Unnecessarily Complicated Research Title

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Abstract

Keywords: Science, Publication, Complicated

1. Introduction

- Risk and uncertainty
- One rule for all?
- Impact of life histories
- Comparision of constant catch v changing catch based on trends in an empirical index.

Sustainability of non target exploited marine fish stocks requires both estimates of current stock status, the effects of fishing pressure (catchability and fishing effort) and the effects of management measures on target populations, however these data are often lacking. Subsequently there is a growing need for the development of innovative approaches so that management of all marine stocks not just those of high commercial value can be included into the Common Fisheries Policy (CFP [**?**]) framework. Under the CFP Management objectives are to recover stocks and to maintain stocks within safe biological limits to levels that can produce Maximum Sustainable Yield (MSY), including by-catch species by 2015 (Implementation Plan adopted at the World Summit on Sustainable Development, Johannesburg in 2002) and no later than 2020. These conservation objectives are currently being achieved by introducing biological target reference points e.g. population size (stock biomass) and/or yields (catches) and/or long–term yields and fishing mortality against which the preservation of stocks within such limits are assessed. These targets or reference points are often referred to as harvesting strategies which include an operational component called a harvest control rule (HCR) that are based on indicators (e.g. monitoring data or models) of stock status.

The International Council for the exploration of the Sea (ICES) categorises stocks in to classes "data-rich", (categories 1 and 2) i.e those that have a quantitive assessment based on conventional mehods that require large amounts of data that include a long historical time series of catches and sound biological information [? ?]; or "data-limted" [?](categories 3 and 4) (often called data poor) those without and assessment and forecasts. For data-rich stocks ICES uses two types of reference points for providing fisheries advice;

1. Precautionary Approach (PA) reference points (those relating to stock status and exploitation relative to precautionary objectives) and 2. MSY reference points (those relating to achieving MSY),

In contrast for data limited stocks MSY 'proxy' reference points are used to estimate stock status and exploitation. Often many of the methods used to estimate MSY proxy reference points require length based inputs as they are cheap and easy to collect [? ?] and are related to life history paramters such as size, mortality and fecundity as well as fishery selectivity. For example many methods are being developed to estimate MSY, but currently only 4 are approved by ICES, these include, Surplus Production model in Continuous Time (catch based) (SPiCT; [? ?], Mean Length Z (MLZ; [? ?]), Length Based Spawner Per Recruit (LBSPR; [?]) and Length Based Indicators (LBI; e.g. [?]). The aforementoned data limited procedures have differing data requirements, intended uses and obviously have their own strengths and weaknesses.

To test the performance of candidate management procedures often requires evaluation of alternative hypothesis about the dynamics of the system e.g. population dynamics and the behaviour of the fishery (e.g life history dynamics, range contraction and density dependence) etc.. Due to the nature of conflicting objectives, stakeholder interests and the uncertainty in the dynamics of the resource and/ or the plausibility of alternative hypotheses can lead to poor decision making and can be problematic when defining management policy.

An intense area of work being researched over the last 2 decades is Management Strategy Evaluation (MSE), which focuses on the broader aspects of fishing (the Ecosystem) whereby different management options are tested against a range of objectives (see [? ?]. The approach is not to come up with a definitive answer, but to lay-bare the trade offs associated with each management objective, along with identifying and incorporating uncertainties in the evaluation and communicating the results effectively to client groups and decision-makers. MSE is not intended to be complex but to provide a robust framework that account for conflicting poorly defined objectives and uncertainties that have been absent in conventional management [**? ?**]. To better understand the performance of a range of management procedures we aim to test generic empirical HCR (based on catch per unit effort – CPUE indices) that maximises yield without stock collapse for a selection of ICES data-limited fisheries.

Often empirical harvest control rules require extensive exhaustive parameter searches to tune hyper-parameters that aren't directly learnt from estimators. This requires a technique known as a grid search that extensively searches for all combinations of all parameters. In contrast and some what less time consuming, other efficient parameter search strategy's can be considered given range of parameter space and a known distribution a sample can be obtained and is known as a random search.

To test case specific harvest strategies (via simulation) within the MSE, we will implement a management procedure based on a empirical harvest control rule that adjusts yield depending on stock status for a constant catch and a given range of hype-parameters for each empircal harvest strategy, and test their robustness to risk and uncertainty. This approach could also help identify similar conditions across species where particular advice rules are likely to work well, and where they perform poorly for a given a set of hyper-parameters. Assessment will be made as to the performance of each HCR via a set of utilities: safety (a proportion, recruitment/virgin recruitment), yield (a proportion, $yield/MSY$), kobe proportion (proportion of years that stay in the green zone of kobe plot $(B/B_{MSY} > 1$ and $F)/F_{MSY} < 1$, and Yield Annual Variation (yield changes by 10% year on year).

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2. Material and Methods

2.1. Materials

Fishnets

2.2. Methods

FLife and MSE

2.2.1. Operating Model

Age based.

2.2.2. Management Procedure

The management procedure was based on an empirical MP, where an increase in an index of abundance resulted in an increase in the TAC, while a decrease in the index results in an decrease in the TAC.

2.2.3. Random Search

When running an MSE commonly a set of MP scenarios are run to tune the MP, this requires running the MSE for each OM scenario for a range of fixed values in the HCR and then choosing the rule that best meets management objectives. If there are a lot of parameters to tune then a grid search may become unfeasible. An alternative is random search [**?**] as randomly chosen trials are more efficient for parameter optimisation than trials based on a grid.

3. Results

[EXAMPLES TO BE UPDATED]

- Figure 2 shows the life history parameters
- Figure 3 shows the vectors
- Figure 4 shows the time series relative to reference points
- Figure **??** shows the performance statistics; points are

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    5. Figure 5 shows the utility functions for the seven study stocks points area

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4. Discussion

- Bullet point one
- Bullet point two

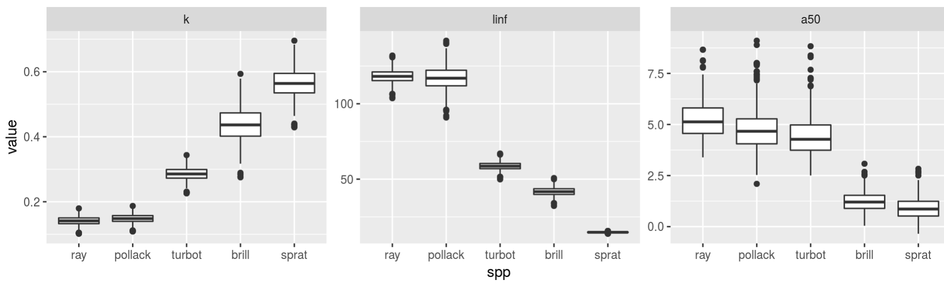
5. Conclusions

- Bullet point one
- Bullet point two

6. References

References

7. Figures



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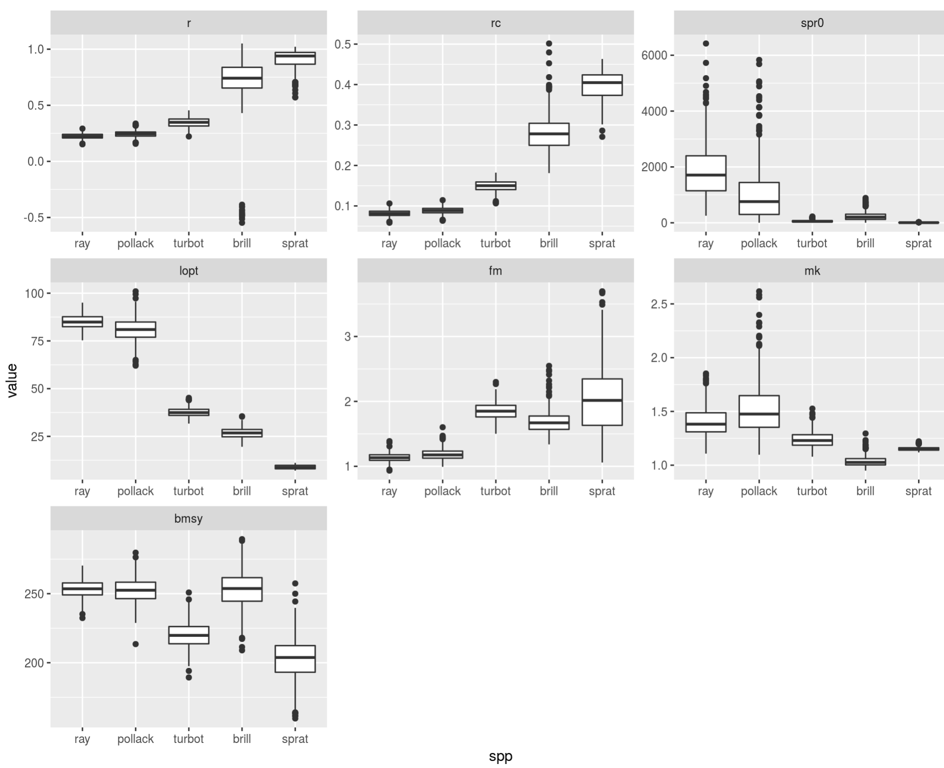

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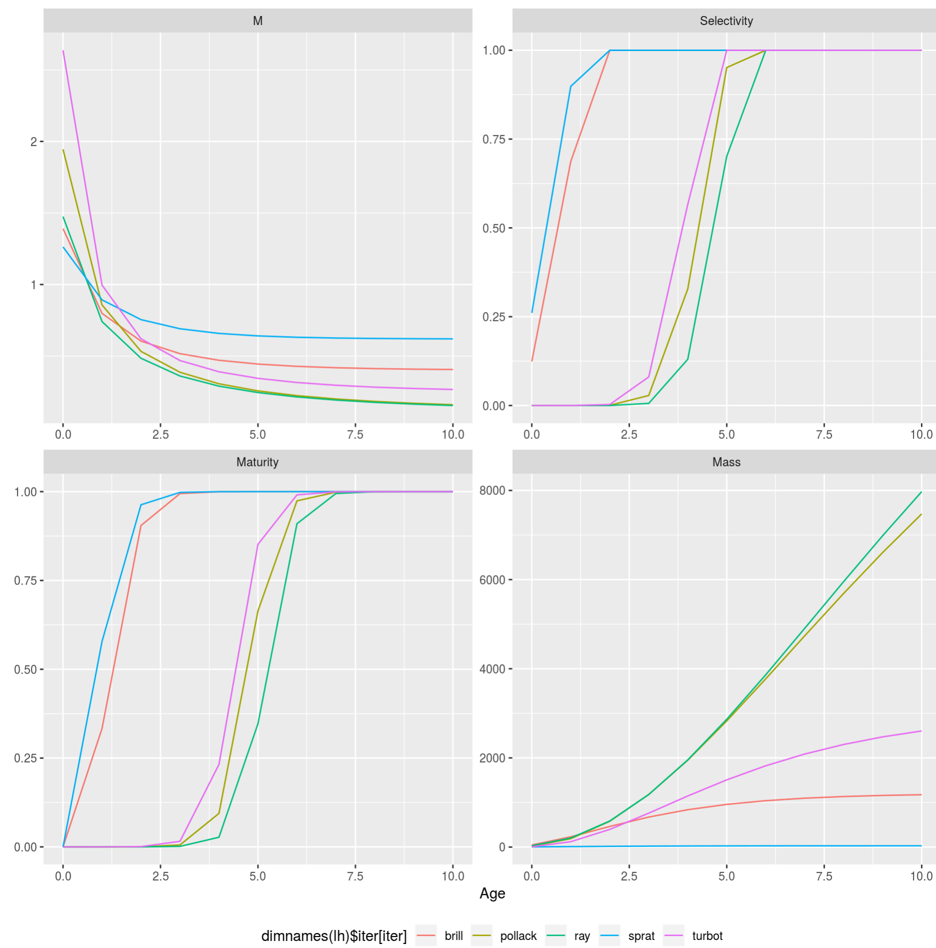
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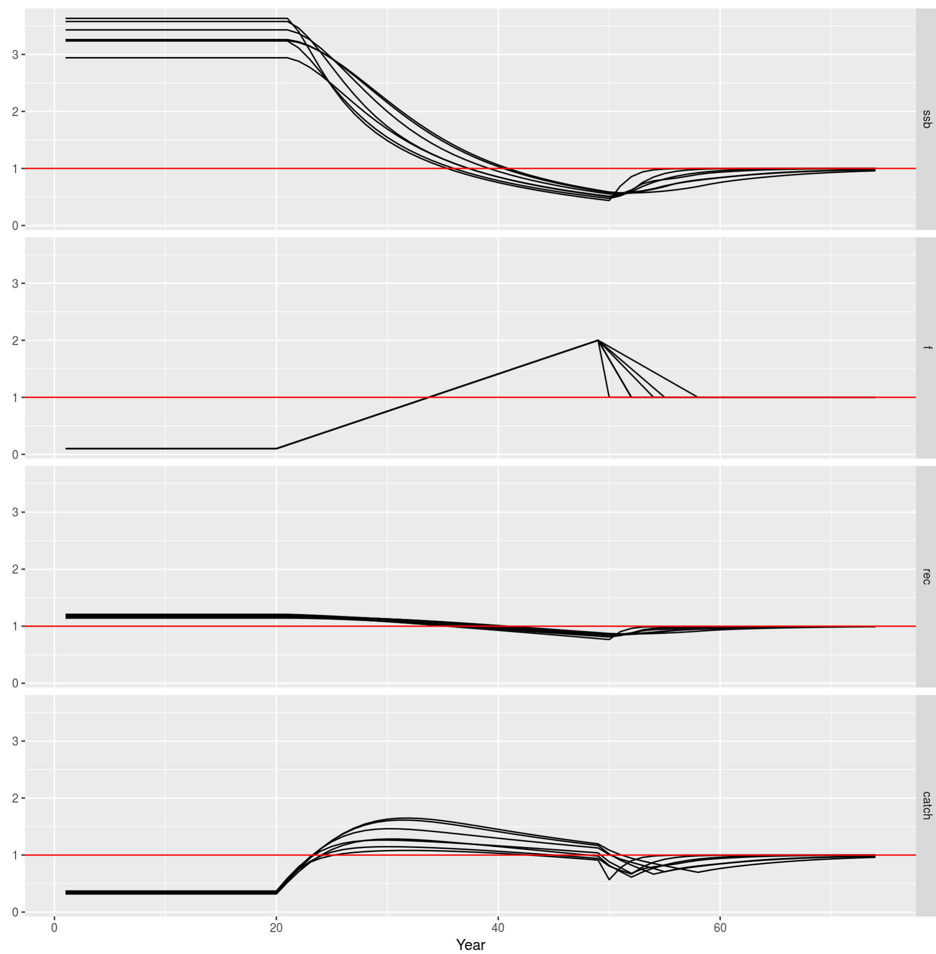
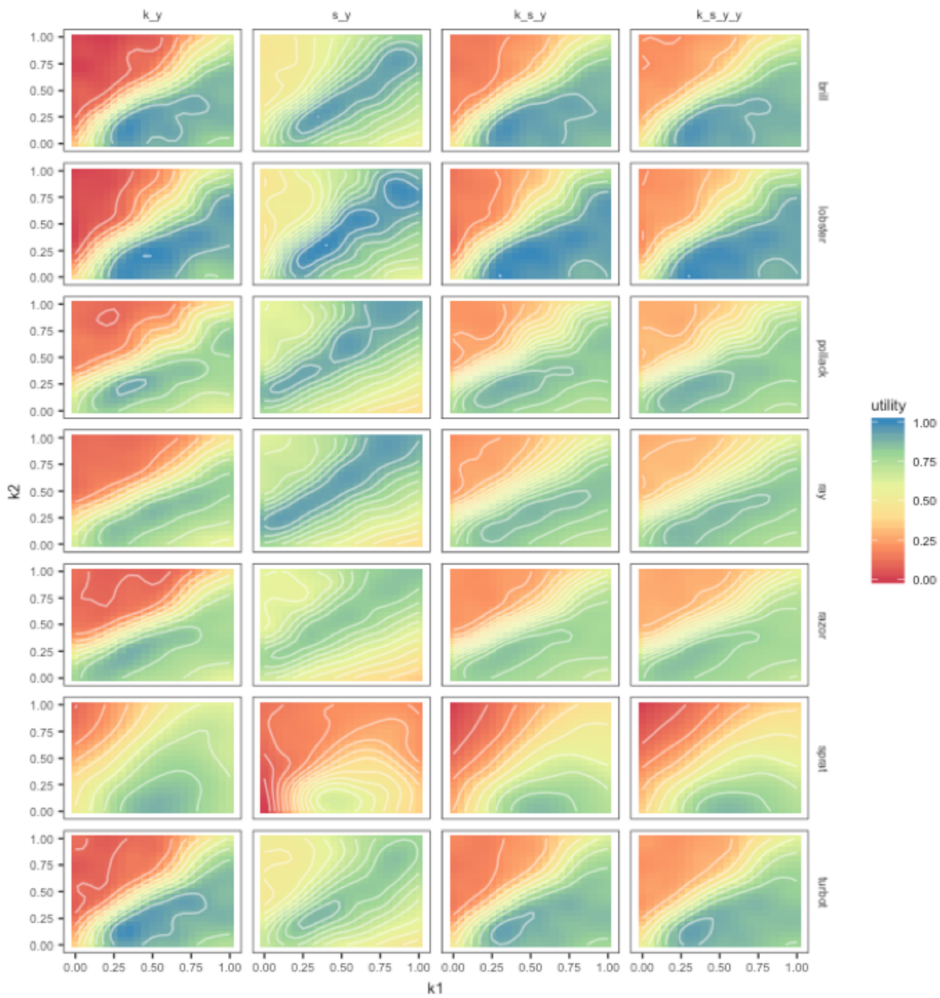


Figure 4: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0.00
utility

Figure 5: