Ecotoxicology is not normal.

A comparison of statistical approaches for analysis of count and proportion data in ecotoxicology.

Eduard Szöcs, Ralf B. Schäfer

March 23, 2015

Supplement 1 - Additional Figures / Tables

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

N	μ_C	LM	GLM_{nb}	GLM_{qp}	GLM_p
3.00	2.00	1.00	0.33	1.00	1.00
3.00	4.00	1.00	0.53	1.00	1.00
3.00	8.00	1.00	0.79	1.00	1.00
3.00	16.00	1.00	0.94	1.00	1.00
3.00	32.00	1.00	0.99	1.00	1.00
3.00	64.00	1.00	1.00	1.00	1.00
3.00	128.00	1.00	1.00	1.00	1.00
6.00	2.00	1.00	0.63	1.00	1.00
6.00	4.00	1.00	0.85	1.00	1.00
6.00	8.00	1.00	0.98	1.00	1.00
6.00	16.00	1.00	1.00	1.00	1.00
6.00	32.00	1.00	1.00	1.00	1.00
6.00	64.00	1.00	1.00	1.00	1.00
6.00	128.00	1.00	1.00	1.00	1.00
9.00	2.00	1.00	0.76	1.00	1.00
9.00	4.00	1.00	0.95	1.00	1.00
9.00	8.00	1.00	1.00	1.00	1.00
9.00	16.00	1.00	1.00	1.00	1.00
9.00	32.00	1.00	1.00	1.00	1.00
9.00	64.00	1.00	1.00	1.00	1.00
9.00	128.00	1.00	1.00	1.00	1.00

Table 2: Count data simulations - Power to detect a treatment effect. N = sample sizes, μ_C = mean abundance in control, LM = Linear model after transformation, GLM_{nb} = negative binomial model, GLM_{qp} = quasi-Poisson model, GLM_{qp} = Poisson model, np = pairwise Wilcoxon test.

N	μ_C	LM	GLM_{nb}	GLM_{qp}	GLM_p	np	NA
3.00	2.00	0.13	0.17	0.17	0.08	0.36	0.04
3.00	4.00	0.14	0.18	0.17	0.10	0.54	0.06
3.00	8.00	0.19	0.36	0.24	0.21	0.78	0.09
3.00	16.00	0.23	0.49	0.33	0.29	0.95	0.14
3.00	32.00	0.31	0.57	0.38	0.35	0.99	0.16
3.00	64.00	0.32	0.58	0.38	0.34	1.00	0.18
3.00	128.00	0.35	0.61	0.42	0.37	1.00	0.19
6.00	2.00	0.26	0.30	0.29	0.22	0.49	0.21
6.00	4.00	0.36	0.48	0.44	0.40	0.78	0.32
6.00	8.00	0.48	0.64	0.57	0.53	0.94	0.44
6.00	16.00	0.59	0.76	0.70	0.65	0.99	0.54
6.00	32.00	0.68	0.82	0.76	0.73	1.00	0.63
6.00	64.00	0.72	0.85	0.80	0.77	1.00	0.64
6.00	128.00	0.73	0.84	0.80	0.76	1.00	0.63
9.00	2.00	0.34	0.40	0.42	0.35	0.64	0.31
9.00	4.00	0.56	0.69	0.66	0.63	0.91	0.54
9.00	8.00	0.70	0.82	0.79	0.76	0.98	0.68
9.00	16.00	0.81	0.91	0.89	0.88	1.00	0.79
9.00	32.00	0.89	0.95	0.94	0.92	1.00	0.87
9.00	64.00	0.92	0.96	0.95	0.95	1.00	0.89
9.00	128.00	0.94	0.97	0.96	0.95	1.00	0.91

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

N	μ_C	LM	GLM_{nb}	GLM_{qp}	GLM_p	np
3.00	2.00	0.05	0.01	0.02	0.02	0.00
3.00	4.00	0.08	0.09	0.08	0.15	0.00
3.00	8.00	0.11	0.22	0.12	0.30	0.00
3.00	16.00	0.13	0.30	0.18	0.42	0.00
3.00	32.00	0.17	0.35	0.22	0.50	0.00
3.00	64.00	0.19	0.37	0.23	0.51	0.00
3.00	128.00	0.18	0.37	0.23	0.53	0.00
6.00	2.00	0.14	0.11	0.09	0.15	0.06
6.00	4.00	0.17	0.23	0.19	0.30	0.12
6.00	8.00	0.28	0.39	0.32	0.52	0.20
6.00	16.00	0.33	0.48	0.39	0.59	0.23
6.00	32.00	0.40	0.54	0.47	0.64	0.28
6.00	64.00	0.44	0.56	0.48	0.61	0.29
6.00	128.00	0.44	0.57	0.49	0.56	0.29
9.00	2.00	0.19	0.20	0.18	0.26	0.13
9.00	4.00	0.29	0.37	0.31	0.48	0.27
9.00	8.00	0.40	0.52	0.46	0.62	0.35
9.00	16.00	0.51	0.63	0.57	0.70	0.45
9.00	32.00	0.57	0.69	0.63	0.68	0.52
9.00	64.00	0.61	0.72	0.66	0.65	0.53
9.00	128.00	0.65	0.73	0.68	0.61	0.58

Table 4: Count data simulations - Type 1 error to detect a global treatment effect. N = sample sizes, μ_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 boostrap, GLM_p = Poisson model, np = Kruskal-Wallis test.

N	μ_C	LM	GLM_{nb}	GLM_{qp}	GLM_{pb}	GLM_p	np
3.00	2.00	0.07	0.04	0.02	0.07	0.21	0.03
3.00	4.00	0.05	0.07	0.03	0.05	0.37	0.01
3.00	8.00	0.04	0.12	0.05	0.05	0.58	0.02
3.00	16.00	0.05	0.14	0.05	0.05	0.84	0.02
3.00	32.00	0.04	0.13	0.03	0.04	0.94	0.01
3.00	64.00	0.05	0.16	0.05	0.05	0.99	0.03
3.00	128.00	0.05	0.13	0.05	0.06	1.00	0.02
6.00	2.00	0.04	0.05	0.04	0.06	0.20	0.03
6.00	4.00	0.05	0.08	0.05	0.05	0.36	0.04
6.00	8.00	0.06	0.09	0.05	0.06	0.58	0.04
6.00	16.00	0.05	0.08	0.05	0.05	0.80	0.04
6.00	32.00	0.06	0.08	0.05	0.06	0.94	0.04
6.00	64.00	0.05	0.09	0.05	0.05	0.98	0.04
6.00	128.00	0.05	0.09	0.04	0.05	1.00	0.04
9.00	2.00	0.06	0.06	0.05	0.07	0.20	0.05
9.00	4.00	0.04	0.08	0.05	0.06	0.36	0.04
9.00	8.00	0.05	0.08	0.05	0.06	0.58	0.04
9.00	16.00	0.04	0.07	0.04	0.05	0.81	0.04
9.00	32.00	0.04	0.06	0.04	0.06	0.94	0.05
9.00	64.00	0.04	0.07	0.05	0.05	0.99	0.04
9.00	128.00	0.05	0.07	0.05	0.06	1.00	0.04

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

N	μ_C	LM	GLM_{nb}	GLM_{qp}	GLM_p	np
3.00	2.00	0.05	0.02	0.02	0.02	0.00
3.00	4.00	0.04	0.08	0.04	0.14	0.00
3.00	8.00	0.05	0.11	0.06	0.24	0.00
3.00	16.00	0.03	0.11	0.04	0.36	0.00
3.00	32.00	0.04	0.15	0.05	0.55	0.00
3.00	64.00	0.05	0.16	0.06	0.61	0.00
3.00	128.00	0.04	0.13	0.05	0.68	0.00
6.00	2.00	0.04	0.04	0.02	0.07	0.02
6.00	4.00	0.03	0.06	0.03	0.15	0.02
6.00	8.00	0.04	0.08	0.05	0.26	0.03
6.00	16.00	0.04	0.08	0.05	0.37	0.03
6.00	32.00	0.04	0.08	0.04	0.52	0.03
6.00	64.00	0.05	0.10	0.05	0.61	0.04
6.00	128.00	0.04	0.08	0.04	0.66	0.05
9.00	2.00	0.03	0.05	0.04	0.08	0.03
9.00	4.00	0.04	0.06	0.05	0.15	0.04
9.00	8.00	0.04	0.05	0.04	0.27	0.04
9.00	16.00	0.04	0.07	0.04	0.38	0.03
9.00	32.00	0.03	0.05	0.04	0.49	0.03
9.00	64.00	0.04	0.06	0.04	0.61	0.04
9.00	128.00	0.04	0.06	0.04	0.67	0.04

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	0.97	1.00	0.87
3.00	0.65	0.90	0.99	0.76
3.00	0.70	0.78	0.95	0.60
3.00	0.75	0.60	0.84	0.41
3.00	0.80	0.36	0.64	0.22
3.00	0.85	0.20	0.41	0.10
3.00	0.90	0.11	0.17	0.05
3.00	0.95	0.06	0.06	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	0.97	1.00	0.97
6.00	0.80	0.85	0.93	0.82
6.00	0.85	0.53	0.62	0.48
6.00	0.90	0.17	0.24	0.15
6.00	0.95	0.04	0.08	0.03
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	0.75	0.82	0.73
9.00	0.90	0.26	0.32	0.23
9.00	0.95	0.05	0.07	0.04

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	GLM	np
3.00	0.60	0.86	0.70	0.00
3.00	0.65	0.74	0.57	0.00
3.00	0.70	0.59	0.40	0.00
3.00	0.75	0.41	0.17	0.00
3.00	0.80	0.23	0.04	0.00
3.00	0.85	0.11	0.01	0.00
3.00	0.90	0.05	0.00	0.00
3.00	0.95	0.01	0.00	0.00
6.00	0.60	0.98	0.95	0.97
6.00	0.65	0.97	0.93	0.91
6.00	0.70	0.93	0.90	0.82
6.00	0.75	0.82	0.78	0.62
6.00	0.80	0.60	0.55	0.36
6.00	0.85	0.33	0.19	0.16
6.00	0.90	0.08	0.01	0.03
6.00	0.95	0.01	0.00	0.00
9.00	0.60	0.97	0.95	0.97
9.00	0.65	0.98	0.96	0.98
9.00	0.70	0.97	0.96	0.96
9.00	0.75	0.94	0.93	0.89
9.00	0.80	0.82	0.81	0.73
9.00	0.85	0.46	0.43	0.35
9.00	0.90	0.13	0.08	0.08
9.00	0.95	0.01	0.00	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	0.05	0.06	0.02
3.00	0.65	0.06	0.06	0.02
3.00	0.70	0.04	0.05	0.02
3.00	0.75	0.06	0.05	0.02
3.00	0.80	0.05	0.07	0.02
3.00	0.85	0.06	0.07	0.02
3.00	0.90	0.05	0.08	0.01
3.00	0.95	0.06	0.07	0.02
6.00	0.60	0.06	0.06	0.04
6.00	0.65	0.04	0.05	0.03
6.00	0.70	0.04	0.05	0.04
6.00	0.75	0.05	0.05	0.03
6.00	0.80	0.06	0.06	0.04
6.00	0.85	0.04	0.06	0.04
6.00	0.90	0.06	0.06	0.04
6.00	0.95	0.05	0.08	0.03
9.00	0.60	0.05	0.05	0.04
9.00	0.65	0.06	0.06	0.05
9.00	0.70	0.06	0.05	0.05
9.00	0.75	0.05	0.05	0.05
9.00	0.80	0.06	0.07	0.06
9.00	0.85	0.04	0.05	0.04
9.00	0.90	0.06	0.07	0.05
9.00	0.95	0.06	0.06	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	GLM	np
3.00	0.60	0.03	0.03	0.00
3.00	0.65	0.04	0.03	0.00
3.00	0.70	0.04	0.03	0.00
3.00	0.75	0.04	0.03	0.00
3.00	0.80	0.03	0.01	0.00
3.00	0.85	0.04	0.01	0.00
3.00	0.90	0.03	0.00	0.00
3.00	0.95	0.05	0.00	0.00
6.00	0.60	0.05	0.06	0.02
6.00	0.65	0.03	0.04	0.01
6.00	0.70	0.05	0.04	0.02
6.00	0.75	0.03	0.03	0.02
6.00	0.80	0.04	0.04	0.01
6.00	0.85	0.03	0.02	0.01
6.00	0.90	0.05	0.01	0.01
6.00	0.95	0.05	0.00	0.01
9.00	0.60	0.04	0.04	0.04
9.00	0.65	0.04	0.03	0.04
9.00	0.70	0.05	0.04	0.05
9.00	0.75	0.03	0.04	0.02
9.00	0.80	0.04	0.04	0.03
9.00	0.85	0.04	0.03	0.03
9.00	0.90	0.04	0.03	0.03
9.00	0.95	0.05	0.00	0.01