

FISH 505 Assignment #10
 DUE: April. 3, 2009
 Management Procedure Evaluation

Management procedure evaluation is the latest tool in Fisheries stock assessment designed to compare likely future consequences of adopting specific management procedures. The management procedure includes everything from data collection, the type of assessment model, the harvest control rule and implementing the harvest strategy. Management procedure evaluation relies on simulation testing the whole procedure and evaluating each procedure using performance measures derived from operational objectives (Cooke, 1999). A management procedure consists of the following:

Objectives that can be measured. Defined by stakeholders, not scientists.

Data e.g., catch effort, tagging, age-comps, etc.

Estimator stock assessment model or statistics derived from data.

Harvest control rule or decision rule to calculate allowable exploitation.

Obviously there are numerous options in the management procedure that could be used; the idea is to use Management Procedure Evaluation (MPE) to find a procedure that is robust to uncertainty and balances conflicting objectives between catch, conservation and stability. Alternative management procedures are tested using an operating model. An operating model consist of four components: 1) a simulator that represents the real population and generates observed data, 2) an estimator determining stock status, 3) a harvest control rule to define next years quota, and 4) summary statistics for measuring objectives.

Performance statistics usually consist of three measures 1) catch related, or average catch obtained over the performance period, 2) stability related, or average annual variation in catch, and 3) risk-related such as the probability of the stock falling below some threshold or a measure of stock depletion (Table 1).

The `Assin5.R` code provided with this assignment performs a Management Procedure Evaluation for the Namibian Hake data provided in Table 10.1 of Hilborn and Mangel (1997). In this example the Age Structured Assessment Model (ASAM) that we've developed in class is used as the simulation model that represents the true state of nature. Two different estimation models are used in the MPE: 1) a simple

Table 1: Performance statistics for evaluating Management Procedures

$\bar{C} = \frac{1}{n} \sum_{t_1}^{t_2} C_t$	Average catch
$AAV = \sum_{t_1}^{t_2} C_t - C_{t-1} / \sum_{t_1}^{t_2} C_t$	Variation
$\bar{D} = \frac{1}{t_2 - t_1 + 1} \sum_{t_1}^{t_2} \frac{B_t}{B_o}$	Depletion

Schaefer production model, and 2) a Lagged Recruitment Growth Survival (LRGS) model. Both models are documented in Hilborn and Mangel (1997). Note also that the estimators are programmed in ADMB and the leading estimated parameters are MSY and F_{MSY} . Both assessment models use weak informative priors for MSY and F_{MSY} . There are three alternative harvest rules: a) a fixed fishing rate equal to F_{MSY} , b) a fixed fishing rate equal to $0.9F_{MSY}$, and c) a fishing rate based on a 40:10 harvest control rule. The combination of HR and Estimators for each management procedure are defined in Table 2. The performance statistics that are calculated are defined in Table 1. Two alternative scenarios are explored: Scenario 1 assumes the CPUE data is proportional to stock abundance and Scenario 2 assumes the CPUE data is hyperstable (i.e., $CPUE = qB_t^\beta$, where $\beta = 0.7$).

Table 2: Summary of candidate management procedures.

CMP #	Estimator	Harvest rule
MP1	Schaefer model	F_{MSY}
MP2	Schaefer model	$0.9F_{MSY}$
MP3	Schaefer model	40:10 rule
MP4	LRGS model	F_{MSY}
MP5	LRGS model	$0.9F_{MSY}$
MP6	LRGS model	40:10 rule

For your assignment, pretend that your a fisheries manager and choose a Management Procedure (MP1-MP6) that you would like to use for future decision making in this fishery. Justify this decision based on the tradeoffs between average catch, absolute average variation in catch, and median depletion levels. Note that the Law requires fisheries management agencies to close fisheries if the stock falls below 25% of its unfished biomass. Use the summary statistics (e.g., Fig. 1) to justify your answer.

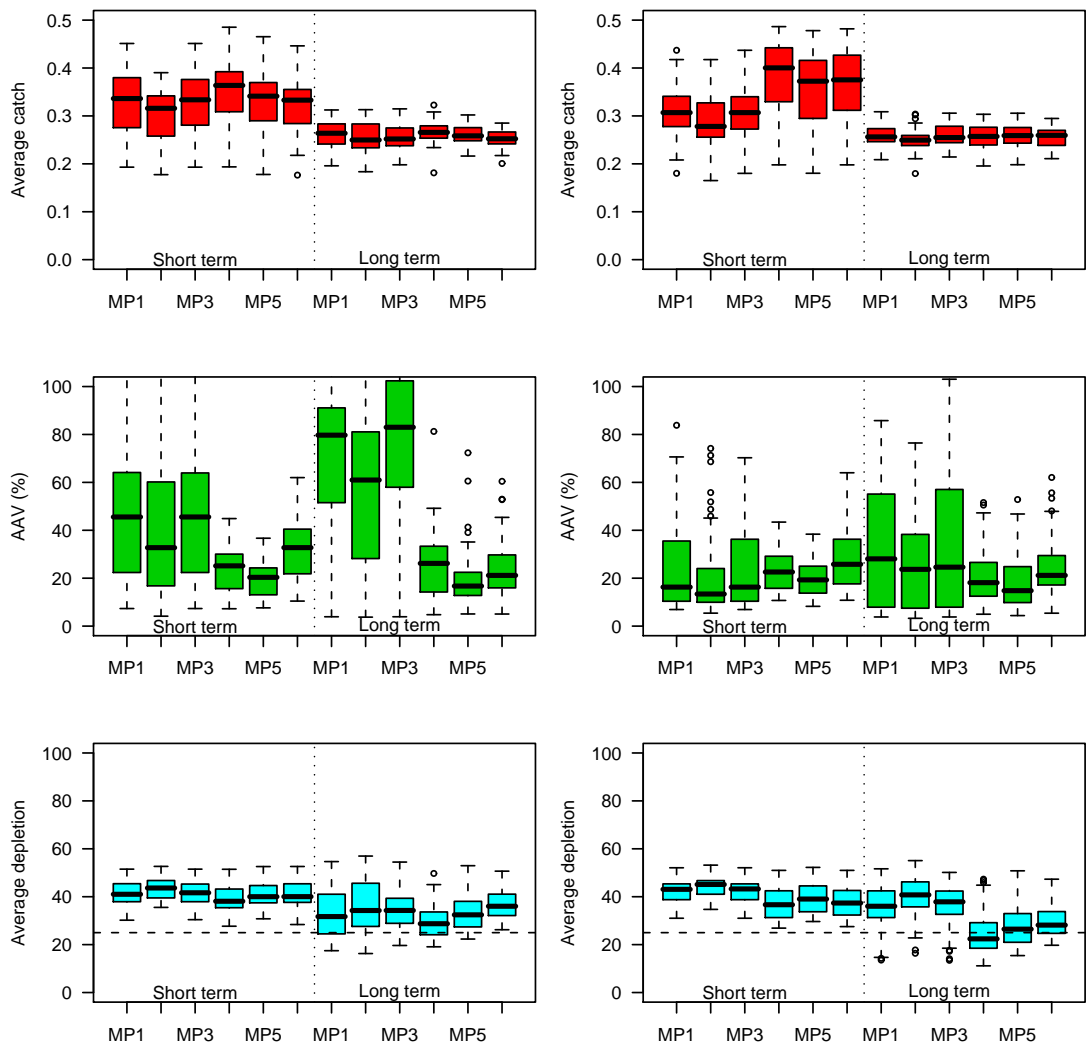


Figure 1: Summary of short-term (1989-1994) and long-term (1994-2012) performance statistics for average catch, absolute average variation in catch, and average depletion (B_t/B_o) for each Management Procedure. Results from scenario 1 are provided in the left column, scenario 2 in the right column.

Remember you have to sell your decision to stakeholders, government officials and the general public.

In order to get the code to run properly be sure that the Namibian hake data file is in the same directory as your R-code. Before running the R-Code, compile the `Schaefer.tp1` and `LRGS.tp1` files using your ADModel builder tools. Also, the `Schaefer.exe` and `LRGS.exe` files should be in the same directory as your `Assn5.R` code. Lastly, the code should take somewhere between 12-20 minutes to complete, depending on the speed of your computer. As the code is running, you will see figures of biomass and catch predictions for each replicate. You can comment out lines 153-156 to speed up the code if you wish. With 50 replicates and 25 projection years, your code will con-

duct 15,600 stock assessments. At the end of the simulation you will see Fig. 1, as well as worm plots that demonstrate the simulation envelop for each management procedure and scenario.

References

- Cooke, J. G. 1999. Improvement of fishery-management advice through simulation testing of harvest algorithms. *ICES Journal of Marine Science*, 56(6):797-810.
- Hilborn, R. and Mangel, M. 1997. *The Ecological Detective: Confronting Models with Data*, volume 28 of *Monographs in Population Biology*. Princeton University Press, New Jersey.