Scenarios vs. Mechanisms

Tutorial: The Scenarios vs. Mechanisms video tutorial can be found on the MEDDLE for Multiple Drivers Research YouTube channel.

Speaker: Dave Hutchins, University of Southern California

Video: Christina McGraw, University of Otago, New Zealand

Transcripts: Rebecca Zitoun, University of Otago, New Zealand

Resources: The complete resources for the *Best Practice Guide for Multiple Drivers Marine Research* are available on the MEDDLE website.

So let's just imagine that you are a marine biologist from French Polynesia and the question you are interested in is *'How are our coral reefs going to change over the next 100 years as the ocean acidifies'.*

You are most likely going to think about taking a traditional scientific approach, the way we are all trained, and try to isolate that variable from all the others: Vary the pH or pCO_2 of your water while keeping everything else constant. And that is going to tell you what is going to happen to your reefs over the next 100 years, right? Well, not necessarily.

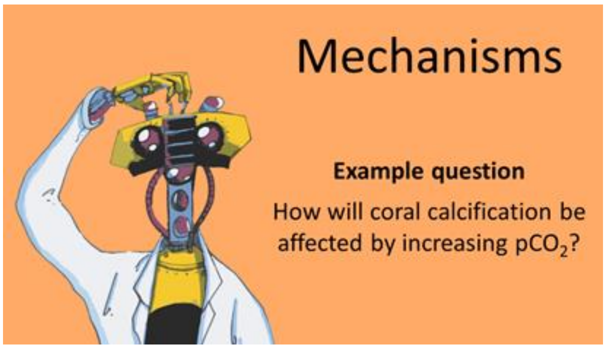
Text (0:31): Two approaches to answer this question

1. ***Mechanistic**: vary pH or pCO_2, while keeping everything constant*
2. ***Scenario**: vary pH, warming, nutrients, salinity and stratification at the same time.*

Of course there are a lot of other factors that are changing at the same time as pCO_2 and pH. Things like warming, nutrients, salinity, and stratification.

Text (0:51): pH and pCO_2 are not changing in isolation. You may need to consider other factors, such as warming, nutrients, salinity, and stratification.

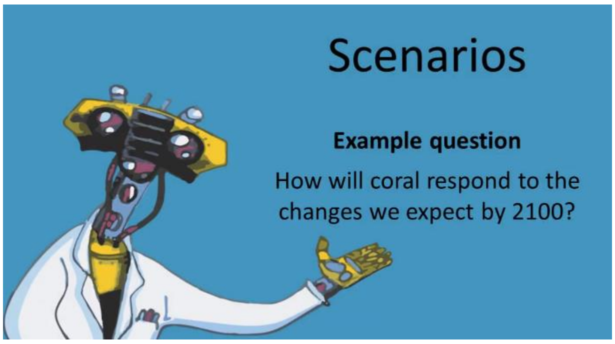
There is a whole host of variables that are also changing at the same time (*such as pCO_2 and pH*). And probably, if you really want to know what is going to happen to your coral reef, you are going to have to also look at all of those variables. In that case, you may consider doing what we call a scenario based approach. So one approach is to define a question and to do a mechanistic experiment, such as '*How is the calcification of your coral going to be affected by pCO_2*?' (1:36)



In which case you would set up an experiment to look at the mechanism of calcification under ocean acidification. You might measure calcification rate, you might measure the expression in the genes that are involved in calcification. And you would understand a lot more about how calcification is affected by acidity. But that may not answer the question, especially if you are interested in management of the coral reefs. There is a lot more to it than just the calcification.

Text (2:00): You will understand a lot more about calcification, but not a lot about coral in the future ocean.

You might want to design a scenario-based approach that incorporates all those other variables: warming, nutrients, salinity. You might want to put all those [other variables] together in an experiment that will answer the question '*How is my coral going to respond to the environment in the year 2100?*' rather than just the one variable of ocean acidification. (2:36)



Now that we introduced you to the idea of a mechanistic approach versus a scenario based approach, you are still not ready to go out and do an experiment.

Text (2:45): You've decided between mechanistic and scenario approaches. What's next?

You need to think about the question you are asking and the best way to answer it. One thing that might help you do that is try watch the video by Jon Havenhand where he talks about different experimental methods ranging from very reductionist mechanistic experiments all the way up to scenario-based approaches. You also might want to watch Peter Dillingham's video were he talks about what you are going to do with the data once you have it, and how to handle and analyse your results. At that point you may be ready to go forward and decide whether a mechanistic or a scenario based approach is the best for the question that you have in mind.

For more information see Global Change Biology 24, 2239-2261 (2018).