

# Experimental design

# How would you evaluate fertilizer effect?

Discuss with partner (5')



## Experimental design principles

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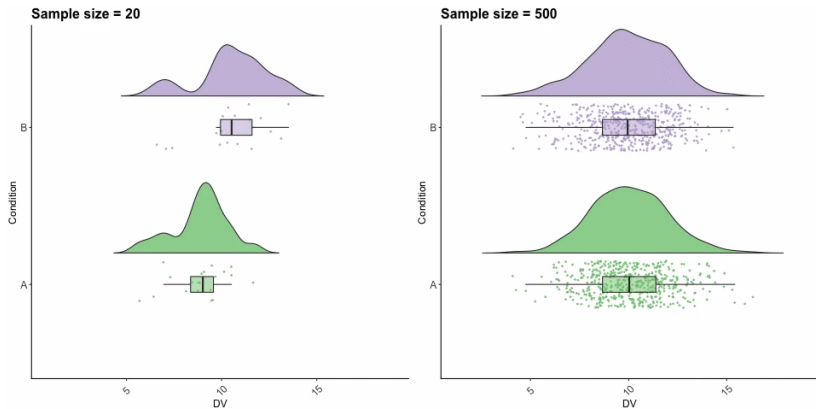
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- ▶ How many? As much as you can! See Gelman & Carlin 2014.
- ▶ Traditionally, ecology studies have had **too low sample sizes**.
- ▶ Low sample sizes miss subtle effects, but also **prone to bias**.

# Low sample sizes very sensitive to random noise



[https://twitter.com/ajstewart\\_lang/status/1020038488278945797](https://twitter.com/ajstewart_lang/status/1020038488278945797)

# Low sample sizes may bias inferences about population

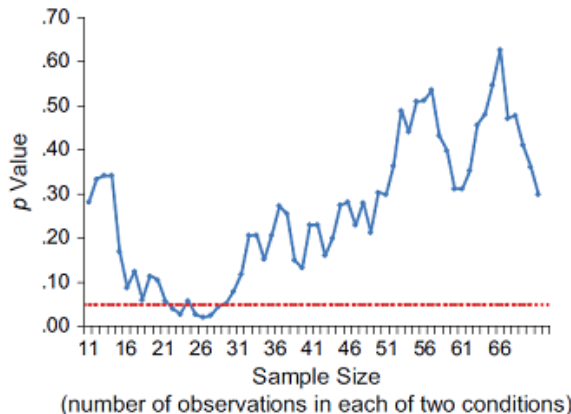


<http://statisticalgate.com/regression-simulation/>

# Low sample sizes may bias inferences

See *The evolution of correlations*

## Stopping rules



**Fig. 2.** Illustrative simulation of  $p$  values obtained by a researcher who continuously adds an observation to each of two conditions, conducting a  $t$  test after each addition. The dotted line highlights the conventional significance criterion of  $p \leq .05$ .

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- ▶ **Do simulations.** Power/Sample size/Precision analyses (e.g. this or this).
- ▶ Plan to have at least **10-30 observations per predictor**.
- ▶ Complex models (w/ many predictors, interactions etc) require **high** sample sizes.



## Randomization

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- ▶ Stratify: randomize within groups (e.g. species, soil types)

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- ▶ Measure **before & after** treatment.
- ▶ Consider **blind designs** to avoid observer bias.

# Experimental design principles

## 1. Replication

# Experimental design principles

1. Replication
2. Randomization

# Experimental design principles

1. Replication
2. Randomization
3. Controls

## To read more

- ▶ Ruxton & Colegrave. Experimental Design for the Life Sciences.  
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