**Second Pass: Identify responses, drivers and experimental design**

* **What is the nature of the study?**

|  |  |
| --- | --- |
| Will this be a study to understand the *mechanisms* of the response under study?  e.g. do you want to understand a dose-response relationship or identify a tipping point? If so, you will need to gain detailed biological knowledge (physiological response curves, tolerance ranges, behaviour, biochemistry, ecology, etc.).  Or do you want to know how species or ecosystems will respond to different environmental *scenarios* (future combinations of drivers)?  e.g. do you want to predict a response under two, or a range of, IPCC scenarios. If so, you will need access to regionally relevant environmental forecasts.  Note: you may be able to combine these two approaches, but this will limit your choice of treatments. See SCOR GCB Review for more detail. |  |
| What are the relevant spatial scales?  Nanometer to global |  |
| What are the relevant temporal scales?  Past, present or future; seconds to millennia; will you include environmental variability on diurnal, seasonal, decadal, scales? |  |
| How many experimental units will you have (i.e. total number of all replicates)?  Your answer to this will define much of your experimental design.  If you have relatively few units (≤ 10), or if you’re considering a *mechanistic* study, perhaps consider using a “regression style” design with many levels of driver(s) but only one replicate per level.  If you have many more units, or your question relates to a number of specific levels of a driver, perhaps consider using a categorical experimental design (“ANOVA design”) |  |

* **What biological responses are most relevant?**

|  |  |
| --- | --- |
| Which biota specifically?  Ecosystems / communities /  species / genetic strains / life stages |  |
| Which specific biological responses / traits will you measure, and how will you measure them?  Do you have the necessary tools to measure them?  After what time of exposure do you expect a response? |  |
| Are these the most relevant or most tractable responses/traits?  Are more easily measured variables available that can be used as a proxy (e.g., change in ash weight instead of rate of calcification?) |  |
| What additional biological processes / parameters may affect the responses?  e.g. are there age or sex specific differences?  Will you be able to adequately acclimatise them?  Do you expect responses to differ between locations / populations? Does the presence of mates / predator / competitor / shelter / other variables (e.g. light) alter the response, etc?  Are any of these essential to measure as they may explain a large proportion of the variation in your response, or can they be avoided (the study may be getting too big)? |  |

* **Which driver/s are most relevant?**

|  |  |
| --- | --- |
| What specific driver/s you want to measure or manipulate?  Have you done an inventory of regionally relevant drivers? i.e., local, regional, global? |  |
| Do adequate environmental / field data already exist to tell you what you need to know, so you don’t need to measure them yourself?  Investigate access to remote sensing, International Marine Observing System databases, etc. |  |
| If not, how will you measure these drivers?  List tools. |  |
| Are other drivers more easily measured or more tractable and can be used as proxy for the driver you’re interested in?  (E.g., Secchi depth instead of analysis of suspended solids; pH and alkalinity instead of pH and pCO2) |  |
| For exposure experiments: what are their regionally environmentally relevant levels?  Do you have access to the regional conditions (climatology)? |  |
| Do you need to measure additional drivers? What secondary drivers may be altered by your primary driver?  (E.g., change in temperature alters carbonate saturation state; is the food quality for your focal species also affected by your driver? Etc) |  |