***Selecting assessment methodologies for species with complex biology and data limitations: mantis shrimp in the Bohai Sea as a case study***

Many methods for assessing harvested marine populations exist, but selecting an appropriate method can be difficult given constraints on data quantity and quality, analyst expertise, and the biology of a species. Data-limited methods require few inputs and are easy to apply, but often substitute knowledge about the population with assumptions that may or may not be valid. Integrated population models allow for a more complete representation of population processes, but are only effective when data are available to inform the biological processes in the model and can require extensive quantitative skills to implement. Here we developed a simulation model based on the fishery for mantis shrimp in the Bohai Sea to evaluate the effectiveness of two methods at opposite ends of the spectrum of assessment complexity: LBSPR and an integrated assessment model. LBSPR performs LIKE THIS. The integrated assessment performed LIKE THIS. INSERT RECOMMENDATION BASED ON THE RESULTS (for mantis shrimp and also bigger picture).

(I imagine the conclusion will be something like ‘complexities of biology are essential to incorporate into assessments, otherwise erroneous conclusions can be made about the status of a stock)

**Introduction**

Spectrum of assessment complexity.

Trade-offs between data availability, biological complexity, bias in status estimates, and uncertainty around population dynamics.

Biological complexity trade-offs for assessment complexity.

Importance of ‘status’ and why we want to estimate it.

Introduce mantis shrimp and note why it is useful to explore these tradeoffs. Valuable, changes in ecosystem structure, Chinese fishery management reform, complex biology.

Develop an operating model to test data-limited and data-moderate assessments.

**Methods**

General outline: make an operating model, apply assessment methods, compare estimated statuses.

Compare a simple life history vs. a more complex life history.

Compare estimation model in more complex life history when assumptions about the timing of life history processes are correct and incorrect.

NEED TO WRITE THE REFERENCE POINT CALCULATIONS FOR INTEGRATED ANALYSIS

**Results**

**Discussion**

Importance of knowledge of biology

Importance of simulation testing methodology

Circumstances in which data-limited methods are appropriate/inappropriate

Recommendations for mantis shrimp

Data limited may provide status, but integrated models can give estimates of other quantities (e.g. recruitment) that can be important for other sorts of analysis

Recommendations for other species lacking assessments in similar circumstances

Data collection should be the most basic goal of any assessment endeavor

Figure 0. Spectrum of assessment methodologies?

Figure 1. Bohai mantis shrimp fishery background. (Map, catch time series, survey timing)

Figure 2. Workflow structure.

Figure 3. Show equilibrium size structure for each scenario. Show the estimated equilibrium size structure for each type of model.

Figure 4. Simple OM estimation performance. 5 panel figure four left panels are estimation model output, 5th big one at right is the estimated status from each methodolgy.

Figure 5. Complex OM estimation performance with correct underlying assumptions. 5 panel figure four left panels are estimation model output, 5th big one at right is the estimated status from each methodolgy.

Figure 6. Complex OM estimation performance with incorrect underlying assumptions. 5 panel figure four left panels are estimation model output, 5th big one at right is the estimated status from each methodolgy.

Paper 1: what assessment?

Paper 2: real assessment

Meeting in China to discuss results

Video of collaboration—port sampling, survey time

Publish a paper on complexities of biology?