

Technical Documentation for the Pacific Halibut Operating Model



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1 Introduction

This document describes the technical details of the operating model for the Pacific halibut fishery. An operating model is a mathematical model used to describe actual resource dynamics in simulation trials and is used to generate resource monitoring data from a known population for use in testing alternative management procedures (Rademeyer et al., 2007). A management procedure is the combination of pre-defined data, statistical methods in which the data are evaluated, and a rule in which to calculate a Total Allowable Catch (TAC). Lastly, Management Strategy Evaluation, or Management Procedure Evaluation, is the process by which alternative procedures are simulation tested and evaluated using performance metrics that are related to Management Objectives.

1.1 Key halibut demographics of managment importance

Growth, recruitment and migration. Variability and non-stationarity.

1.2 Halibut fishery demographics

Regulatory areas, bycatch, sizelimits, allocation, apportionment.

2 Model Description

To summarize the detailed model description that follows, the operating model uses an age-structured, spatially explicit population model to represent simultaneous process such as growth, recruitment, movement, and survival of the Pacific halibut stock among all regulatory areas.



The following graphic summarizes the routines and development status of the routines used in the operating model. It also represent the order of operations used in the operating model. The general model description will detail each of the routines shown in runScenario, describe the algorithm and mathematical notation of the model elements.

```

* ----- *
* STATUS LEGEND
*   : not implemented yet.
* - : partially implemented
* + : implemented & testing
* ● : Good to go!
* ----- *
* runScenario:                                STATUS
*   |- readMSEcontrols                        [-]
*   |- initParameters                        [-]
*       |- surveyQ                          [ ]
*       |- stock-recruitment parameters    [ ]
*   |- initMemberVariables                  [-]
*   |- conditionReferenceModel              [-]
*   |- setRandomVariables                   [-]
*   |- | getReferencePointsAndStockStatus  [-]
*       | calculateTAC                     [-]
*       | allocateTAC                      [-]
*       | implementFisheries               [-]
*           |- calcSelectivity              [ ]
*           |- calcRetentionDiscards        [ ]
*           |- calcTotalMortality           [-]
*       | calcRelativeAbundance             [-]
*       | calcCompositionData               [-]
*       | calcEmpiricalWeightAtAge          [-]
*       | updateReferenceModel              [-]
*       | writeDataFile                    [-]
*       | runStockAssessment                [-]
*   |- |
*   |- writeSimulationVariables              [-]
*   |- calculatePerformanceMetrics          [ ]
* ----- *

```

2.1 Management Procedure Controls

The management procedure controls is an input file with the extension .mpc that is used to define a management procedure. The details of a management procedure include the number of simulation years, what type of harvest control rule to use, and controls that define fishing



fleet operations. All variables within the simulation framework that can be managed (e.g., size-limits, area's fished, sampling intensity) are defined in the management procedure control file. A unique management procedure is defined by a single `.mpc` file, and multiple files will generate multiple procedures.

2.2 Simulation scenarios

Alternative scenarios representing variables that cannot be affected by management (e.g., recruitment variation, changes in growth) are located in a scenario file with the extension `.scn`. If you are using the GNU makefiles to run the program, the combinations of scenarios and procedures will be set up for you automatically. The advantage of using the supplied makefile to automate this process is two fold: 1) simulations are run in parallel over multiple cores, this dramatically improves runtime efficiency, and 2) if you add a new scenario, or procedure, the previous simulations are not re-run, unless you've changed the source code or control files for the scenario combinations.

2.3 Initializing the operating model

The operating model is conditioned on data from the historical reference period and model parameters that may, or may not, have come from the most recent assessment. Generally, historical assessments are used to parameterize the operating model to best reflect the current state of knowledge.

In addition to fixed parameters used in the historical reference period, there are a number of parameters, or structural assumptions, that must also be specified by the user. Two important parameters for the population model are the stock recruitment parameters that define the average recruitment versus spawning stock biomass relationship in the model. Two alternative recruitment models are available, 1) a Beverton-Holt relationship, and 2) a Ricker recruitment model.



References

Rademeyer, R., Plaganyi, E., and Butterworth, D. (2007). Tips and tricks in designing management procedures. *ICES Journal of Marine Science*, 64(4):618.