Ecotoxicology is not normal.

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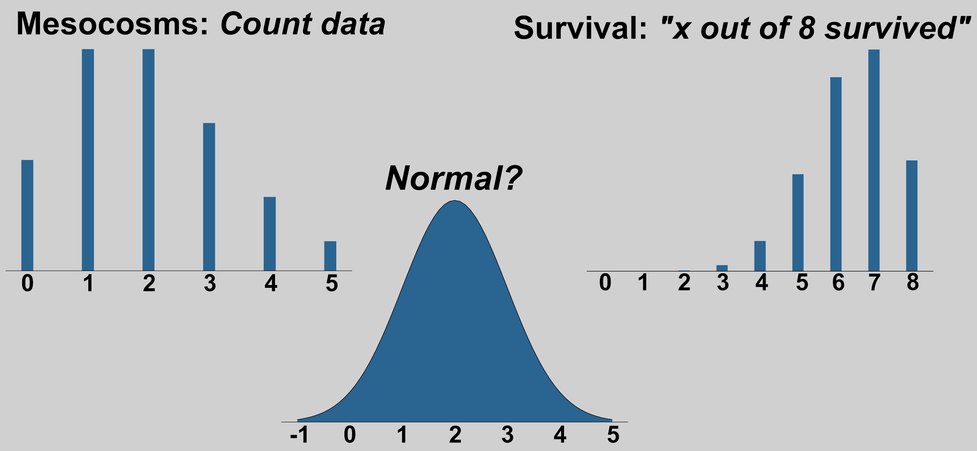
Most eco(toxico)logical data is not normally distributed



- Usually analysed by using
  - transformations (e.g. $log(Ax+C)$, $x^{0.5}, arcsine\ x^{0.25}$) for linear model [2]
  - non-parametric methods [3]
- *Generalized Linear Models* (GLM) can directly model such data
- Can GLMs enhance inference in ecotoxicology?

Methods: Simulation study

- Simulated overdispersed counts
- One-factorial design, 50% effect
- Variates:
  - Number of replicates
  - Abundance
- Methods:
  - linear model on transformed data
  - GLM (Poisson, negative binomial, quasi-Poisson)
  - Kruskal-Wallis / pairwise Wilcoxon
- Endpoints:
  - Global Treatment effect (F-Test, LR-Test)
  - LOEC (Dunnett contrasts)

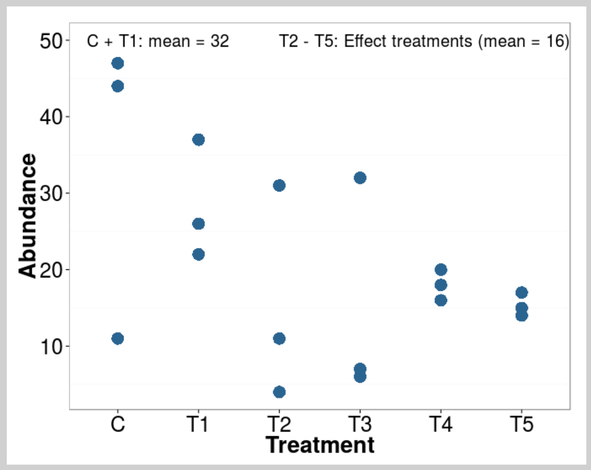


Figure 1 : A realised simulation. N = 3, mean = 32, effect = 50%

Results: Claiming an effect when there is none (Type I error)

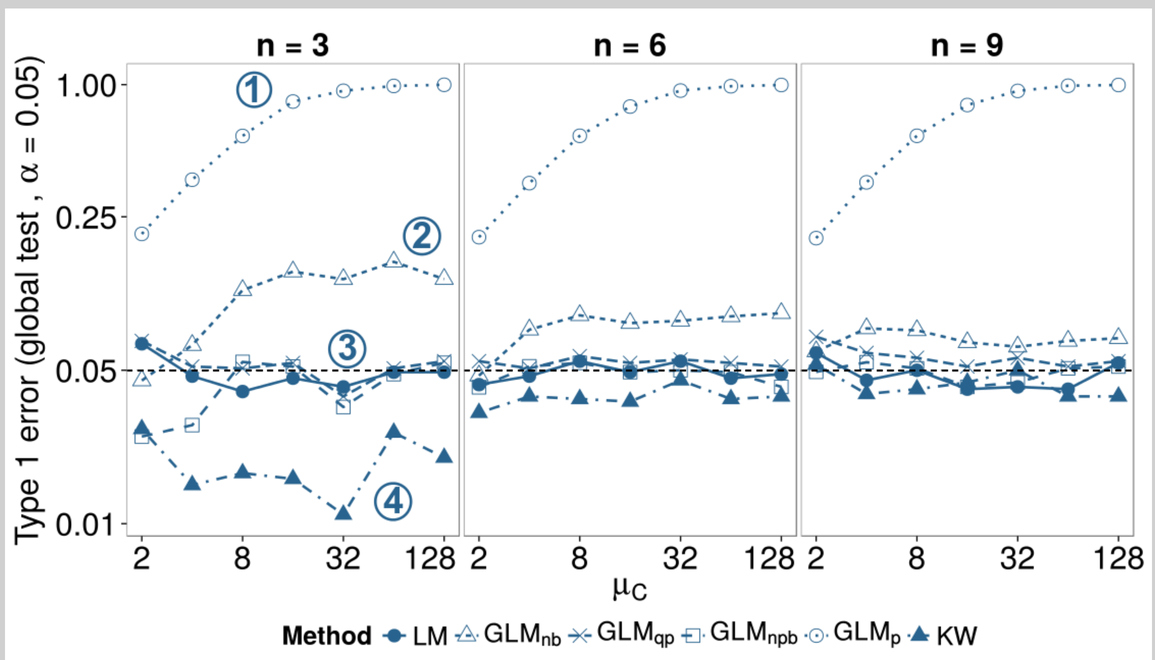


Figure 2 : Type I errors for testing a global treatment effect.

① Poisson GLM does not fit to the data (overdispersion) and overestimates significance

② Increased Type I errors for negative binomial GLM

③ Negative binomial GLM + bootstrap gives correct levels. Quasi-Poisson GLM and Linear model give appropriate error levels.

④ Kruskal-Wallis test shows low Type I error (loses power)

Results: How often is a reduction of 50% detected? (Power)

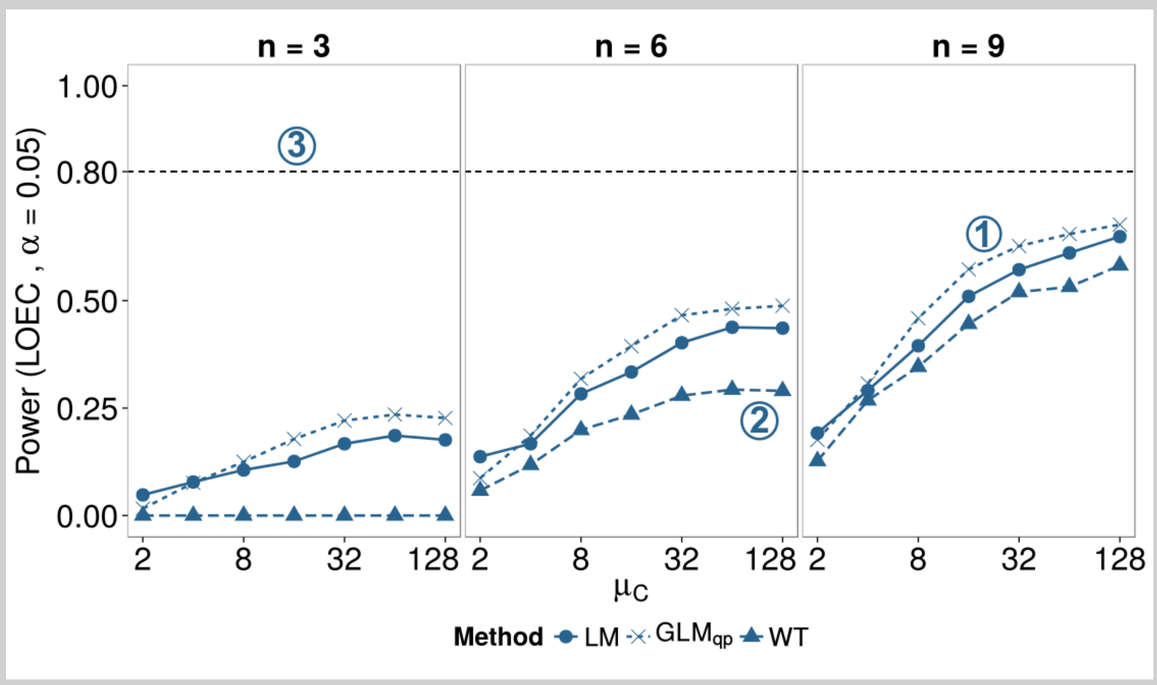


Figure 3 : Power to detect LOEC. Only methods wtih appropriate Type I errors are displayed.

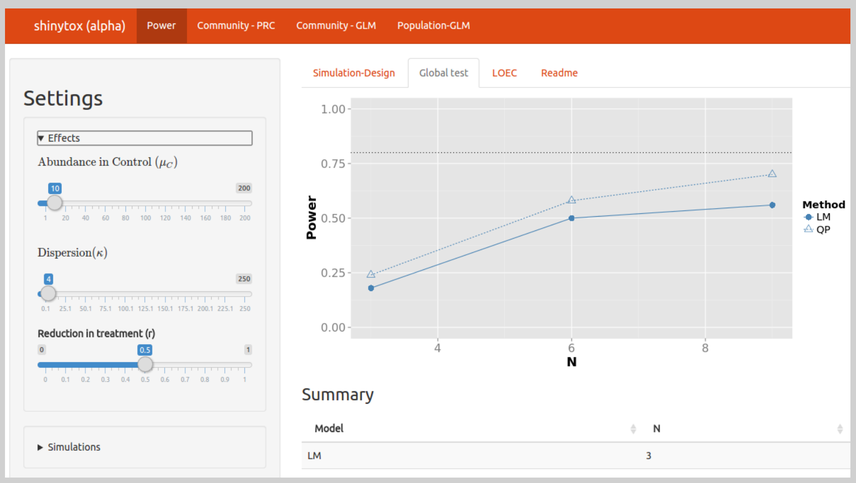
① Quasi-Poisson GLM has greater power then the linear model on transformed data

② Pairwise Wilcoxon has reduced power

③ Low power to detect LOEC at a reduction of 50% for common mesocosm designs

Power estimation app

- *For "a priori"* power calculations
- web based, easy to use, for one factorial designs
- Currently hostet at **http://52.28.43.83/shinypower/**



Conclusions

- Low power at common experimental designs (NOEC !?)
- Change your model, not your data!
- GLM increases Power for count and binomial data
- Negative binomial GLM not recommended (but see bootstrap).
- GLMs for multivariate data? See [1] for a comparison with PRC.

References

[1] Szöcs E. et al. Analysing chemical-induced changes in macroinvertebrate communities in aquatic mesocosm experiments: a comparison of methods. *Ecotoxicology*, 24(4):760–769, 2015.

[2] Newman M. *Quantitative ecotoxicology*. Taylor & Francis, Boca Raton, FL, 2012.

[3] Wang M. and Riffel M. Making the right conclusions based on wrong results and small sample sizes: interpretation of statistical tests in ecotoxicology. *Ecotoxicology and Environmental Safety*, 74(4):684–92, 2011.

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Paper, poster & source code here: https://github.com/EDiLD/usetheglm