IAEA Ocean Acidification International Coordination Centre OA-ICC

UNIVERSITY OF GOTHENBURG

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Basic training course on ocean acidification

EVT1804704

14-19 March 2022

Experimental design

Take home messages

Every experiment is an abstraction of reality

George E. P. Box

There is nothing like a perfect experiment !

"Essentially, all models are wrong, but some are useful"

Essentially, all experiments are wrong, but most are useful

Be aware and honest about your limitations

How to design your experiment

1. What is your question? Your hypothesis?
2. How can I test this?
    - What are my limitations?
    - What is the best model?
    - What are the best endpoints?
    - What are the best design/stats?
    - What are my controls?
    - etc.

Can I REALLY answer my question with the collected data?

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Do the right thing

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Do the things right

Can I REALLY answer my question with the collected data?

Trade-offs

Realism

[duration, tested parameter, environment, etc.]

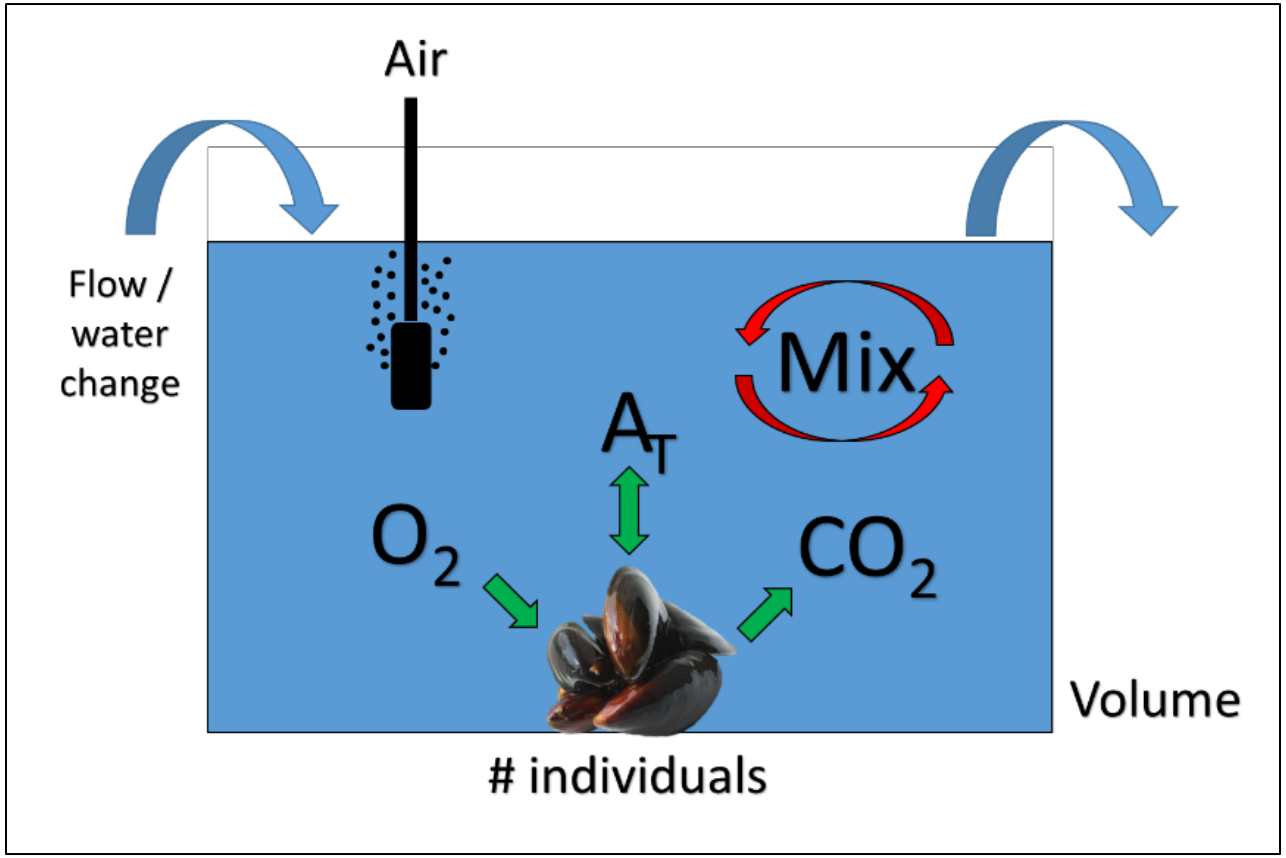
vs.

Feasibility

[manpower, money, space, time]

The aquarium system

Depend on the species and stage/size/density/species specificities



The aquarium system

Depend on the species

- ✓ Type and amount of food
- ✓ Physico-chemical conditions
- ✓ Behaviour (escape, cannibalism, etc.)
- ✓ Etc.

If not well designed, can lead to confounding factors

Need pilot experiment

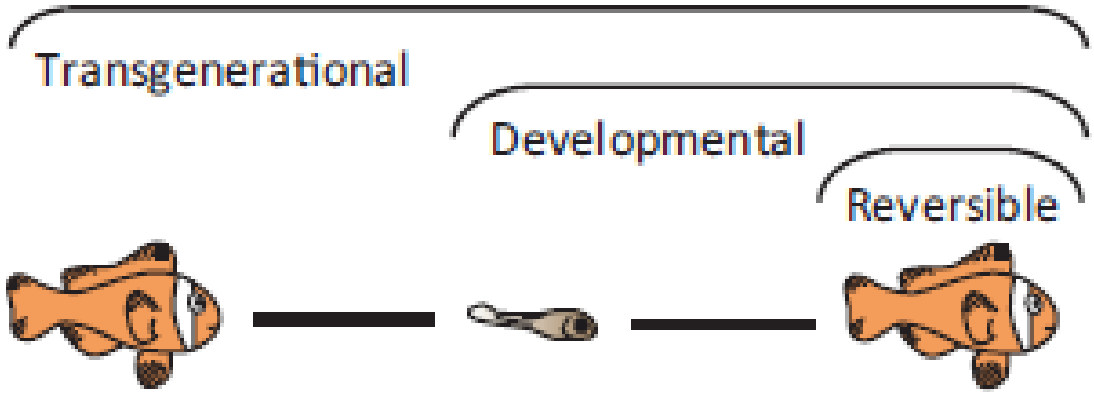
Duration

Depend on the species and question

Effect of ocean acidification on fecundity

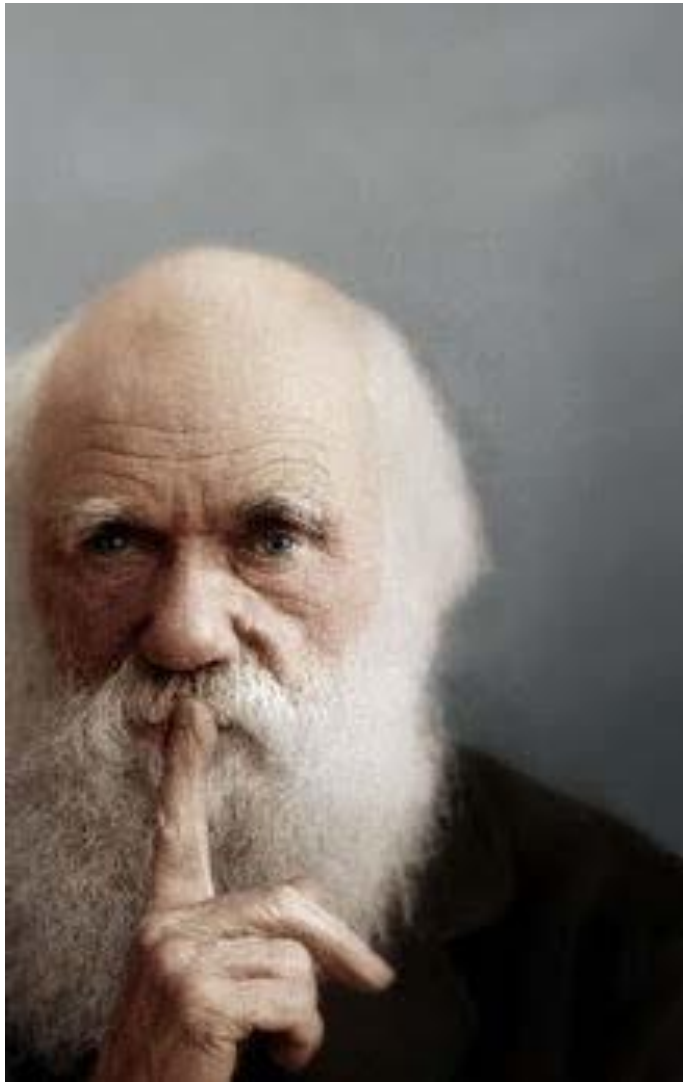
… but can be long

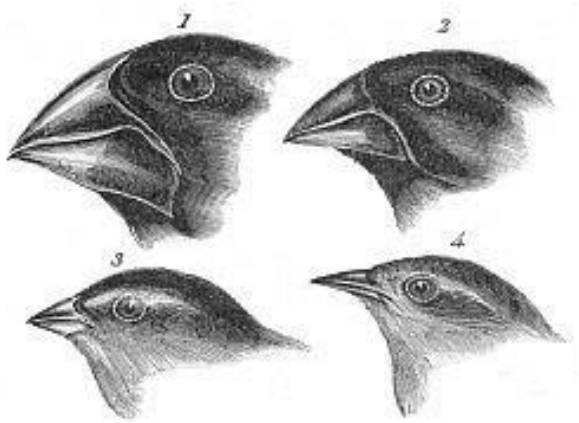
Duration - stages



More relisient offsprings to OA

Variability

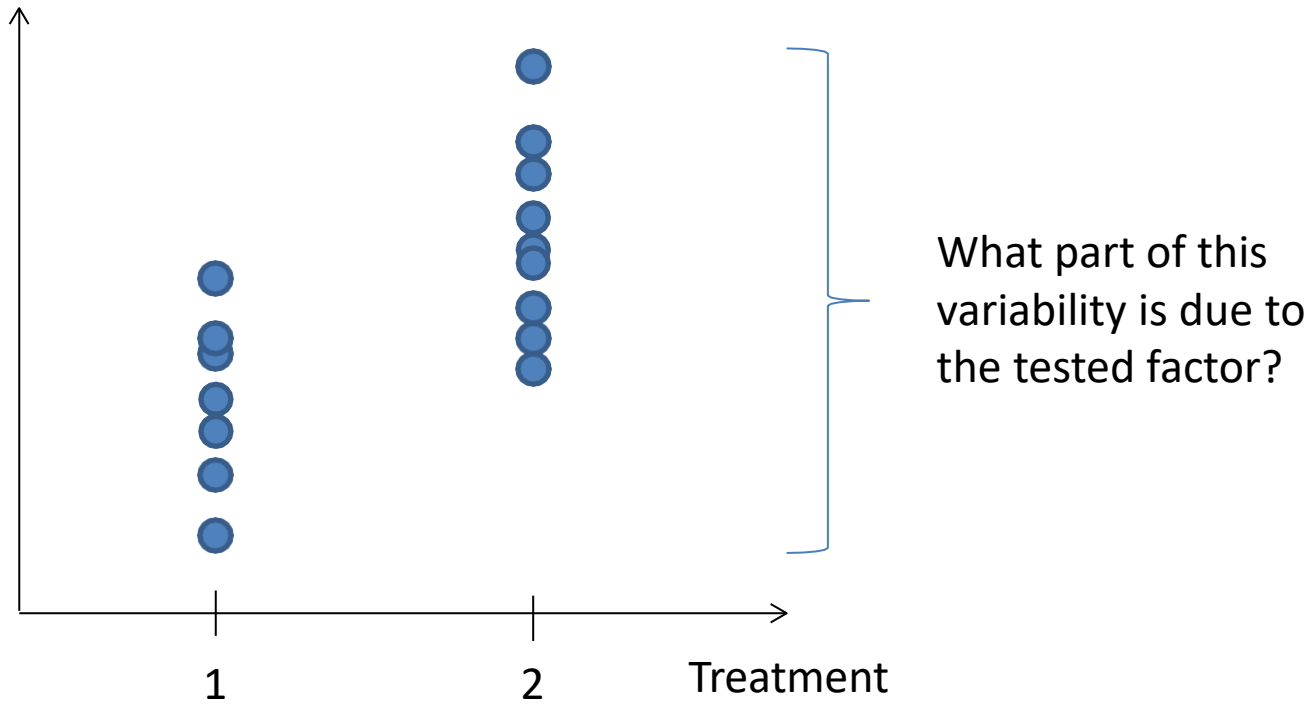




Finches from Galapagos Archipelago

Explain variability

Sources of variability



”biologically relevant” vs.
”technical/confounding factors”

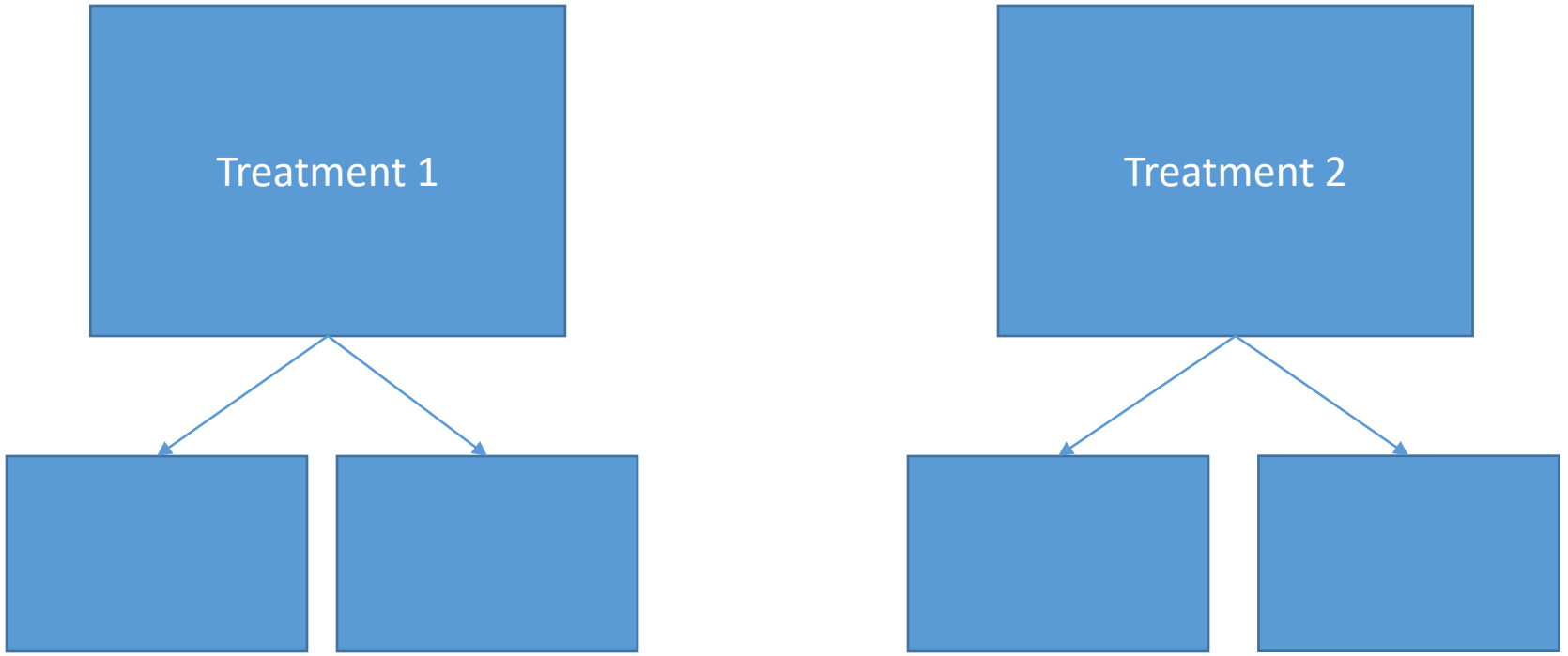
Confounding factors – need for replication

e.g. position in the room
dirt in aquarium
etc.

-> Observed effect not attributed to the treatment

Solution: replication + randomization

Pseudo-replication



Sources of variability

Unwanted variability may ”hide” real variability

Higher the variability, the more data you need to see effects

Variability depends on endpoints

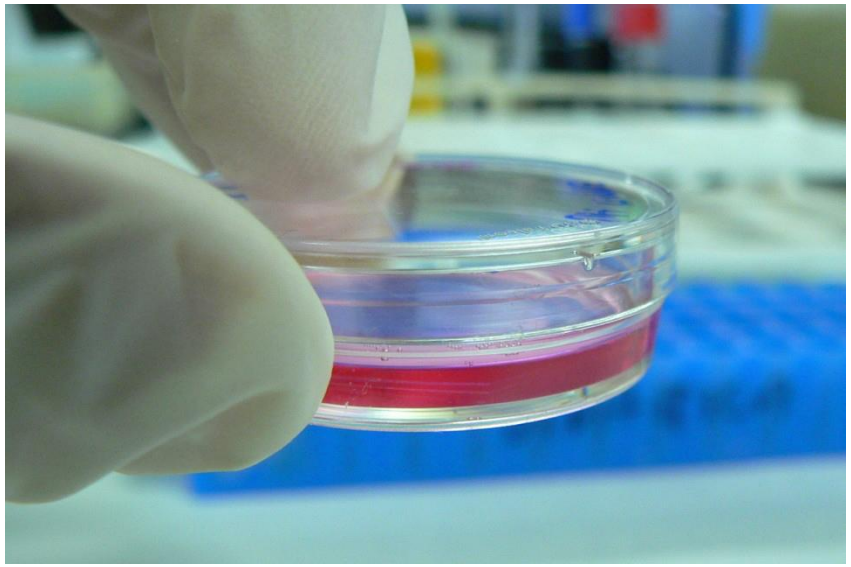
-> Minimize unwanted variability

-> Pilot studies + power analyse (number of replicates / samples)

Replication

# Parameters		# Treatments		# replicates		# tanks
1	x	2	x	2	=	4
1	x	2	x	4	=	8
1	x	4	x	4	=	16
2	x	4	x	4	=	32
3	x	4	x	4	=	48

Practical limitations



Practical aspects - Summary

- ✓ Aquarium system
  (water quality, stability, etc.)
- ✓ Duration
- ✓ Source of variability / Frequency
- ✓ True replication
- ✓ Randomization

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Can I REALLY answer my question with the collected data?

August Krogh

VIII.

The Abnormal CO_2-Percentage
in the Air in Greenland and the General Relations between
Atmospheric and Oceanic Carbonic Acid.

By

August Krogh.

(Krogh 1904)

Krogh's principle

"For such a large number of problems there will be some animal of choice, or a few such animals, on which it can be most conveniently studied"

The top model

- Biological feature (e.g. life cycle, generation time)

- Ecological / Economical importance

- Tools available (e.g. functional methods, genome)

- Charismatic species

- etc.

What fits your question?

- Size / Weight

- Age

- Life-history stages

- Etc.

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Endpoints?

Fitness (e.g. survival, growth, reproduction)

Physiology – energy budget
(e.g. respiration, feeding, excretion, calcification)

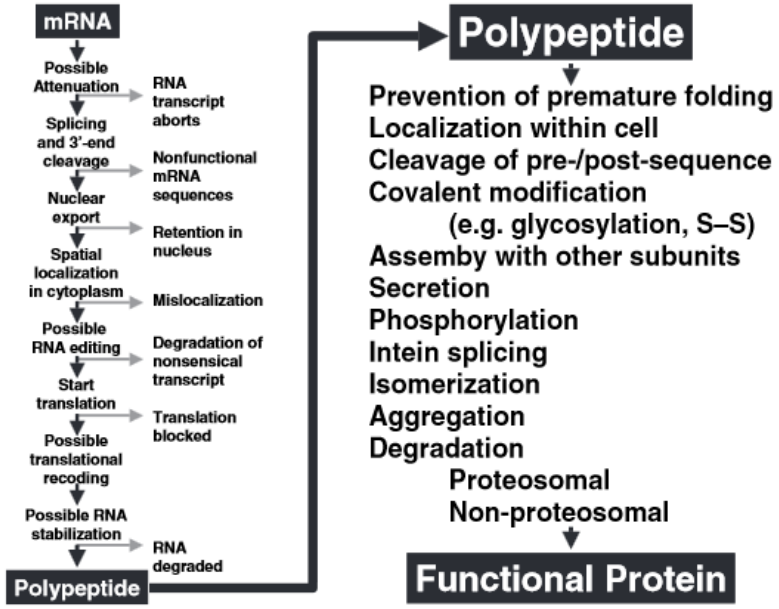
Etc. etc.

Best endpoints?

- Not the “coolest” method

- Not the most familiar method

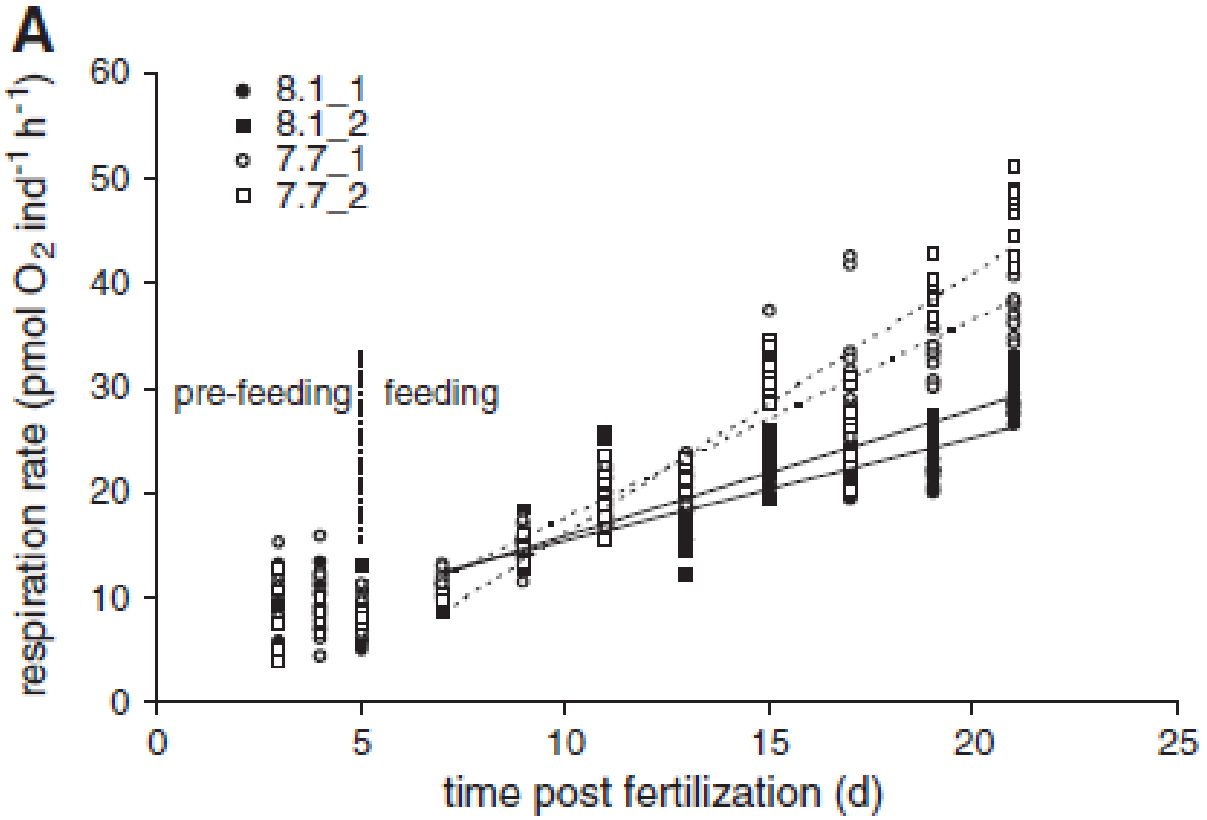
- As close to function as possible (e.g. fitness)



Feder & Walser 2005

How often?

Frequency (more = more chance to identify effects & interactions)



Changes ≠ bad

We like bad news

Negative effect:	9.8 citations / year
Positive/neutral effect:	6.2 citations / year

A change in your proxy ≠ change in fitness

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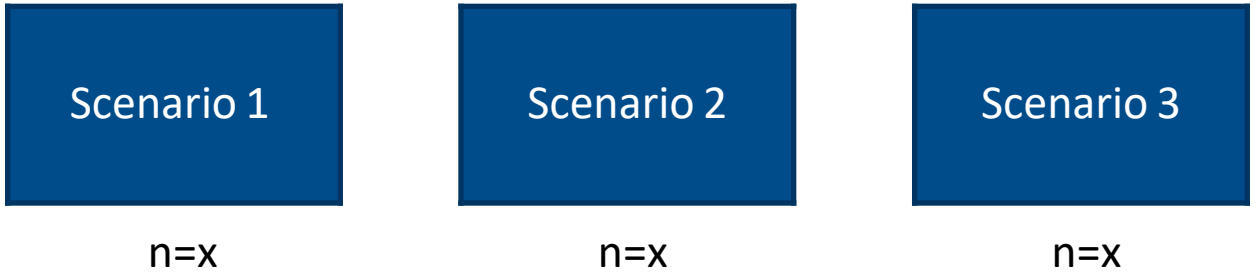
How to design your experiment

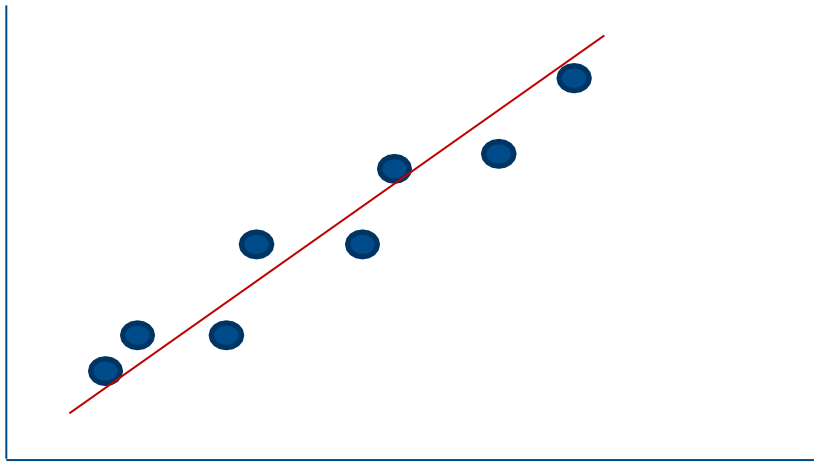
“ANOVA” design

Little predictive power

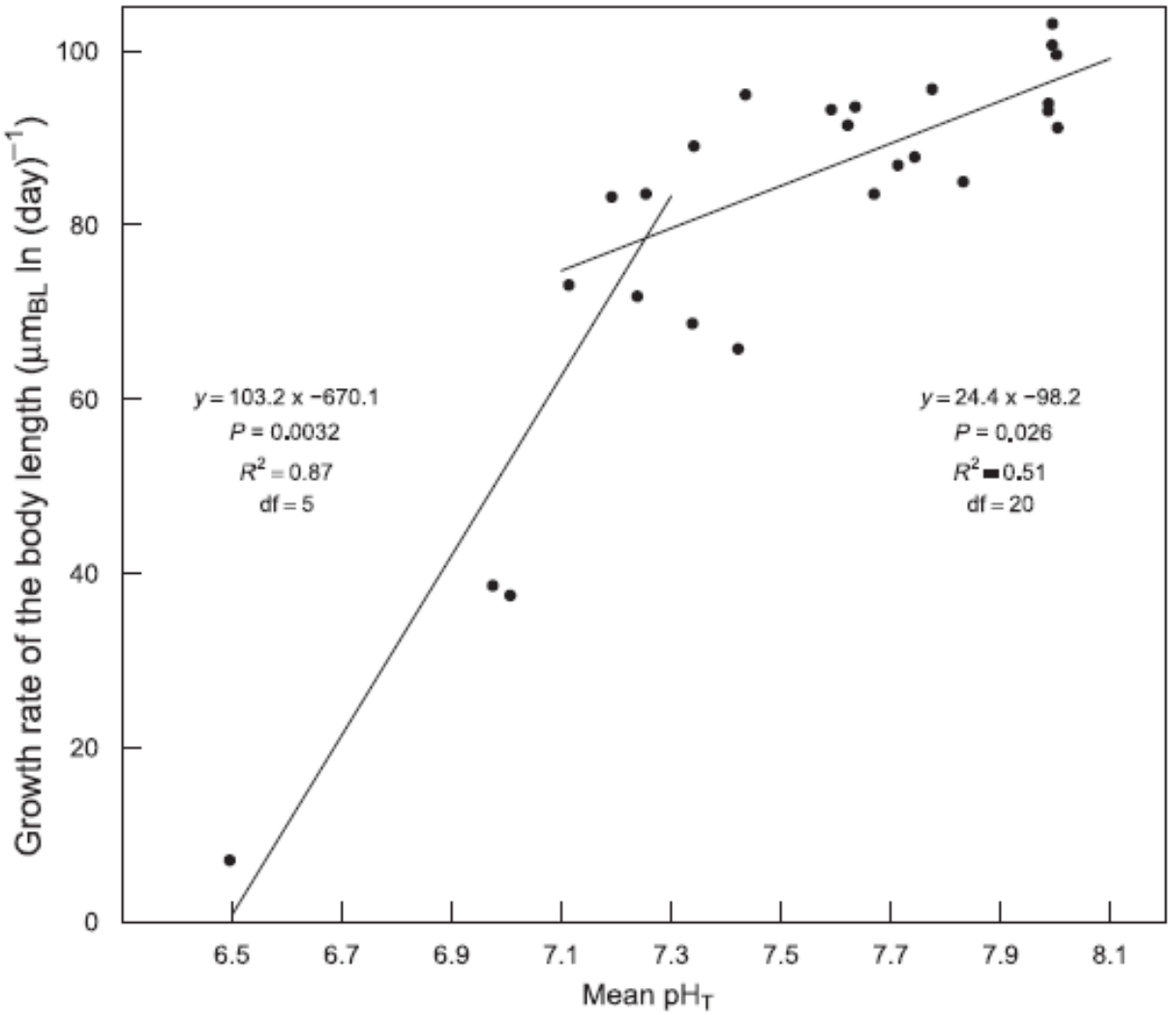


“Regression” design

Need to have a relationship



ANOVA vs. Regression



(Dorey et al. 2013)

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Test the right scenarios

Take species niche, behaviour & variability into your thinking

Example: impact of ocean acidification on chemical communication

Two temperature: CTL vs OA

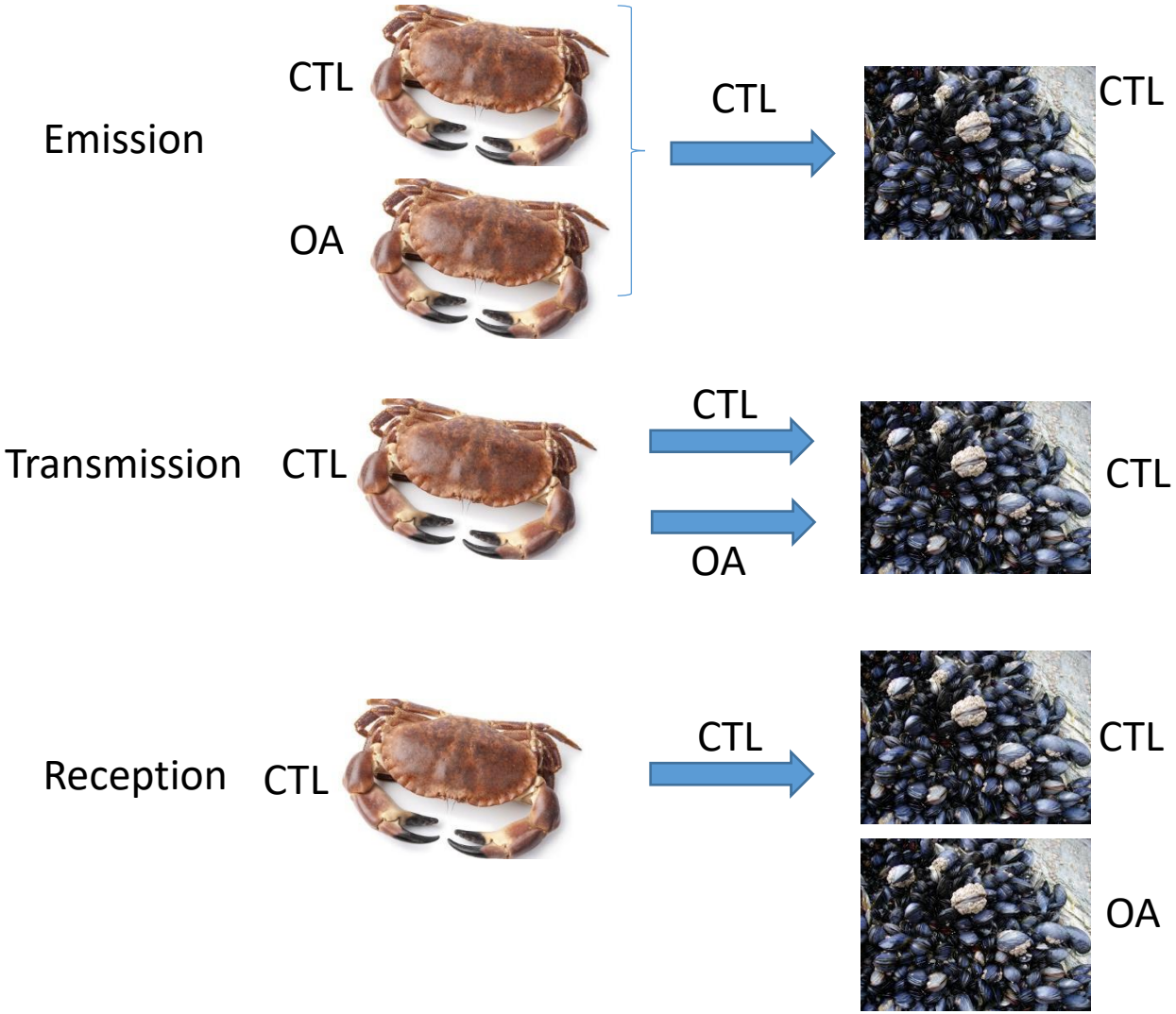
Example: impact of ocean acidification on chemical communication

Emission

Transmission

Reception

Example: impact of ocean acidification on chemical communication



+ *interactions*

2 emissions x
2 transmissions x
2 receptions
= 8 treatments x replicates

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