Projected changes in fishery yields under climate change

Most large-scale studies examining projected changes in yield have not explicitly modeled the population processes that may be influenced by climate change (e.g. growth, natural mortality, maturity, recruitment), yet the population processes changing can have different implications for sustainable harvests. Here we collect estimates for population process parameters required to calculate yield per recruit for XX stocks and results from XX studies to predict how population processes will change under climate change scenarios. We use Monte Carlo simulations to develop distributions of potential yield per recruit for these stocks in the future. Projected changes in THIS PROCESS influence the changes in fishery yield most and POSITIVE/NEGATIVE changes in recruitment would be required to maintain the current levels of fishery yields. Managers could also pursue THIS ACTION to mitigate changes in yield.

To make this happen, there are two types of task that need to be done—data collection and code frameworks.

Tasks:

1. Write yield per recruit function that accepts relevant parameters.
2. Collect current parameters for yield per recruit calculations for as many stocks as possible.
3. Collect projections of changes in those parameters for a given RCP (with uncertainty and, if possible, as a time series). How do we approach this if there are no projections for a species/stock? Build a model from the estimates that we do have and apply those to stocks is probably the easiest way to do this. The functional form of these relationships will likely be important (e.g. a process normal vs. exponentially distributed).
4. Monte Carlo sampling from projected distributions for population parameters to determine distributions for future yield per recruit. How to define a covariance matrix for sampling? The changes in natural mortality and growth (for example) probably should not be independent of one another. Need a database of observed interactions between population processes.
5. Calculate the relative influence of changes in each parameter to fishery yields.
6. Calculate how much recruitment would have to change to maintain current fishery yields, given the projected yield per recruit. How does this compare to the observed changes in recruitment (by species or region)? How much would be needed to satisfy projected demand for seafood?
7. Determine if there are any ways in which fisheries management could be changed to mitigate changes in yield with the new knowledge of which population process is driving changes. (A potential example is thinking about how selectivity could be modified to change yields.)

What is the relative contribution of changes in different population processes to change in yields? Is recruitment driving the boat or changes in growth?

Do we have to fish harder or softer to maximize yield per recruit? To achieve B40?

What is the range of pretty good yields?

Figure 1. Distributions of changes in yield per recruit by stock. I imagine this as a multipanel plot, with a map that shows change in yield per recruit by region, then a big ‘ridgelines’ plot that has each of the stocks in the analysis or perhaps a ‘ridgelines’ plot that groups the changes by species or order or fishing methodology.

Figure 2. Show what process is influencing changes in yield the most.

Figure 3. Demonstrate required changes in recruitment to maintain fisheries yield by region and species (similar to figure 1).

Figure 4. something to do with selectivity or management mitigations