Supplementary material for Jacobsen et al 2021.

**This documents describes the equations for the AgeSim package (ok it’s not a package yet).**

**Supplementary tables and figures**

Table S1: Notation used to describe variables and parameters used in operating and estimation models. Operating model (OM) values describe the features of the population and fishery, some of which are estimated parameters in the estimation model (EM).

|  |  |  |  |
| --- | --- | --- | --- |
| **Notation** | **OM Value ([range])** | | **Explanation** |
| **Time and Space** |  | |  |
| y | years | |  |
| t | season | |  |
|  | Spatial area | |  |
|  | Initial spatial distribution | |  |
| **Life history** |  | |  |
| *a* | Age | | [1...A] |
| *A* | Max age | |  |
| *M* | Natural mortality | |  |
|  | Unfished recruitment | |  |
|  | Weight of spawners | |  |
|  | Weight at age in catch | |  |
|  | Weight at age in survey | |  |
| *b* | Bias adjustment | | [0;1] |
| *h* | Steepness | | [0.2:1] |
| Z | Total mortality | |  |
| **State variables** |  | |  |
| *N* | Numbers of fish | |  |
| *R* | Recruitment | |  |
| *F* | Fully selected fishing mortality | |  |
| *R* | Recruitment | |  |
|  | |
|  | |
|  | |
|  | |
| **Derived variables** |  | |  |
| *C* | Catch | |  |
| *S* | Spawning biomass | |  |
|  | Unfished spawning biomass | |  |
| *I* | Survey index | |  |
| *V* | Biomass vulnerable to fishing | |  |
| *H* | Harvest rate | |  |
| **Stochastic variables** |  | |  |
|  | Recruitment deviations | |  |
|  | Initial recruitment deviations | |  |
|  | Recruitment standard deviation | |  |
|  | Survey observation error | |  |
|  | Survey error standard deviation | |  |
|  |  | |  |
| **Selectivity** |  | |  |
|  | Age at 50% selectivity | |  |
|  | Slope of selectivity function | |  |
|  | Age at 50% maturity | |  |
|  | Slope of maturity function | |  |
|  |  | |  |
|  |  | |  |
| *q* | Survey catchability | |  |
| **Movement** |  | |  |
|  |  | |  |
|  | Movement function | | [0…κ] |
|  | Age at 50% of max movement rate | |  |
|  | Slope of movement function | |  |
|  |  | |  |
|  |  | |  |

Table S2: Equations used to govern the population, fishing, and observation processes in the operating model. Notation is described in Table S1.

|  |  |
| --- | --- |
| Equation | Description |
| **Abundance** |  |
|  | Equilibrium  abundance |
|  | Maturity |
|  | Spawning biomass |
|  | Initial abundance |
|  | Recruitment |
|  |  |
|  | Total mortality |
|  | Annual change in abundance |
| **Fisheries** |  |
|  | Selectivity |
|  |  |
|  | Seasonal catch (weight) |
|  | Seasonal catch (numbers) |
| . | Vulnerable biomass |
| **Movement** |  |
|  | Initial spatial distribution |
|  |  |
|  | Movement between areas |
|  | Age specific movement rate |
| Data generation |  |
|  | Annual observed total catch (weight) | EQ 18 |
|  | Annual numbers of age in catch | EQ19 |
|  | Age composition in catch | EQ 20 |
|  | Survey selectivity parameter | EQ 21 |
|  | Survey biomass | EQ 22 |
|  | Survey numbers at age | EQ 23 |
|  | Age composition in survey | EQ 24 |
|  |  |  |