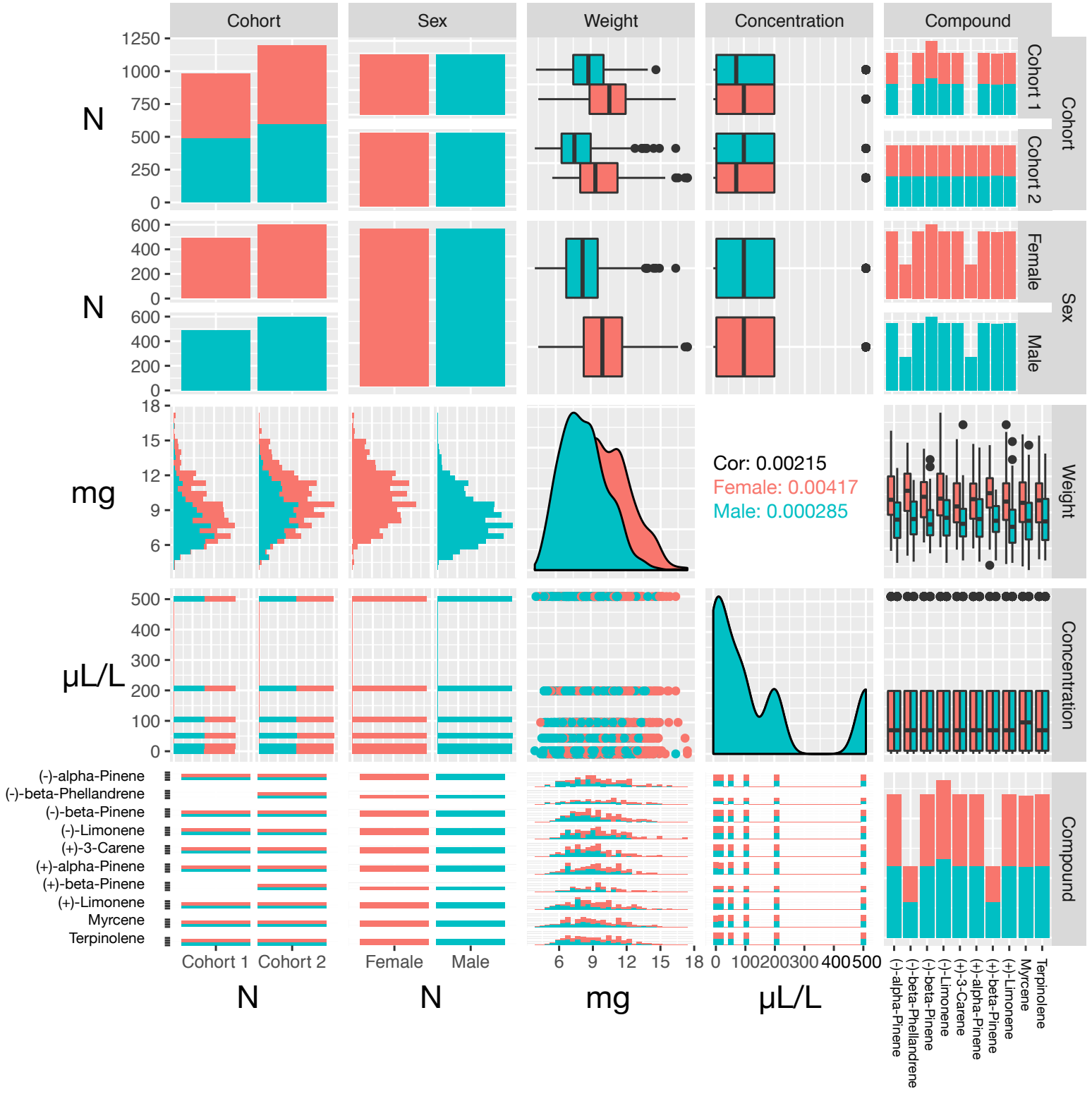
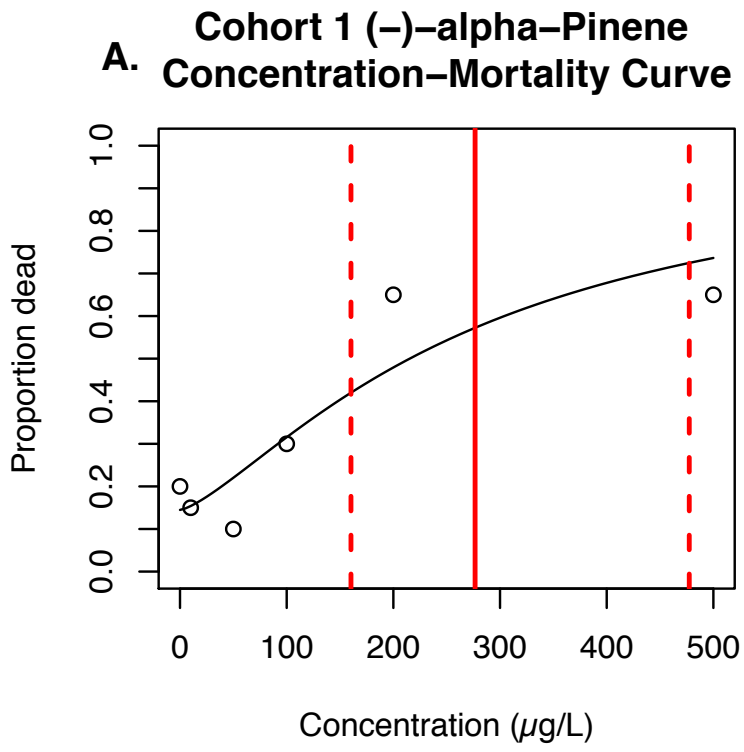
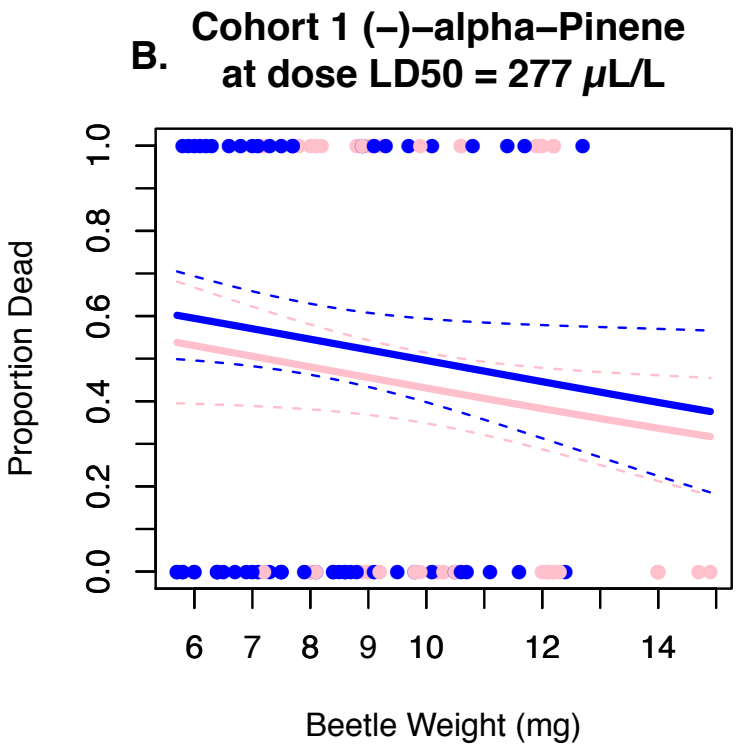
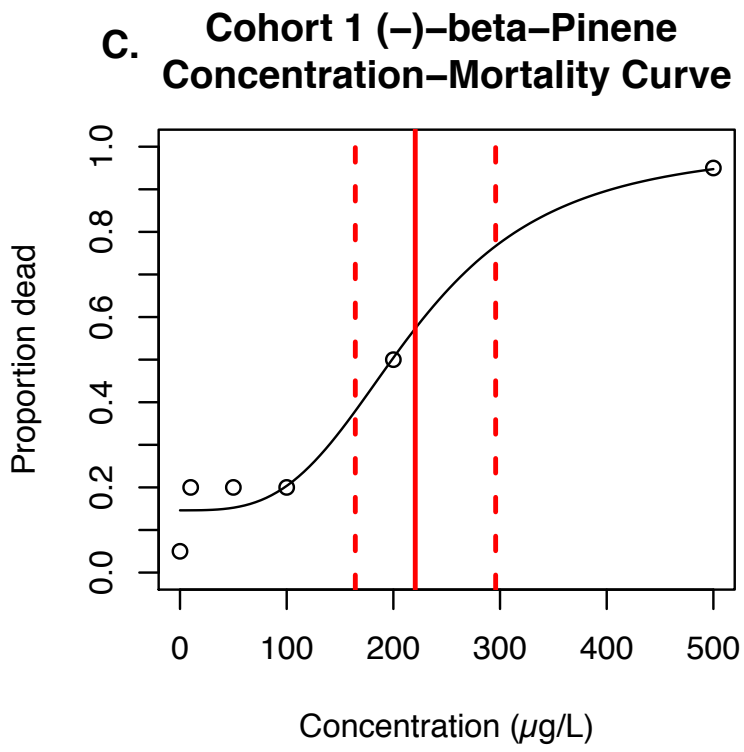

Cohort
Sex
Weight
Concentration
Compound
Cohort 1
Cohort 2
Female
Male
N
mg
µL/L
Cor: 0.00215
Female: 0.00417
Male: 0.000285
(-)-alpha-Pinene
(-)-beta-Phellandrene
(-)-beta-Pinene
(-)-Limonene
(+)-3-Carene
(+)-alpha-Pinene
(+)-beta-Pinene
(+)-Limonene
Myrcene
Terpinolene

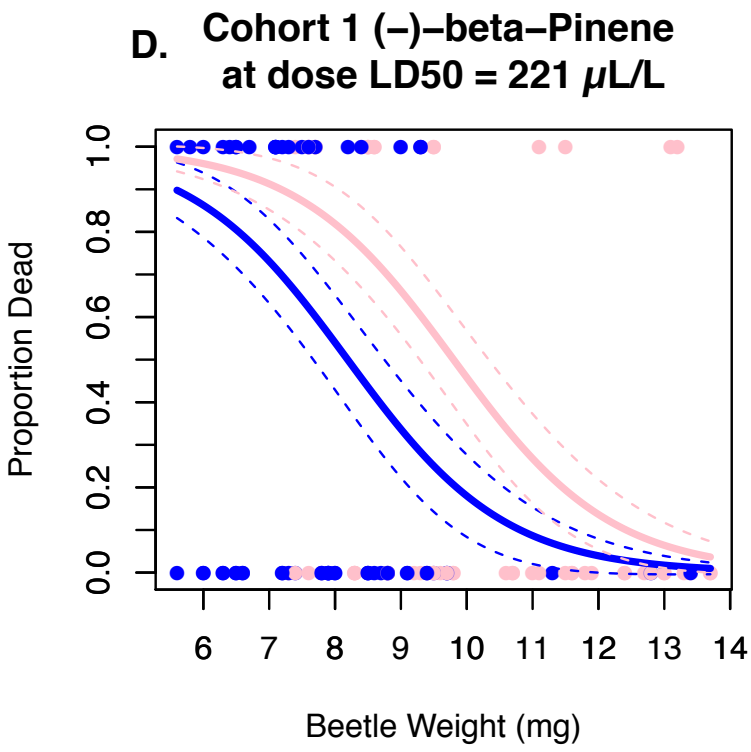
Figure S1: Graphical summary of the raw data.

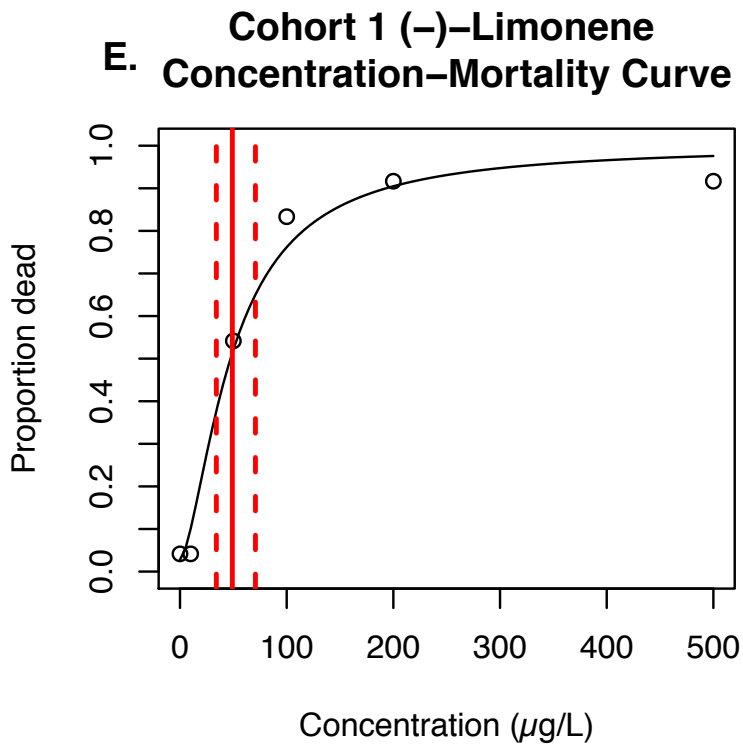
Matrix of graphics representing the relationship of the factors *Cohort*, *Sex* (female, red; male, blue), beetle *Weight*, compound *Concentration*, and *Compound* to each other. For examples, (1) the *Weight* column x *Cohort* row graph shows the distribution of beetle weights for each sex, for each cohort; (2) the *Cohort* column x *Compound* row graph shows the number of beetles of each sex, for each cohort, and for each compound. In this graph one can see that equal numbers of beetles of each sex for each compound were tested, and that (-)-beta-phellandrene and (+)-beta-pinene were only tested with cohort 2.

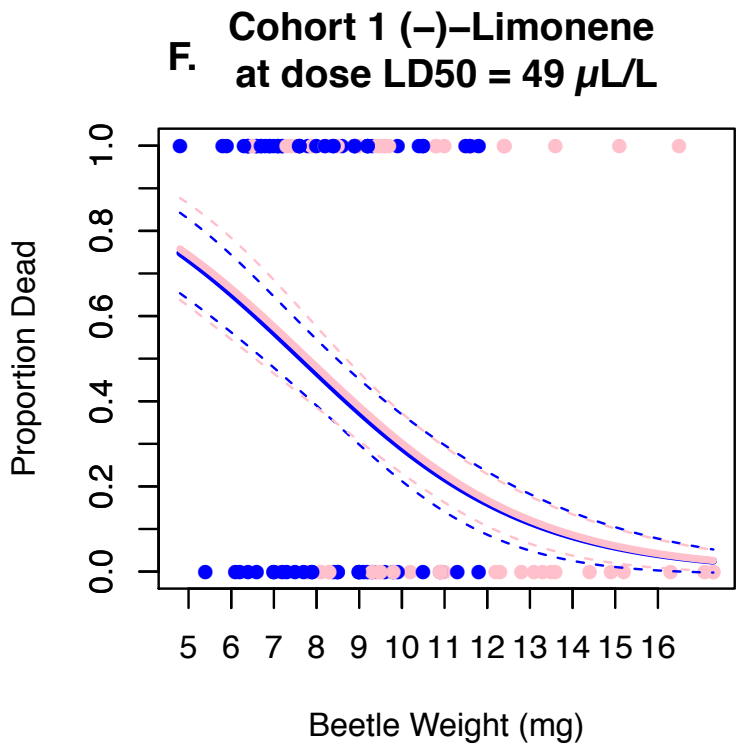

A.
Cohort 1 (–)–alpha–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

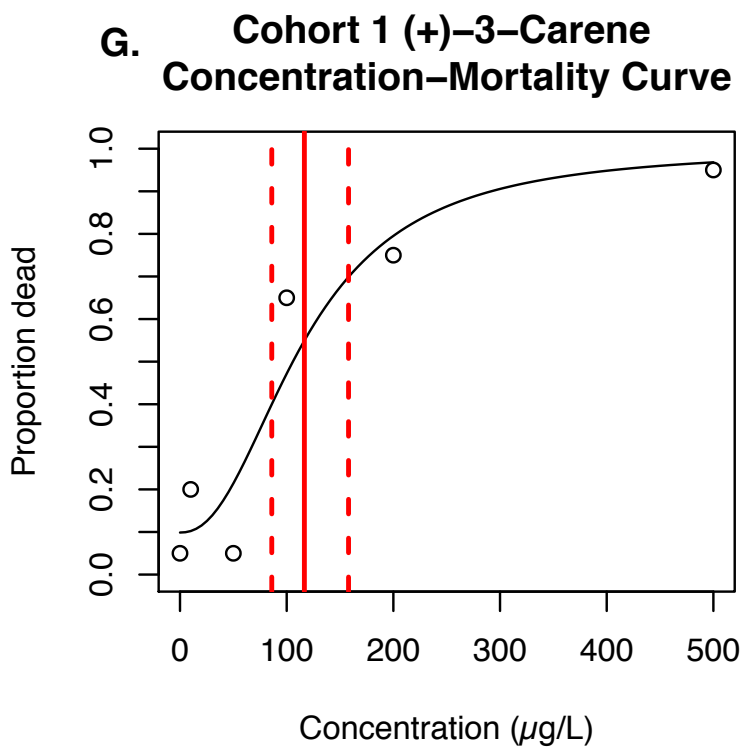

B.
Cohort 1 (–)–alpha–Pinene
at dose LD50 = 277 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
6
7
8
9
10
12
14
Beetle Weight (mg)

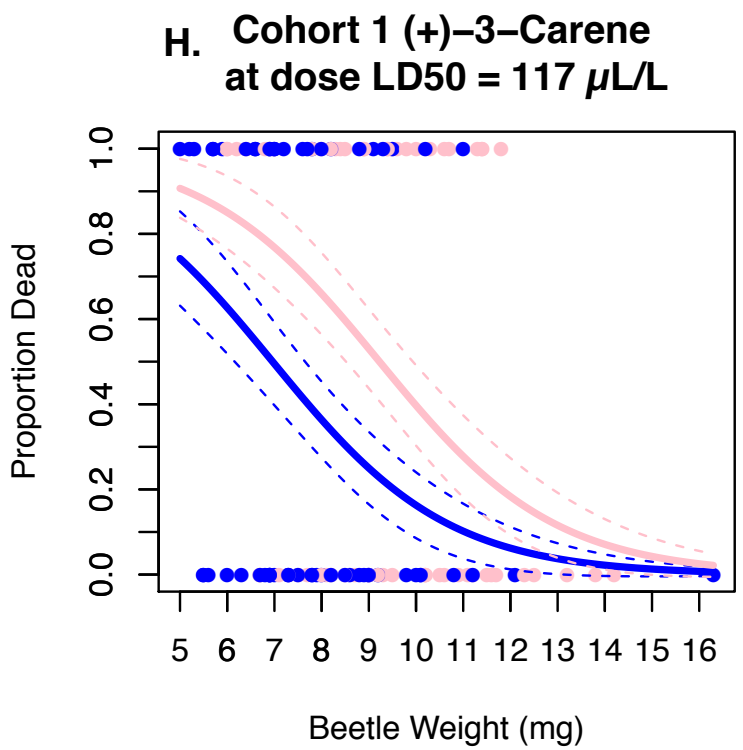

C.
Cohort 1 (–)–beta–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)


D.
Cohort 1 (–)–beta–Pinene
at dose LD50 = 221 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
6
7
8
9
10
11
12
13
14
Beetle Weight (mg)

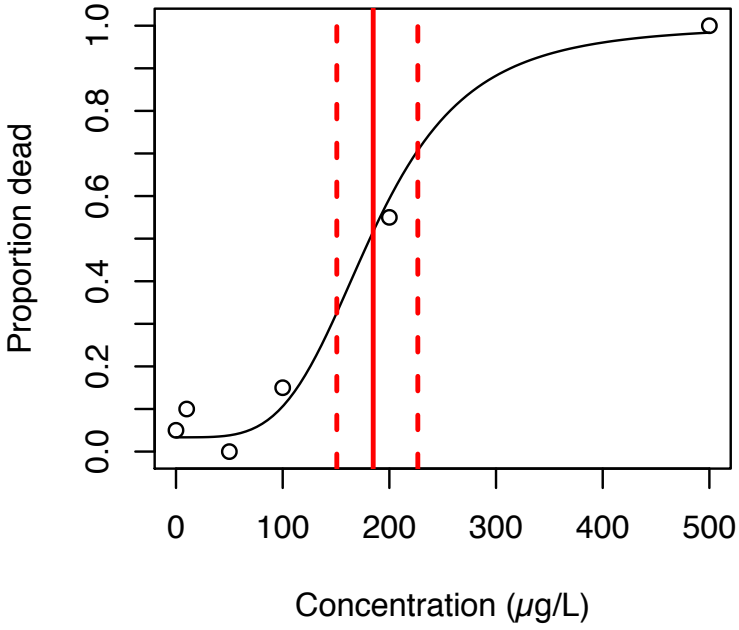

E.
Cohort 1 (–)–Limonene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)


F.
Cohort 1 (–)–Limonene
at dose LD50 = 49 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
16
Beetle Weight (mg)

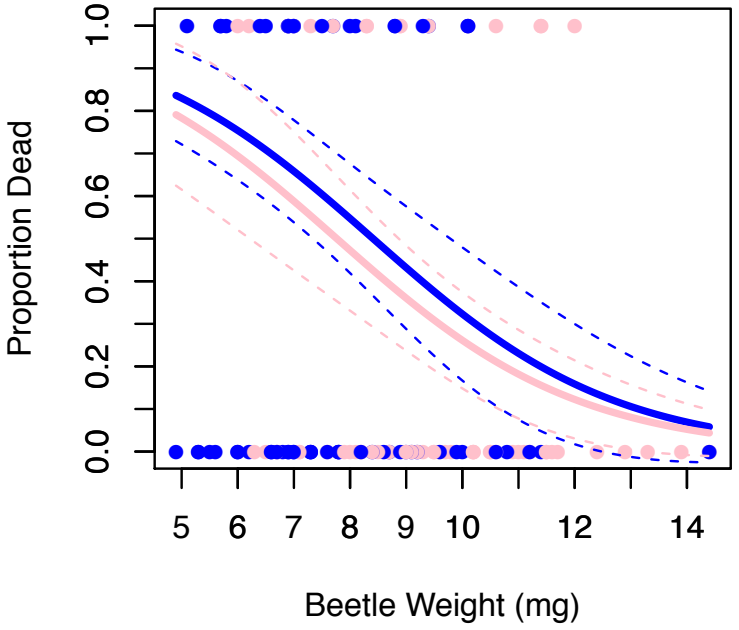

G.
Cohort 1 (+)–3–Carene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)


H.
Cohort 1 (+)–3–Carene
at dose LD50 = 117 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
16
Beetle Weight (mg)

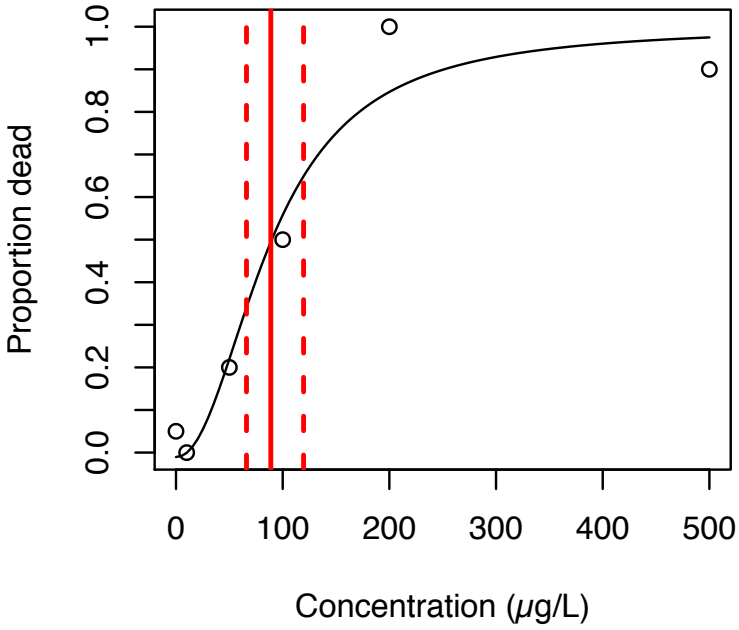
I. Cohort 1 (+)–alpha–Pinene Concentration–Mortality Curve



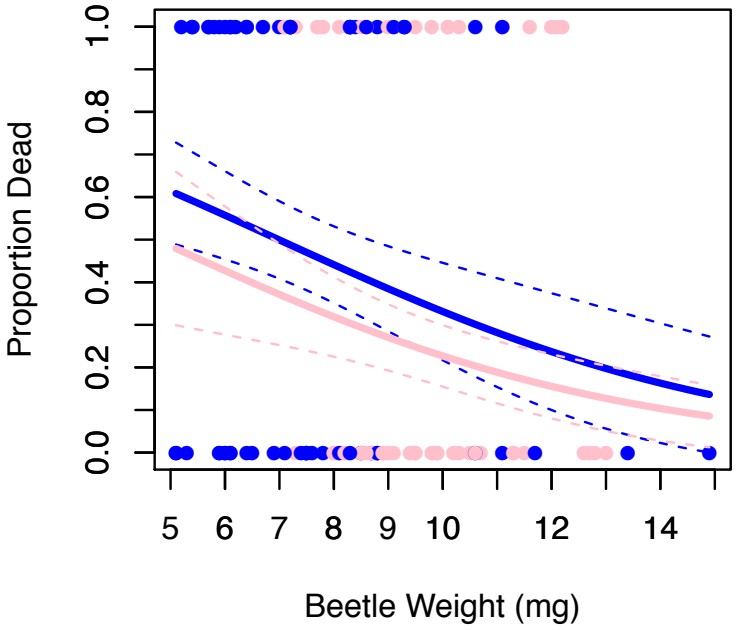
J. Cohort 1 (+)–alpha–Pinene at dose LD50 = 185 μL/L



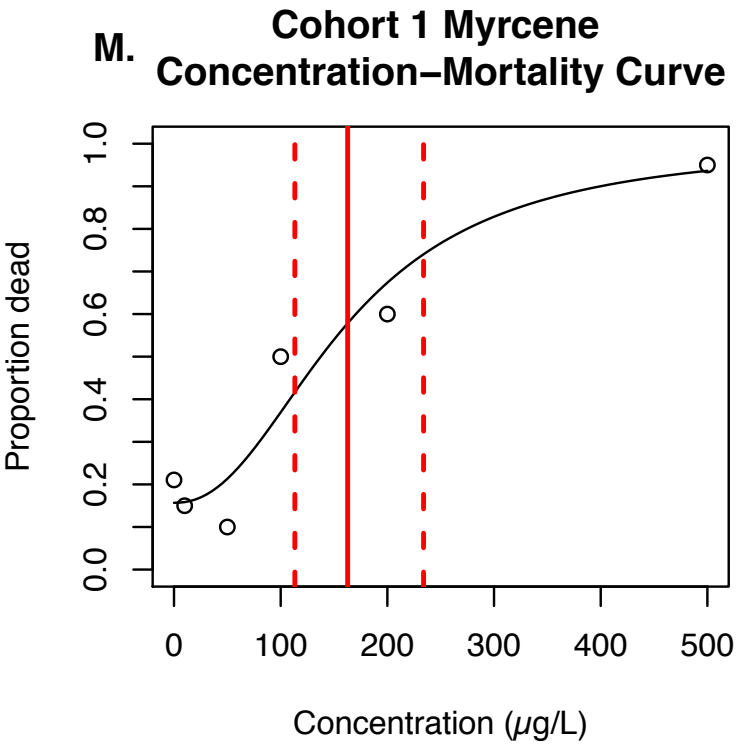
K. Cohort 1 (+)–Limonene Concentration–Mortality Curve



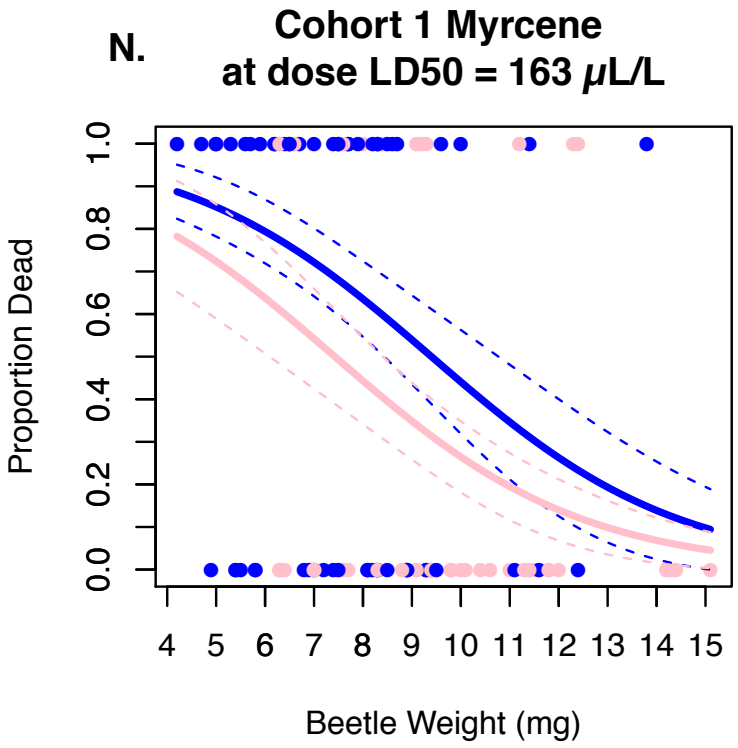
L. Cohort 1 (+)–Limonene at dose LD50 = 89 μL/L



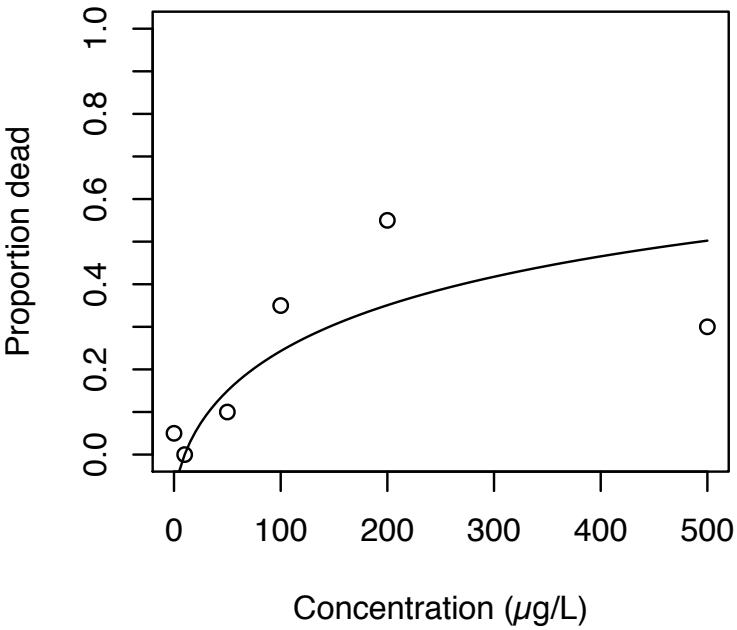
M.


Cohort 1 Myrcene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

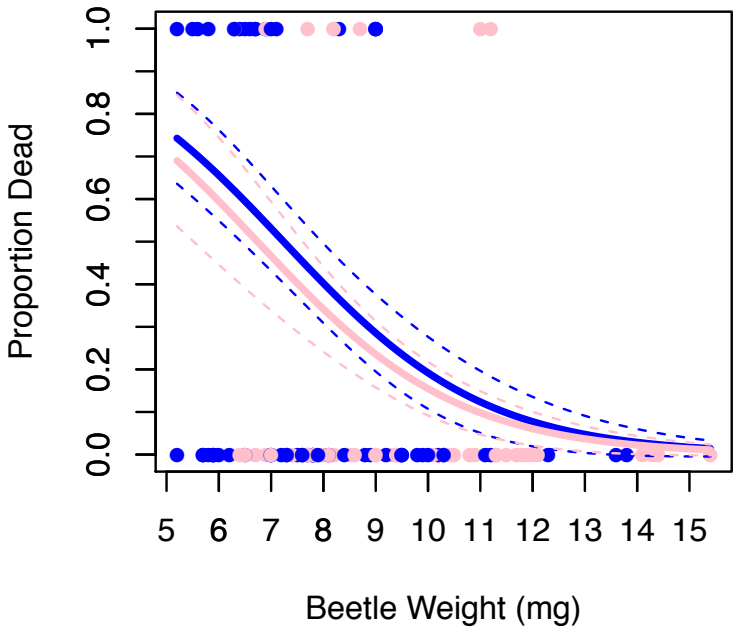
N.


Cohort 1 Myrcene
at dose LD50 = 163 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
4
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

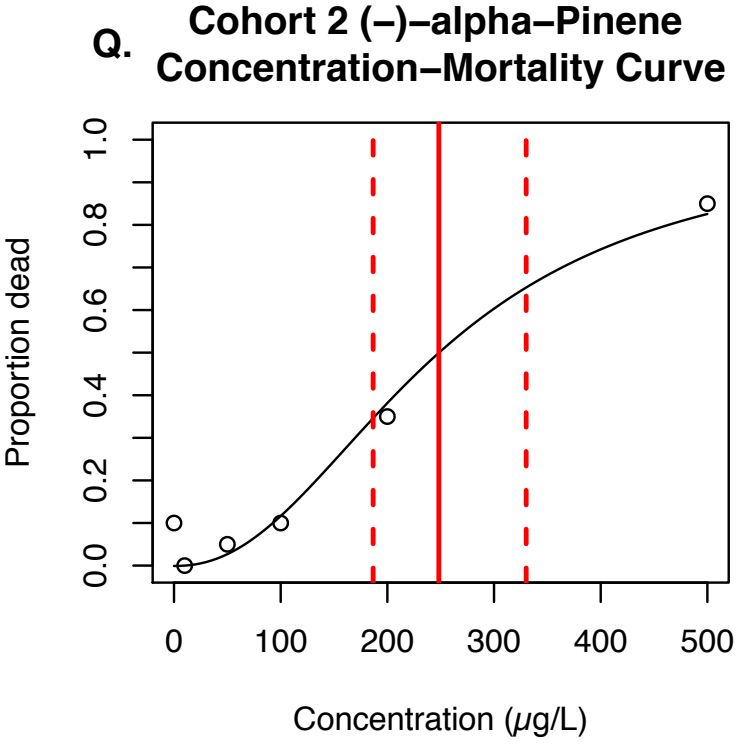
O.


Cohort 1 Terpinolene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

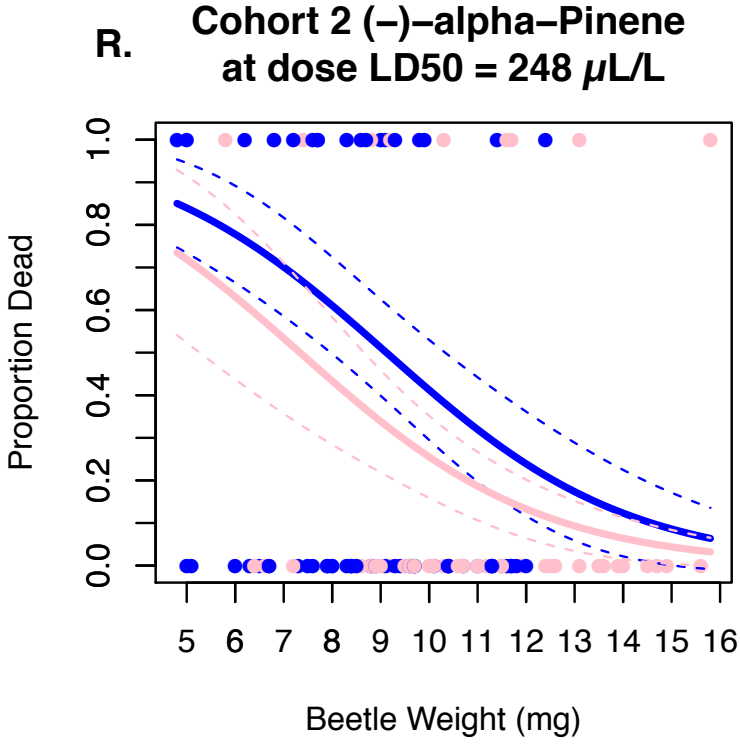
P.


Cohort 1 Terpinolene
at dose LD50 = 340 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

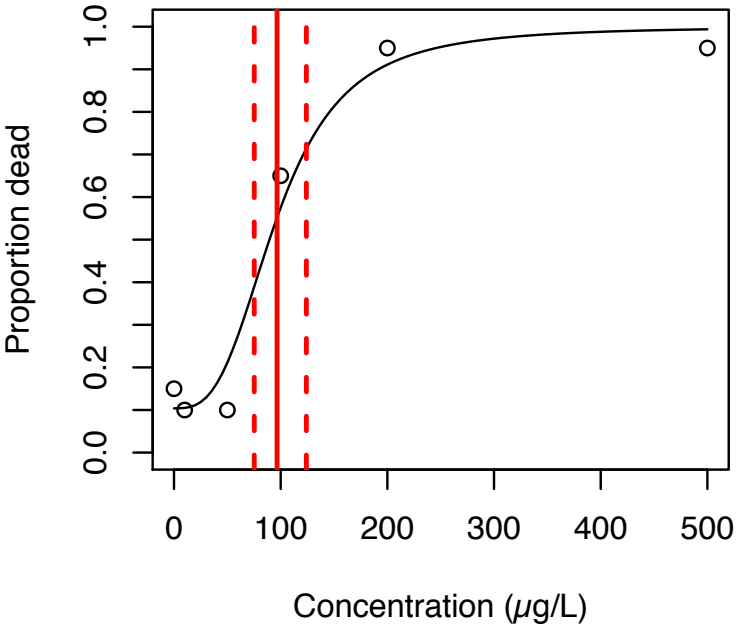
Q.


Cohort 2 (–)–alpha–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

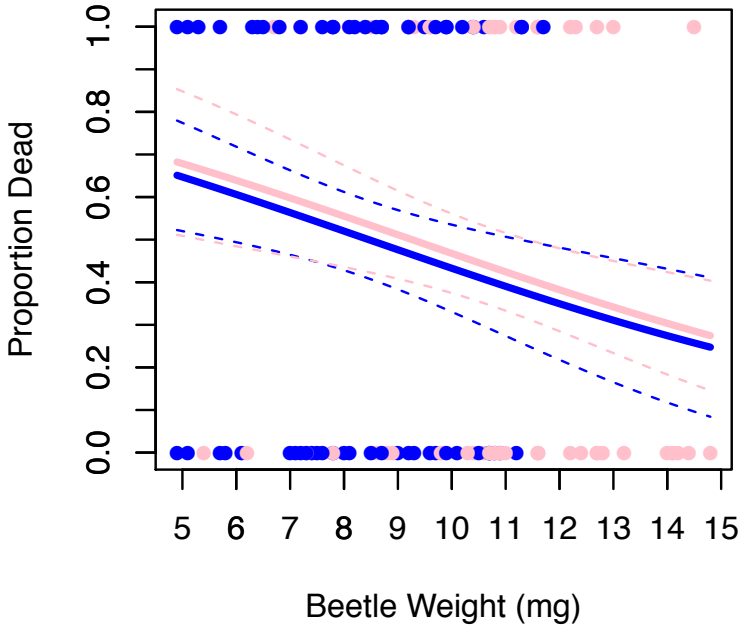
R.


Cohort 2 (–)–alpha–Pinene
at dose LD50 = 248 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
16
Beetle Weight (mg)

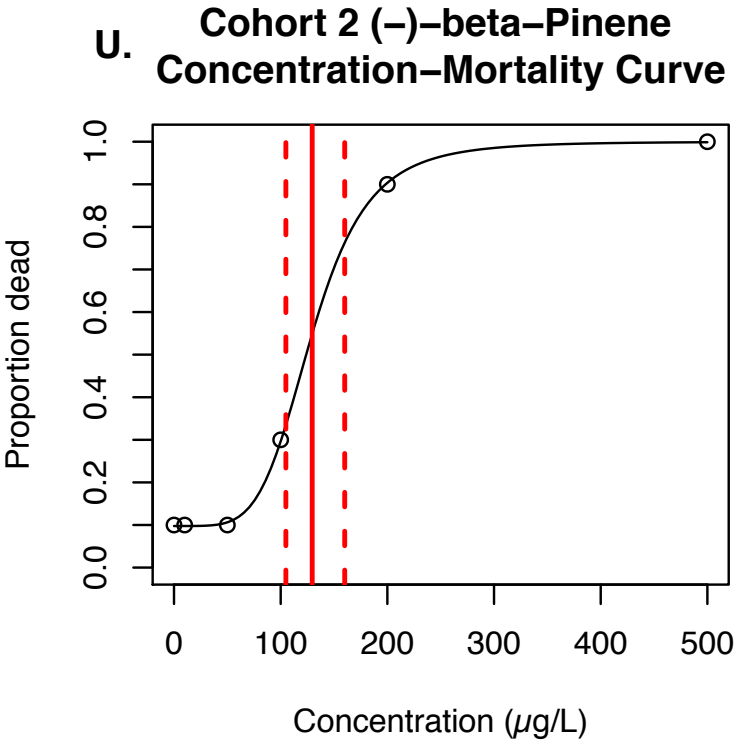
S.


Cohort 2 (–)–beta–Phellandrene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

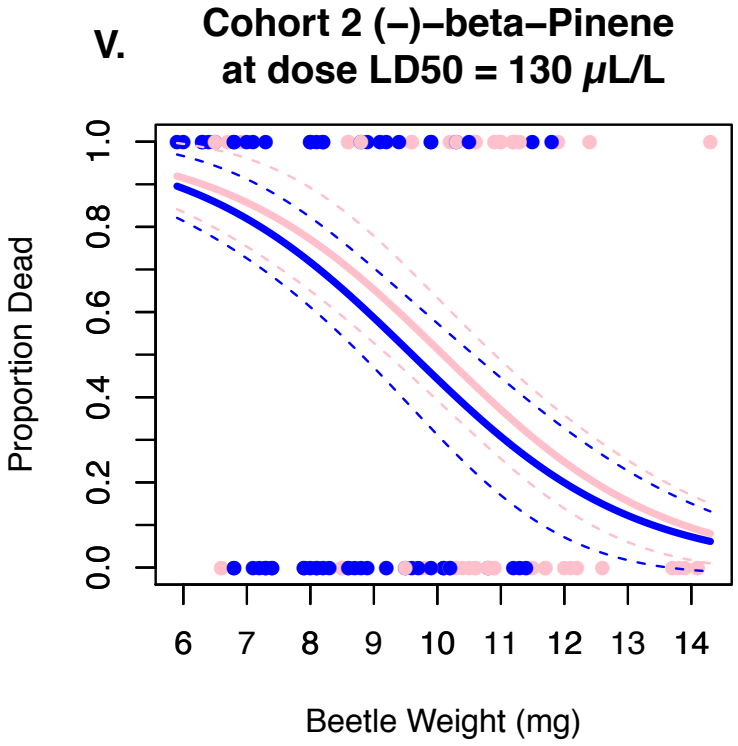
T.


Cohort 2 (–)–beta–Phellandrene
at dose LD50 = 97 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

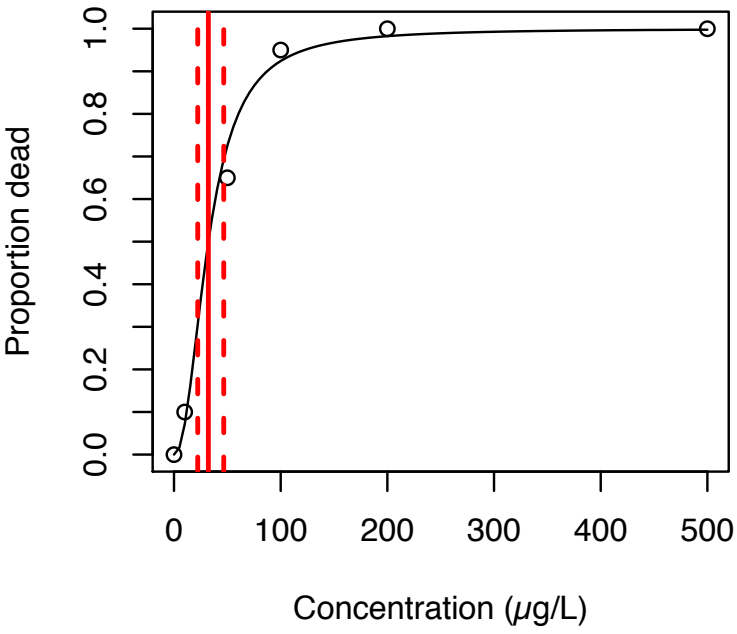
U.


Cohort 2 (–)–beta–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

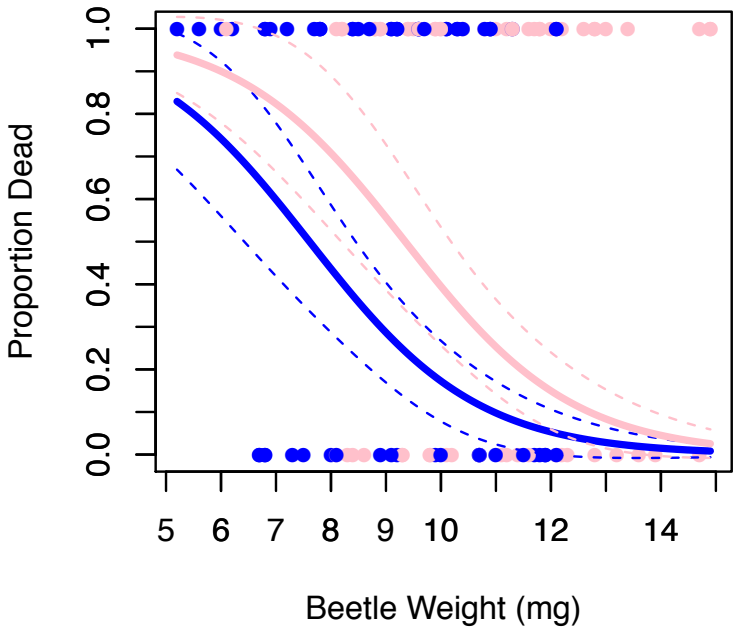
V.


Cohort 2 (–)–beta–Pinene
at dose LD50 = 130 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
6
7
8
9
10
11
12
13
14
Beetle Weight (mg)

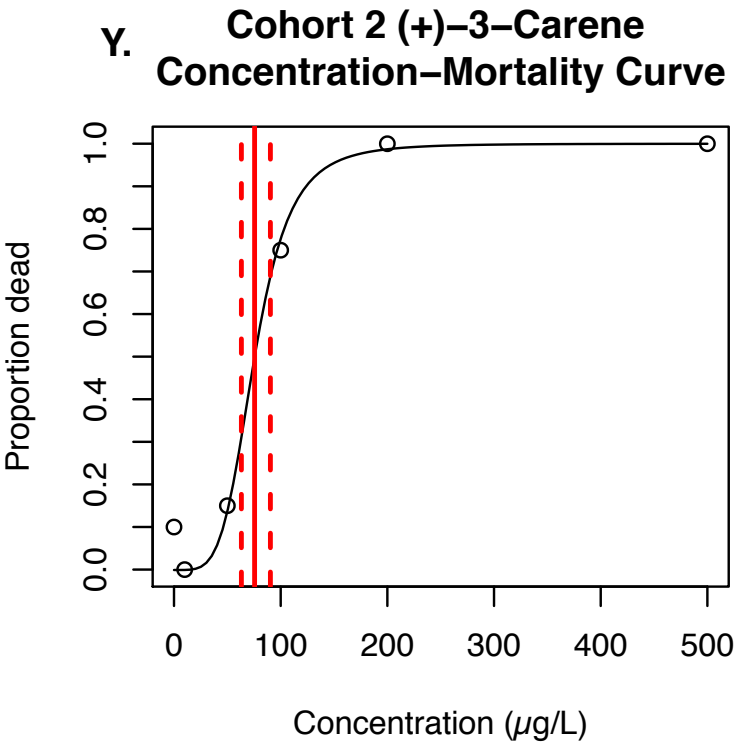
W.


Cohort 2 (–)–Limonene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

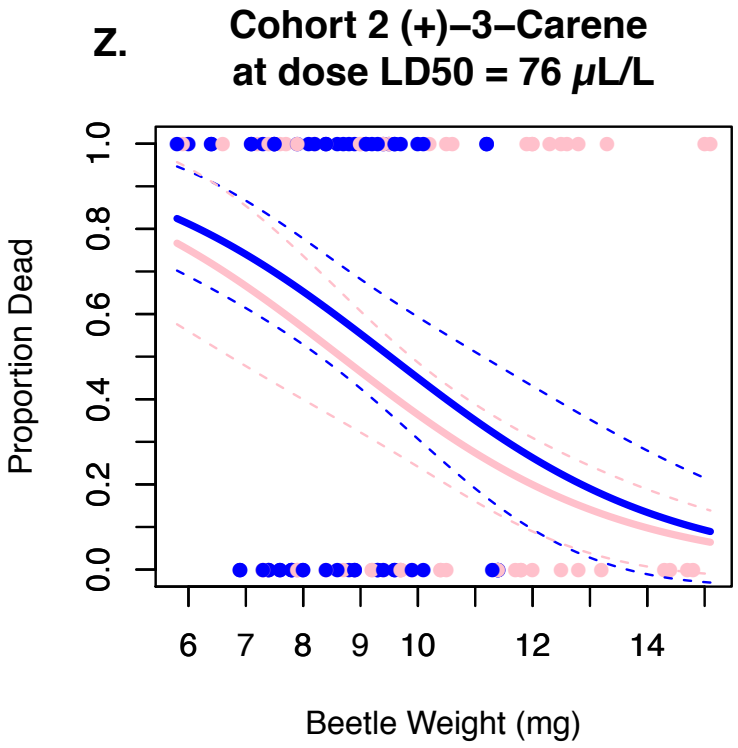
X.


Cohort 2 (–)–Limonene
at dose LD50 = 32 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
12
14
Beetle Weight (mg)

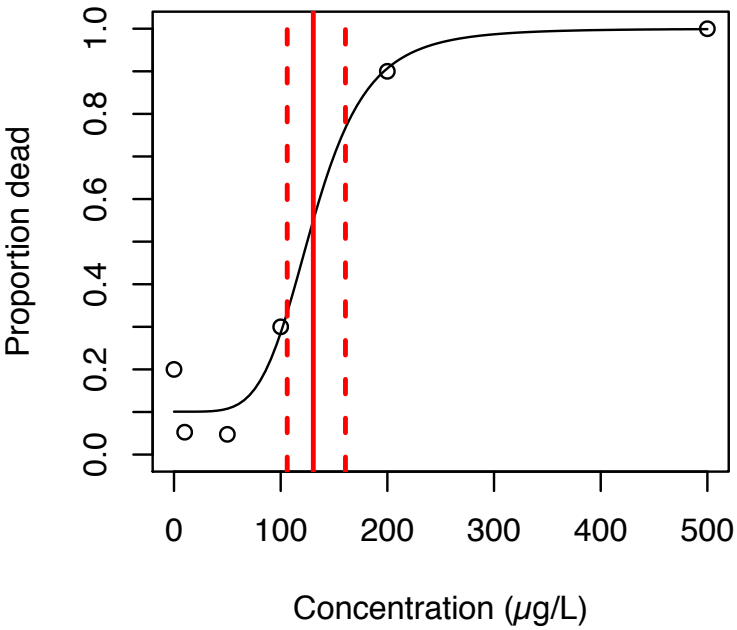
Y.


Cohort 2 (+)–3–Carene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

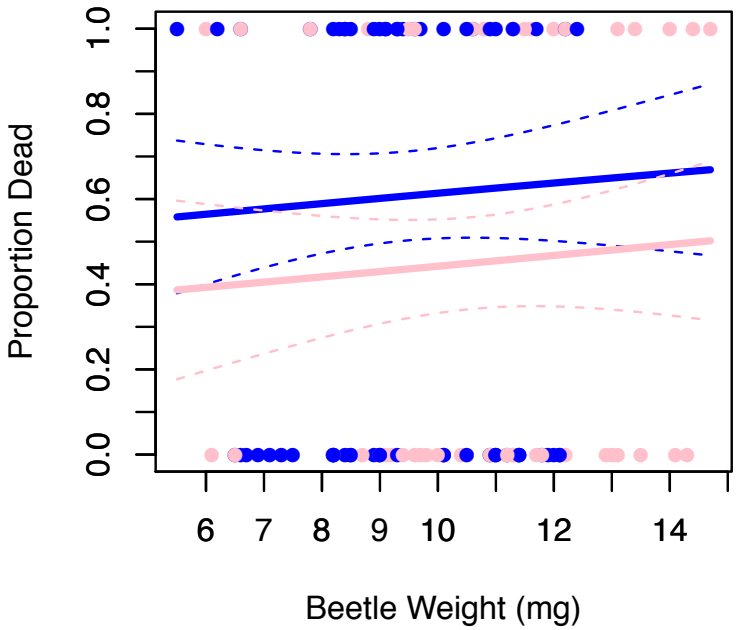
Z.


Cohort 2 (+)–3–Carene
at dose LD50 = 76 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
6
7
8
9
10
12
14
Beetle Weight (mg)

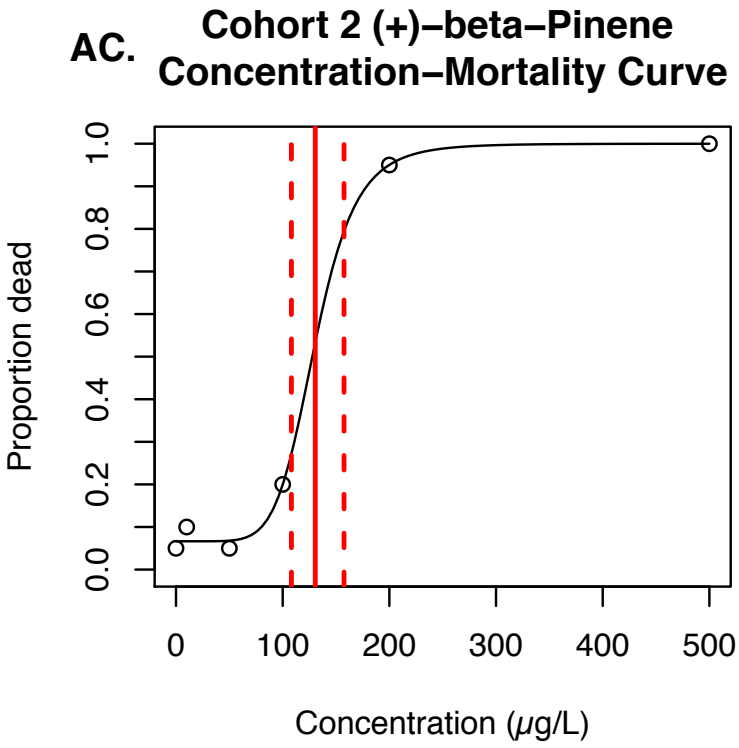
AA.


Cohort 2 (+)–alpha–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

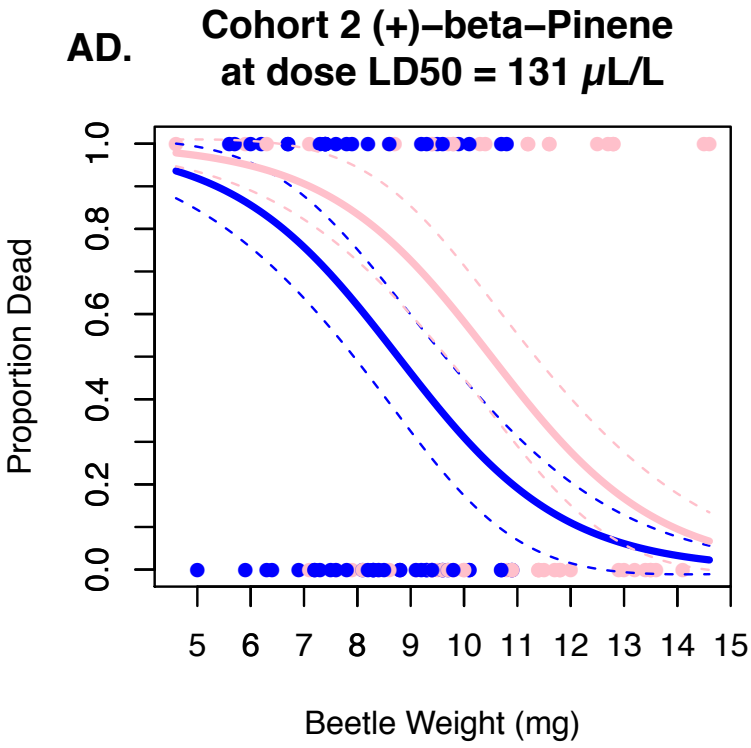
AB.


Cohort 2 (+)–alpha–Pinene
at dose LD50 = 131 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
6
7
8
9
10
12
14
Beetle Weight (mg)

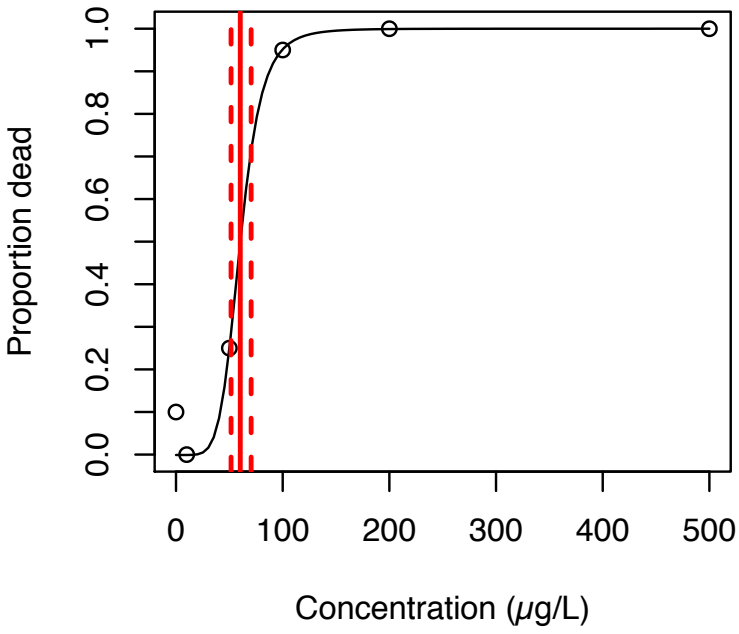
AC.


Cohort 2 (+)–beta–Pinene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

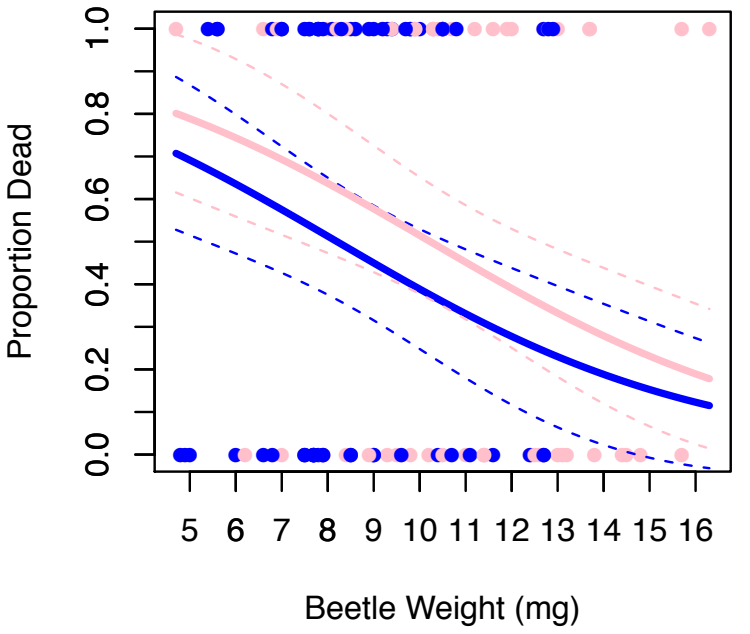
AD.


Cohort 2 (+)–beta–Pinene
at dose LD50 = 131 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

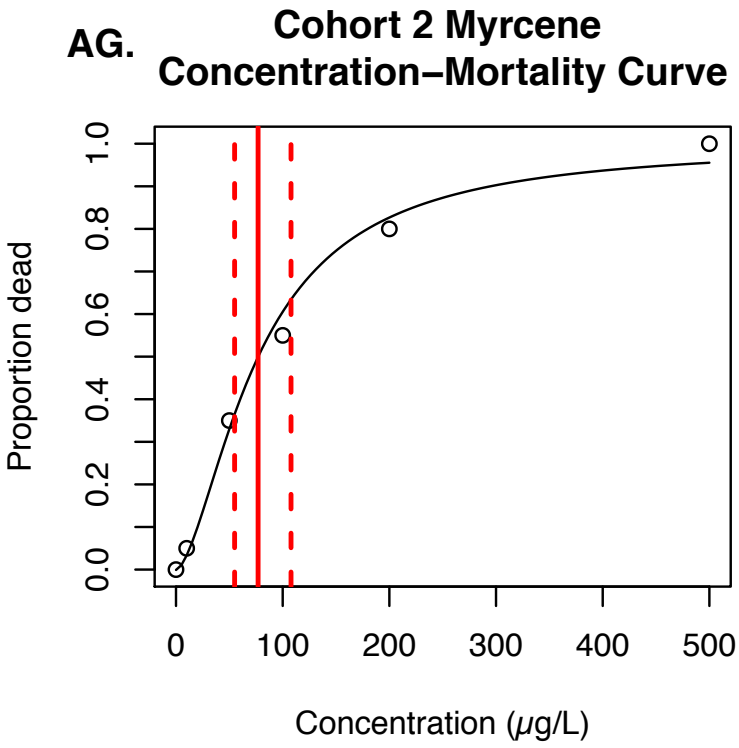
AE.


Cohort 2 (+)–Limonene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

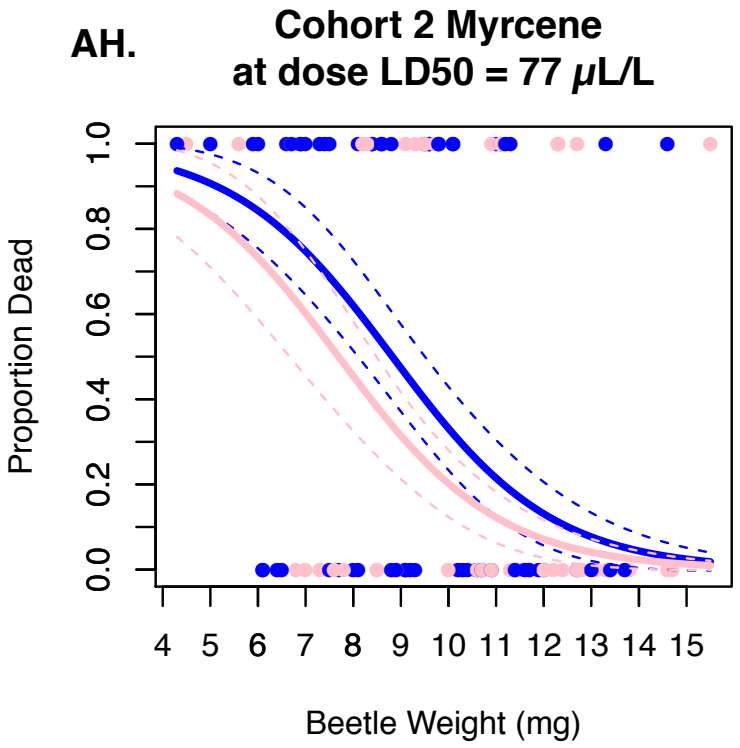
AF.


Cohort 2 (+)–Limonene
at dose LD50 = 60 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
16
Beetle Weight (mg)

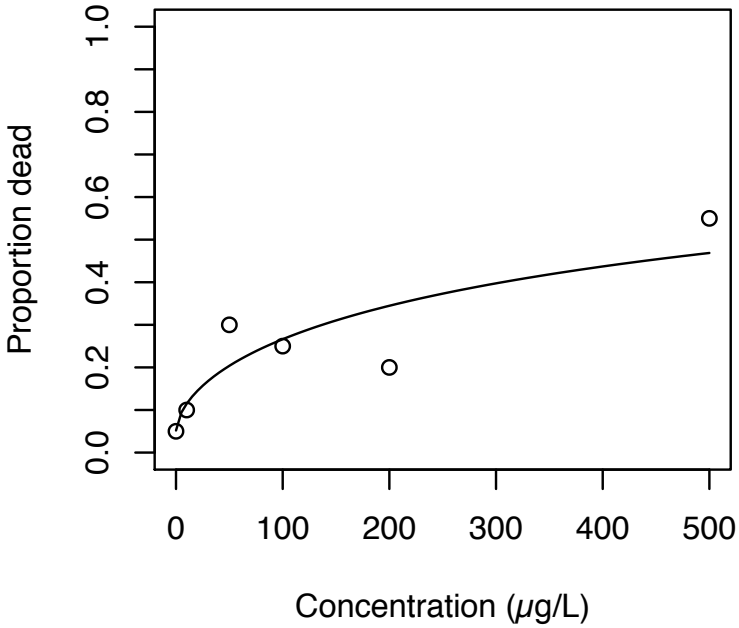
AG.


Cohort 2 Myrcene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

AH.


Cohort 2 Myrcene
at dose LD50 = 77 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
4
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

AI.


Cohort 2 Terpinolene
Concentration–Mortality Curve
Proportion dead
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
Concentration (μg/L)

AJ.

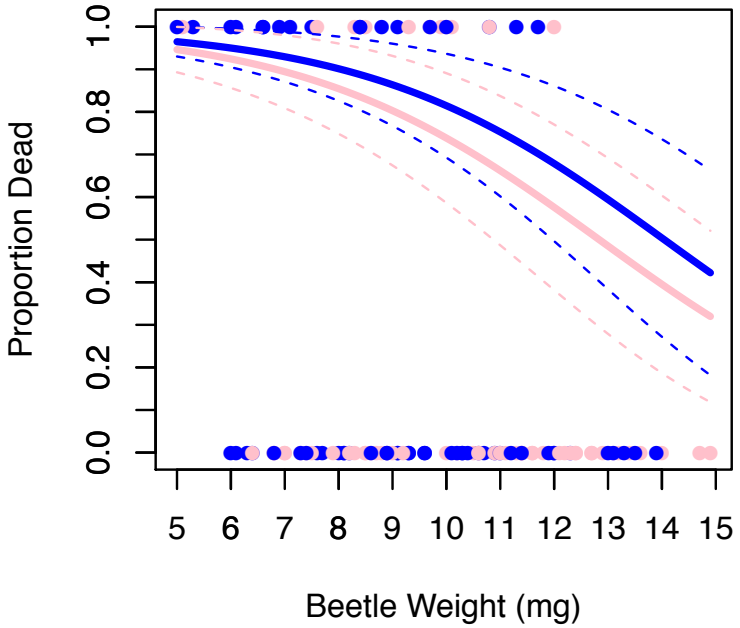

Cohort 2 Terpinolene
at dose LD50 = 742 μL/L
Proportion Dead
0.0
0.2
0.4
0.6
0.8
1.0
5
6
7
8
9
10
11
12
13
14
15
Beetle Weight (mg)

Figure S2: LC_{50} and logit curves for each compound and cohort.

Subfigures A, C, E, G, I, K, M, O, Q, S, U, W, Y, AA, AC, AE, AG, and AI: Concentration-mortality curves for each compound and cohort. Dots represent the proportion of beetles dead at each concentration tested. The solid red line red indicates the LC_{50} value. Dotted red lines indicate the fiducial limits of the LC_{50} value.

Subfigures B, D, F, H, J, L, N, P, R, T, V, X, Z, AB, AD, AF, AH, and AJ: The predicted relationship between beetle weight and mortality for each sex at the LC_{50} value. The solid lines represent the predicted relationship between beetle weight and mortality at the LC_{50} based on logistic regression. Lines that slope down towards the right indicate that heavier beetles survive more often. The further apart the male (blue) and female (pink) lines are, the greater the difference in mortality between the sexes, independent of weight. Dotted lines indicate the 95% confidence intervals. The dots represent each beetle tested that either survived (y=0) or died (y=1) after treatment at all doses.

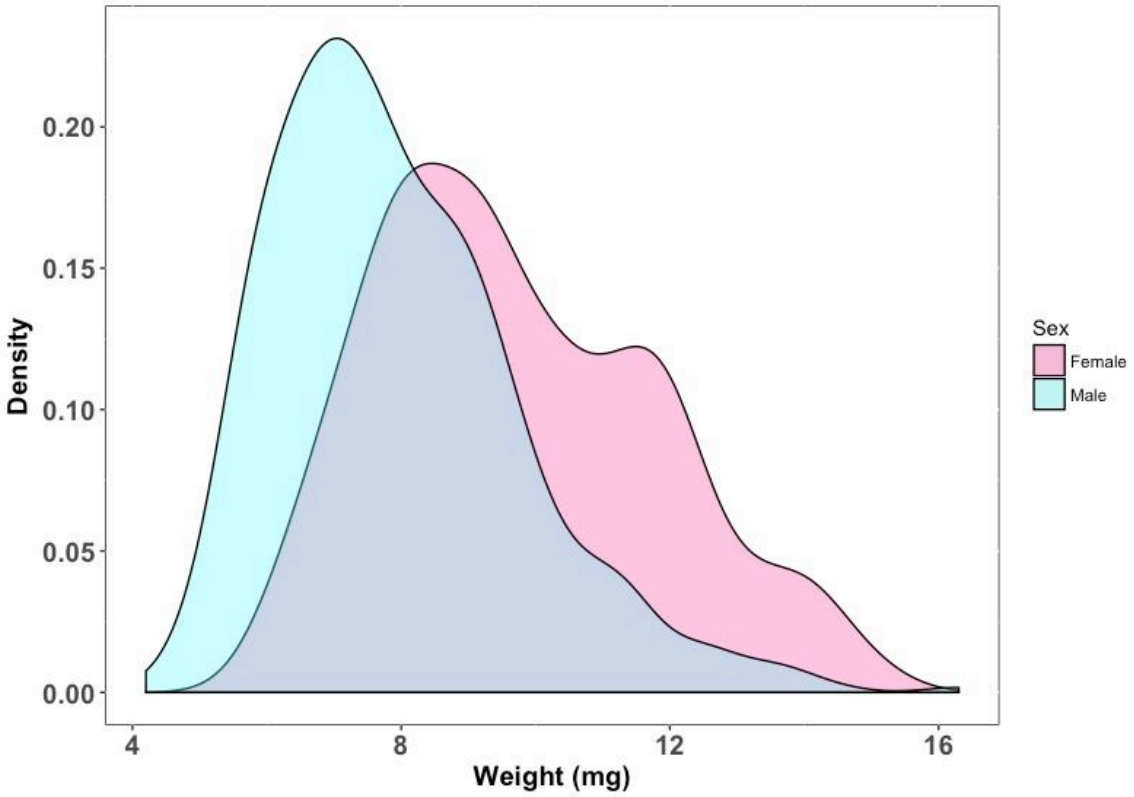


Fig. S3 Weight distribution of MPB from cohort 1
Average weight (±SD) = 8.81 ± 2.24 mg
Female average weight (±SD) = 9.73 ± 2.20 mg (N=492)
Male average weight (±SD) = 7.90 ± 1.87 mg (N=491)

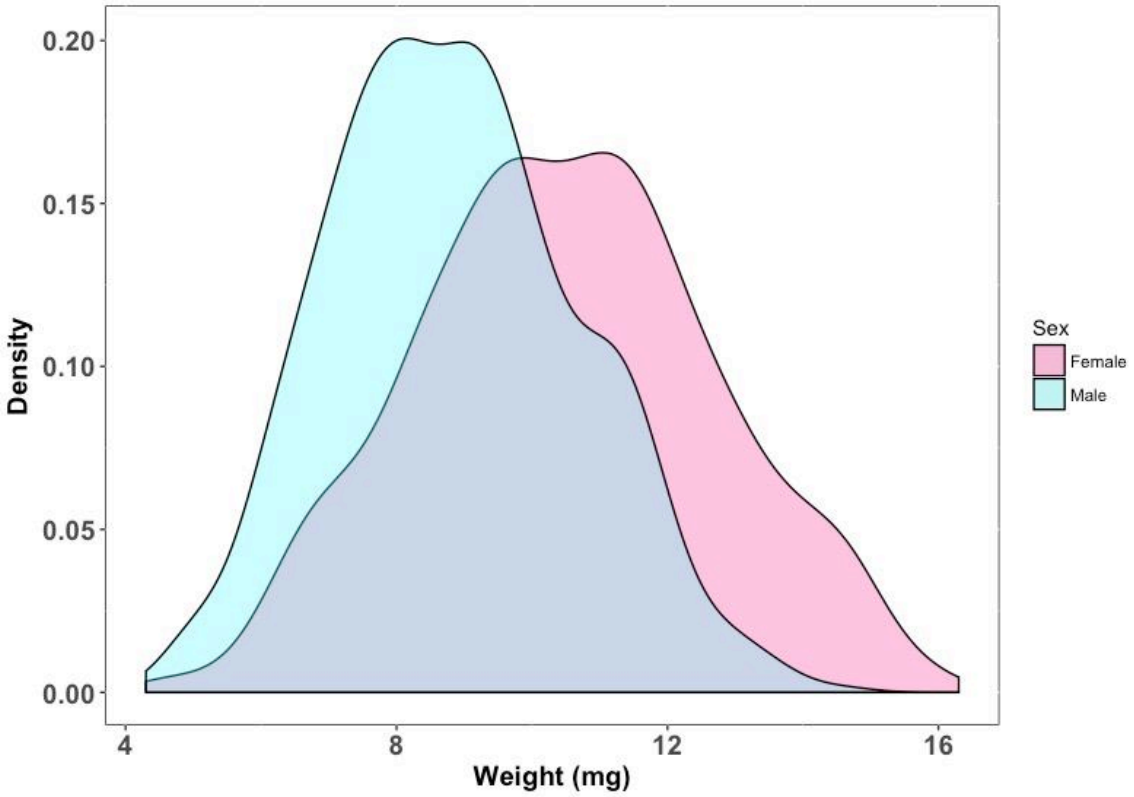


Fig. S4 Weight distribution of MPB from cohort 2
Average weight (±SD) = 9.69 ± 2.24 mg
Female average weight (±SD) = 10.53 ± 2.24 mg (N=599)
Male average weight (±SD) = 8.85 ± 1.90 mg (N=600)