# Starting condition investigation

Review core age-structured software and how they deal with this assumption

WHAM – Tim Miller

ASAP – Chris Legault

SAM – Anders Nielsen

SS – Rick Methot

CASAL2 – Me

Multifan-cl – Nick Davies

Email authors and ask them to check I have reflected their package correctly and review reference points and general input.

Ask if there other packages that I need to consider.

Ask for any other papers that they have come across on this topic that I have missed.

## Methods

### Stating conditions

Review of main packages

#### ASAP

Based on the document from Legault and Restrepo (1998) (equation 9)

Where, and , where is an estimable initial fishing mortality by age.

#### SAM

This research focuses on non-state-space age-structured models, but for completeness we included the common initial conditions for age-structured state-space models using the paper from Nielsen & Berg (2014). This state-space age-structured model estimates the natural logarithm of numbers at age denoted by as an unobserved latent state. The initial conditions are estimated as random effects where

Sometimes a diffuse prior is needed on the initial stating state such as,

#### WHAM

I initially used Stock and Miller (2021) as my reference for this. However, I do not think it describes the initial age-structured conditions i.e. . I will check with authors, but for now, I am going to assume they are the same as ASAP (see below) or the same as SAM.

#### MULTIFAN-CL

There are multiple options in MULTIFAN-CL for estimating initial numbers at age (assuming a single region model). The first option is similar to SAM, which allows users to estimate initial numbers at age as fixed-effect parameter (Is there a transformation on this? i.e., log NAA)

The second approach is similar to the ASAP but changes the definition of and removes the age-specific deviations . The initial numbers at age are,

, where is an estimable parameter and is the recruitment deviation which assumes.

The third approach is the same as the second approach but assumes , where is the average fishing mortality over the set of years denoted by , generally the some initial year period. This assumes you are estimating annual fishing mortality rates as fixed effect parameters. If you are deriving F as catch conditioned using a Newton Raphson algorithm then you may need to estimate an initial Fishing mortality.

#### Estimation model in simulations

EM 1 estimate just initial age-deviations (

Where, and .

EM 2 estimate just

EM 3 – estimate initial age deviations ( and

EM 4 – estimate log numbers at age as an unbounded uniform random variable

### Reference points

Static depletion

Dynamic depletion

Depletion based on initial year SSB

Spawner per recruit (SPR)

Set and assume , where , and , where is the fishery selectivity

Where, is the weight at age and the proportion mature for age . Using the same idea you can also calculate Yield per recruit assuming the baranov catch equation.

Yield per recruit (YPR)

Set and assume , where , and , where is the fishery selectivity

Where, is the weight at age and the proportion mature for age . Using the same idea you can also calculate Yield per recruit assuming the baranov catch equation.

### Simulation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Fast (flatfish) | Medium | Long |
| Age plus group | 50 | 50 | 100 |
| Natural Mortality (M) | 0.15 | 0.08 | 0.05 |
| Steepness (h) | 0.85 | 0.65 | 0.50 |
| Maximum length ( | 58 | 34 | 64 |
| Growth coefficient () | 0.133 | 0.115 | 0.047 |
| Body weight | | | |
| Growth coefficient () |  |  |  |
| Growth coefficient () | 3.50 | 3.17 | 3.17 |
| Maturity (logistic) |  |  |  |
| Age at 50% maturity | 4.5 | 9 | 19.5 |
| Width for 95% mature | 1.8 | 3.2 | 6.4 |
| Fishery selectivity (logistic) | | | |
| Age at 50% selective () | 7 | 7 | 15 |
| Width for 95% selective () | 2 | 5 | 7 |
| Survey selectivity (logistic) | | | |
| Age at 50% selective () | 5 | 3 | 10 |
| Width for 95% selective () | 2 | 2 | 7 |

The Woods Hole Assessment Model (WHAM): A general state-space assessment framework that incorporates time- and age-varying processes via random effects and links to environmental covariates

Estimation of time-varying selectivity in stock assessments usingstate-space models