Unraveling the recruitment problem: A review of environmentally-informed forecasting and management strategy evaluation

Studies describing and hypothesizing the impact of climate change and environmental processes on vital rates of fish stocks are increasing in frequency, and concomitant with that is interest in incorporating these processes in fish stock assessments and forecasting models. Previous research suggests that including environmental drivers of fish recruitment in forecasting is of limited value, concluding that forecasting improvements are minimal while potential spurious relationships were sufficient to advise against inclusion. This review evaluates progress in implementing environmental factors in stock-recruitment projections and Management Strategy Evaluations (MSEs), from the year 2000 through 2017, by reviewing studies that incorporate environmental processes into recruitment forecasting, full-cycle MSEs, or simulations investigating harvest control rules. The only successes identified were for species with a short pre-recruit survival window (e.g., opportunistic life-history strategy), where the abbreviated life-span made it easier to identify one or a limited set of key drivers that directly impact dynamics. Autoregressive methods appeared to perform as well, if not better, for species with a longer pre-recruit survival window (e.g., seasonal, inter-annual) during which the environment could potentially exert influence. This review suggests that the inclusion of environmental drivers into assessments and forecasting is most likely to be successful for species with short pre-recruit survival windows (e.g., squid, sardine) and for those that have bottlenecks in their life history during which the environment can exert a well-defined pressure (e.g., anadromous fishes, those reliant on nursery areas). The effects of environment may be more complicated and variable for species with a longer pre-recruit survival window, reducing the ability to quantify environment-recruitment relationships. Species with more complex early life histories and longer pre-recruit survival windows would benefit from future research that focuses on relevant species-specific spatio-temporal scales to improve mechanistic understanding of abiotic-biotic interactions.
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