

# **Ecotoxicology is not normal.**

**How the use of proper statistical models can increase statistical power in  
ecotoxicological experiments.**

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# 1 Supplement 1 - Additional Figures / Tables

## 1.1 Count data simulations

Table 1: Count data simulations - Proportion of models converged. N = sample sizes,  $\mu_C$  = mean abundance in control, LM = Linear model after transformation,  $GLM_{nb}$  = negative binomial model,  $GLM_{qp}$  = quasi-Poisson model.

N	$\mu_C$	LM	$GLM_{nb}$	$GLM_{qp}$
3.00	2.00	1.00	0.30	1.00
3.00	4.00	1.00	0.51	1.00
3.00	8.00	1.00	0.72	1.00
3.00	16.00	1.00	0.93	1.00
3.00	32.00	1.00	0.98	1.00
3.00	64.00	1.00	1.00	1.00
3.00	128.00	1.00	1.00	1.00
6.00	2.00	1.00	0.57	1.00
6.00	4.00	1.00	0.87	1.00
6.00	8.00	1.00	0.97	1.00
6.00	16.00	1.00	1.00	1.00
6.00	32.00	1.00	1.00	1.00
6.00	64.00	1.00	1.00	1.00
6.00	128.00	1.00	1.00	1.00
9.00	2.00	1.00	0.82	1.00
9.00	4.00	1.00	0.98	1.00
9.00	8.00	1.00	0.99	1.00
9.00	16.00	1.00	1.00	1.00
9.00	32.00	1.00	1.00	1.00
9.00	64.00	1.00	1.00	1.00
9.00	128.00	1.00	1.00	1.00

Table 2: Count data simulations - Power to detect a global treatment effect.  $N$  = sample sizes,  $\mu_C$  = mean abundance in control, LM = Linear model after transformation,  $GLM_{nb}$  = negative binomial model,  $GLM_{qp}$  = quasi-Poisson model,  $GLM_{pb}$  = negative binomial model with parametric bootstrap, np = Kruskal-Wallis test.

$N$	$\mu_C$	LM	$GLM_{nb}$	$GLM_{qp}$	$GLM_{pb}$	np
3.00	2.00	0.14	0.17	0.19	0.07	0.09
3.00	4.00	0.13	0.18	0.20	0.08	0.05
3.00	8.00	0.21	0.38	0.24	0.19	0.12
3.00	16.00	0.28	0.45	0.32	0.26	0.18
3.00	32.00	0.33	0.54	0.45	0.36	0.18
3.00	64.00	0.30	0.57	0.35	0.37	0.14
3.00	128.00	0.25	0.57	0.35	0.32	0.13
6.00	2.00	0.30	0.33	0.33	0.21	0.27
6.00	4.00	0.36	0.45	0.43	0.33	0.26
6.00	8.00	0.44	0.65	0.59	0.53	0.44
6.00	16.00	0.58	0.78	0.72	0.65	0.49
6.00	32.00	0.59	0.82	0.71	0.67	0.51
6.00	64.00	0.65	0.74	0.73	0.68	0.63
6.00	128.00	0.80	0.91	0.85	0.84	0.70
9.00	2.00	0.34	0.30	0.35	0.27	0.30
9.00	4.00	0.54	0.65	0.65	0.61	0.47
9.00	8.00	0.56	0.74	0.73	0.67	0.58
9.00	16.00	0.80	0.89	0.90	0.88	0.79
9.00	32.00	0.88	0.93	0.92	0.91	0.89
9.00	64.00	0.90	0.94	0.95	0.93	0.91
9.00	128.00	0.91	0.95	0.93	0.94	0.91

Table 3: Count data simulations - Power to detect LOEC. N = sample sizes,  $\mu_C$  = mean abundance in control, LM = Linear model after transformation,  $GLM_{nb}$  = negative binomial model,  $GLM_{qp}$  = quasi-Poisson model, np = pairwise Wilcoxon test.

N	$\mu_C$	LM	$GLM_{nb}$	$GLM_{qp}$	np
3.00	2.00	0.08	0.00	0.00	0.00
3.00	4.00	0.11	0.14	0.11	0.00
3.00	8.00	0.14	0.29	0.18	0.00
3.00	16.00	0.15	0.34	0.18	0.00
3.00	32.00	0.18	0.33	0.21	0.00
3.00	64.00	0.15	0.32	0.21	0.00
3.00	128.00	0.18	0.35	0.26	0.00
6.00	2.00	0.19	0.16	0.11	0.02
6.00	4.00	0.25	0.26	0.20	0.07
6.00	8.00	0.25	0.34	0.26	0.11
6.00	16.00	0.33	0.48	0.42	0.16
6.00	32.00	0.31	0.47	0.37	0.16
6.00	64.00	0.40	0.47	0.42	0.16
6.00	128.00	0.54	0.66	0.59	0.25
9.00	2.00	0.19	0.13	0.14	0.03
9.00	4.00	0.30	0.38	0.28	0.10
9.00	8.00	0.35	0.52	0.43	0.23
9.00	16.00	0.53	0.64	0.60	0.36
9.00	32.00	0.65	0.75	0.70	0.50
9.00	64.00	0.55	0.64	0.66	0.40
9.00	128.00	0.61	0.73	0.68	0.40

Table 4: Count data simulations - Type 1 error to detect a global treatment effect. N = sample sizes,  $\mu_C$  = mean abundance in control, LM = Linear model after transformation,  $GLM_{nb}$  = negative binomial model,  $GLM_{qp}$  = quasi-Poisson model,  $GLM_{pb}$  = negative binomial model with parametric bootstrap, np = Kruskal-Wallis test.

N	$\mu_C$	LM	$GLM_{nb}$	$GLM_{qp}$	$GLM_{pb}$	np
3.00	2.00	0.09	0.03	0.00	0.10	0.04
3.00	4.00	0.07	0.11	0.04	0.06	0.03
3.00	8.00	0.05	0.11	0.09	0.07	0.01
3.00	16.00	0.03	0.12	0.05	0.03	0.01
3.00	32.00	0.05	0.14	0.05	0.04	0.00
3.00	64.00	0.02	0.11	0.04	0.04	0.00
3.00	128.00	0.07	0.19	0.05	0.09	0.02
6.00	2.00	0.04	0.03	0.03	0.05	0.02
6.00	4.00	0.04	0.12	0.05	0.09	0.04
6.00	8.00	0.05	0.04	0.04	0.04	0.03
6.00	16.00	0.04	0.09	0.04	0.06	0.04
6.00	32.00	0.06	0.08	0.06	0.07	0.05
6.00	64.00	0.05	0.06	0.05	0.05	0.03
6.00	128.00	0.04	0.09	0.02	0.04	0.01
9.00	2.00	0.04	0.03	0.03	0.05	0.05
9.00	4.00	0.05	0.07	0.03	0.07	0.04
9.00	8.00	0.08	0.12	0.07	0.09	0.08
9.00	16.00	0.07	0.09	0.06	0.08	0.06
9.00	32.00	0.06	0.07	0.05	0.06	0.05
9.00	64.00	0.03	0.06	0.04	0.04	0.03
9.00	128.00	0.05	0.07	0.04	0.07	0.02

Table 5: Count data simulations - Type 1 error to detect LOEC. N = sample sizes,  $\mu_C$  = mean abundance in control, LM = Linear model after transformation,  $GLM_{nb}$  = negative binomial model,  $GLM_{qp}$  = quasi-Poisson model, np = pairwise Wilcoxon.

N	$\mu_C$	LM	$GLM_{nb}$	$GLM_{qp}$	np
3.00	2.00	0.06	0.03	0.02	0.00
3.00	4.00	0.10	0.14	0.10	0.00
3.00	8.00	0.04	0.08	0.05	0.00
3.00	16.00	0.01	0.12	0.02	0.00
3.00	32.00	0.04	0.16	0.03	0.00
3.00	64.00	0.01	0.14	0.03	0.00
3.00	128.00	0.08	0.14	0.11	0.00
6.00	2.00	0.05	0.05	0.05	0.00
6.00	4.00	0.10	0.15	0.09	0.02
6.00	8.00	0.04	0.07	0.03	0.02
6.00	16.00	0.04	0.08	0.04	0.02
6.00	32.00	0.06	0.10	0.06	0.05
6.00	64.00	0.06	0.07	0.05	0.07
6.00	128.00	0.04	0.12	0.06	0.05
9.00	2.00	0.04	0.06	0.04	0.03
9.00	4.00	0.05	0.05	0.05	0.04
9.00	8.00	0.09	0.11	0.09	0.09
9.00	16.00	0.04	0.04	0.01	0.02
9.00	32.00	0.08	0.09	0.07	0.03
9.00	64.00	0.05	0.10	0.04	0.05
9.00	128.00	0.05	0.11	0.05	0.03

## 1.2 Binomial data simulations

Table 6: Binomial data simulations - Power to detect a global treatment effect. N = sample sizes,  $p_E$  = probability in effect treatments, LM = Linear model after transformation,  $GLM$  = binomial model, np = Kruskal-Wallis test.

N	$p_E$	LM	$GLM$	np
3.00	0.60	0.95	1.00	0.86
3.00	0.65	0.87	0.99	0.73
3.00	0.70	0.78	0.97	0.64
3.00	0.75	0.61	0.85	0.44
3.00	0.80	0.42	0.63	0.28
3.00	0.85	0.21	0.42	0.10
3.00	0.90	0.09	0.13	0.04
3.00	0.95	0.06	0.07	0.03
6.00	0.60	1.00	1.00	1.00
6.00	0.65	1.00	1.00	1.00
6.00	0.70	1.00	1.00	1.00
6.00	0.75	0.98	1.00	0.96
6.00	0.80	0.83	0.88	0.80
6.00	0.85	0.55	0.64	0.50
6.00	0.90	0.18	0.24	0.14
6.00	0.95	0.04	0.06	0.02
9.00	0.60	1.00	1.00	1.00
9.00	0.65	1.00	1.00	1.00
9.00	0.70	1.00	1.00	1.00
9.00	0.75	1.00	1.00	1.00
9.00	0.80	0.98	0.99	0.97
9.00	0.85	0.76	0.83	0.73
9.00	0.90	0.28	0.32	0.25
9.00	0.95	0.06	0.06	0.05

Table 7: Count data simulations - Power to detect LOEC. N = sample sizes,  $p_E$  = probability in effect treatments, LM = Linear model after transformation, *GLM* = binomial model, np = pairwise Wilcoxon.

N	$p_E$	LM	<i>GLM</i>	np
3.00	0.60	0.80	0.71	0.00
3.00	0.65	0.72	0.58	0.00
3.00	0.70	0.59	0.43	0.00
3.00	0.75	0.42	0.23	0.00
3.00	0.80	0.28	0.11	0.00
3.00	0.85	0.12	0.03	0.00
3.00	0.90	0.03	0.01	0.00
3.00	0.95	0.01	0.00	0.00
6.00	0.60	1.00	0.95	0.98
6.00	0.65	0.99	0.95	0.95
6.00	0.70	0.94	0.92	0.83
6.00	0.75	0.79	0.76	0.59
6.00	0.80	0.53	0.51	0.32
6.00	0.85	0.32	0.22	0.13
6.00	0.90	0.09	0.04	0.03
6.00	0.95	0.01	0.00	0.00
9.00	0.60	0.99	0.98	0.98
9.00	0.65	1.00	0.99	0.97
9.00	0.70	0.99	0.96	0.95
9.00	0.75	0.96	0.97	0.92
9.00	0.80	0.82	0.81	0.72
9.00	0.85	0.44	0.50	0.34
9.00	0.90	0.16	0.14	0.08
9.00	0.95	0.03	0.01	0.00



Table 8: Binomial data simulations - Type 1 error to detect a global treatment effect. N = sample sizes,  $p$  = probability, LM = Linear model after transformation,  $GLM$  = binomial model, np = Kruskal-Wallis test.

N	$p$	LM	$GLM$	np
3.00	0.60	0.03	0.03	0.02
3.00	0.65	0.04	0.06	0.01
3.00	0.70	0.05	0.04	0.00
3.00	0.75	0.05	0.06	0.01
3.00	0.80	0.06	0.06	0.01
3.00	0.85	0.06	0.06	0.02
3.00	0.90	0.06	0.09	0.02
3.00	0.95	0.04	0.04	0.02
6.00	0.60	0.07	0.08	0.06
6.00	0.65	0.04	0.05	0.04
6.00	0.70	0.04	0.06	0.04
6.00	0.75	0.04	0.06	0.04
6.00	0.80	0.05	0.06	0.03
6.00	0.85	0.04	0.05	0.03
6.00	0.90	0.06	0.08	0.04
6.00	0.95	0.04	0.08	0.03
9.00	0.60	0.05	0.04	0.04
9.00	0.65	0.06	0.04	0.04
9.00	0.70	0.08	0.06	0.07
9.00	0.75	0.04	0.04	0.03
9.00	0.80	0.03	0.02	0.02
9.00	0.85	0.03	0.02	0.02
9.00	0.90	0.03	0.05	0.02
9.00	0.95	0.05	0.07	0.04

Table 9: Binomial data simulations - Type 1 error to detect LOEC. N = sample sizes,  $p$  = probability, LM = Linear model after transformation, *GLM* = binomial model, np = pairwise Wilcoxon.

N	$p_E$	LM	<i>GLM</i>	np
3.00	0.60	0.03	0.04	0.00
3.00	0.65	0.04	0.04	0.00
3.00	0.70	0.05	0.04	0.00
3.00	0.75	0.05	0.02	0.00
3.00	0.80	0.08	0.06	0.00
3.00	0.85	0.05	0.04	0.00
3.00	0.90	0.06	0.00	0.00
3.00	0.95	0.06	0.00	0.00
6.00	0.60	0.06	0.04	0.01
6.00	0.65	0.02	0.04	0.02
6.00	0.70	0.05	0.05	0.02
6.00	0.75	0.04	0.06	0.04
6.00	0.80	0.04	0.04	0.02
6.00	0.85	0.06	0.04	0.02
6.00	0.90	0.06	0.03	0.02
6.00	0.95	0.05	0.00	0.01
9.00	0.60	0.06	0.06	0.04
9.00	0.65	0.04	0.03	0.02
9.00	0.70	0.06	0.06	0.05
9.00	0.75	0.05	0.07	0.04
9.00	0.80	0.03	0.03	0.01
9.00	0.85	0.05	0.04	0.02
9.00	0.90	0.03	0.03	0.02
9.00	0.95	0.04	0.01	0.01