DEVELOPING A WEB-BASED BEST PRACTICE GUIDE FOR MULTIPLE DRIVER BIOLOGICAL MANIPULATION STUDIES

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Group Web site: https://scor149-ocean.com/
Different experimental conditions can exert a major influence on their outcomes

Synthesis of trends from Ocean Acidification studies

- **Feng et al. 2008**
  - CCMP371
  - NZEH

- **Iglesias-Rodriguez et al. 2008**
  - RCC1212
  - RCC1216
  - RCC1238
  - RCC1256

- **Langer et al. 2009**
  - PolyB/11

- **Riebesell et al. 2000**
  - TW1

- **Sciandra et al. 2003**
  - NZEH

- **Shi et al. 2009**
  - RCC1256

This study
- RCC1256
- NZEH

Different ways to manipulate carbonate chemistry

1. Carbon dioxide $\rightarrow$ Carbonic acid $\rightarrow$ Bicarbonate $\rightarrow$ Carbonate
2. $H^+$
Different experimental conditions can exert a major influence on their outcomes.

Hence the need for a Best Practices Guide (Riebesell et al. 2011)
Different outcomes
When we move beyond
Ocean Acidification

Image, Maria Byrne (University of Sydney)
Multiple drivers - A Gordian Knot to unravel

Boyd 2013
Nature Climate Change
There has been a proliferation of multiple driver experimental studies in recent years.
How can we reconcile:
- Multiple drivers
- Interactive effects between drivers
- Multiple treatment levels
- Replication

A huge number of potential permutations

Do we need a bookshelf of BPG’s OR a Fridge magnet??
A www-based BPG
Experimental strategies to assess the biological ramifications of multiple drivers of global ocean change—A review

Boyd et al. (2018)
Handbook to support the www-based Guide to multiple driver experimental design for changing ocean biological systems.
Examples of data archives – selecting controls or fluctuations
Earth System Model Output
Future Projections

Selecting a Scenario

Bopp et al. 2013
Guide:

– Identify how drivers will vary with region and season.

– Make decisions in a step-wise manner using the decision support tool.

– Select the best design for your project/question(s)/study site.
First Pass: Broadly define the research question and background

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>What exactly is your research question?</td>
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<td>Be as precise as possible.</td>
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<td>What are the objectives of your study?</td>
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<td>Provide a comprehensive list of what you aim to achieve.</td>
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<tr>
<td>Get back to this list at the end of the planning process, and double-check whether the objectives have changed, and whether you have addressed them all.</td>
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<tr>
<td>Why is your question relevant? And to whom?</td>
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<tr>
<td>Has anyone already tried to answer a similar research question?</td>
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Third Pass: Quantitative aspects of the study

• Response variables / traits of interest

Repeat for each trait/parameter of interest

Have you chosen your treatment levels to reflect your best guess of expected response norms to the main drivers? (see Fig 2 of GCB manuscript).

Does your design allow you to determine responses to both individual and multiple drivers?
MEDDLE - Multiple Environmental Driver Design Lab for Experiments

A virtual laboratory to:

- Design
- Simulate
- Analyse
- Refine

Resource Allocation Between

- # of Drivers
- Treatment levels
- Replication
The engine of this virtual lab is a series of landscapes for three drivers.
The interplay between each driver differs.
Multiple Landscapes reflect the interactive responses to three drivers
How do users of MEDDLE refine their designs???

Analysis of results - how significant are your findings?  Statistical tools

Visual feedback – how well did your selected drivers and treatment levels capture the landscape?

MEDDLE also has a randomisation module to ensure you can’t get exactly the same results twice.
Step 3  Video tutorials

In “Post-production”

Constructing your multi-driver inventory
Experimental Design
Bio-statistics
Micro-evolution experimental design
Fluctuating environments and design
Mesocosm studies

How not to run an experiment
Instructor Bloopers

“Story-boards prepared”
The role of meta-analyses
Modelling to help with experimental design
Evology - Multigenerational studies
Calibration matters
Links across the www-based BPG

Roll out
GRS July 18
GRC July 18
IAEA early 2019
OCB newsletter and other outlets

Group Web site: https://scor149-ocean.com

Expert advice:
online video tutorials

Short videos (2 – 10 minute) explain the most challenging aspects of multiple driver experiments. These videos complement the pdf guide and decision support tool.