Untitled

Grant Adams

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# Equations

**Table 1.** Population dynamics equations for species and age in each simulation year . BT indicates the AFSC bottom trawl survey and EIT represents the echo-integrated acoustic- trawl survey. For all parameter definititions see Table 3.

|  |  |  |
| --- | --- | --- |
| Definition | Equation |  |
| Recruitment |  | T1.1 |
| Initial abundance |  | T1.2 |
| Numbers at age |  | T1.3 |
| … |  | … |
| Catch |  | T1.4 |
| Total yield (kg) |  | T1.5 |
| Biomass at age (kg) |  | T1.6 |
| Spawning biomass at age (kg) |  | T1.7 |
| Total mortality at age |  | T1.8 |
| Fishing mortality at age |  | T1.9 |
| Weight at age (kg) |  | T1.10a |
| … |  | T1.10b |
| … |  | T1.10c |
| BT survey biomass (kg) |  | T1.11 |
| EIT survey biomass (kg) |  | T1.12 |
| Fishery age composition |  | T1.13 |
| BT survey age composition |  | T1.14 |
| EIT survey age composition |  | T1.15 |
| BT selectivity |  | T1.16 |
| Fishery selectivity |  | T1.17 |
| Proportion females |  | T1.18 |
| Proportion of mature females |  | T1.19 |
| Weight at age (kg) |  | T1.20 |
| Residual natural mortality |  | T1.21 |

**Table 2.** Predation mortality equations for predators of age , and prey of age

|  |  |  |
| --- | --- | --- |
| Definition | Equation |  |
| Predation mortality |  | T2.1 |
| Predator-prey suitability |  | T2.2 |
| Mean gravimetric diet proportion |  | T2.3 |
| Individual specific ration () |  | T2.4 |
| Temperature scaling algorithim |  | T2.5 |
| … |  | T2.5a |
| … |  | T2.5b |
| … |  | T2.5c |
| … |  | T2.5d |

**Table 3.** Parameter definitions.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Definition | Type | Model Object |
| Year |  | M | i |
| Predator |  | M |  |
| Predator age (years) |  | M |  |
| Prey |  | M | k |
| Prey age (years) |  | M |  |
| Number of prey species |  | I | nspp |
| Number of predator species |  | I |  |
| Number of prey ages |  | I | nages |
| Number of predator ages |  | I |  |
| Number of simulation years |  | I | nyrs |
| Start year |  | I | styr |
| Annual relative foraging rate () |  | I |  |
| Intercept of the allometic maximum consumption function () |  | I | aLW |
| Allometric slope of maximum consumption |  | I | bLW |
| Consumption maximum physiological temperature (°C) |  | I | Tcm |
| Consumption optimum physiological temperature (°C) |  | I | Tco |
| Max consumption parameter |  | I | Qc |
| Mean recruitment |  | E |  |
| Annual recruitment deviation |  | E | rec\_dev |
| Initial abundance |  | E |  |
| Mean fishing mortality |  | E |  |
| Anuual fishing mortality deviation |  | E |  |
| Fishery age selectivity coefficient |  | E |  |
| Survey age selectivity slope |  | E |  |
| Survey age selectivity limit |  | E |  |
| VBGF allometric slope of consumption |  | P | d |
| VBGF max asymptotic weight (kg) |  | P | Winf |
| Proportion of mature females at age |  | P |  |
| Residual natural mortality |  | F | M1\_base |
| Intercept for VBGF parameter |  | F |  |
| Annual intercept for VBGF parameter |  | F | log\_mean\_d |
| Temperature covariate for VBGF parameter |  | F | Tcoef |
| VBGF energy loss constant () |  | F | logK |
| VBGF assimilation constant () |  | F | logH |
| VBGF age when (years) |  | F | t0 |
| EIT survey selectivity |  | F |  |
| Female natural mortality |  | F |  |
| Male natural mortality |  | F |  |
| Female proportion of population |  | F |  |
| Age-specific maturity proportions |  | F | pmature |
| Observed total yield () |  | D | tc\_biom\_obs |
| Observed fishery age comp. |  | D | fsh\_age\_obs |
| Observed BT age comp. |  | D | srv\_age\_obs |
| Observed EIT age comp. |  | D | obs\_eit\_age |
| Observed BT survey biomass (kg) |  | D | srv\_bio |
| Observed EIT survey biomass (kg) |  | D | obs\_eit |
| Bottom temperature (°C) |  | D | TempC |
| Gravimetric proportion of prey in predator stomach |  | D |  |
| Biomass of other prey (kg) |  | D | other\_food |
| **Not in table 3** |  |  |  |
| Annual survey biomass error |  | F | srv\_Mean\_CV |
| Number of years with total observed catch |  | M | nyrs\_tc\_biom\_obs |
| Years with total observed catch |  | I | yrs\_tc\_biom\_obs |
| Number of years in the fishery sp\_age composition data |  | E | nyrs\_fsh\_comp |
| Number of estimation years |  | I | nyrs\_est |
| End year |  | I | endyr |
| Number of years in the fishery age composition data |  | I | nyrs\_fsh\_comp |
| Years in the fishery age composition data |  | I | yrs\_fsh\_comp |
| Method of calculating fishery age |  | I | fsh\_age\_type |
| Number of fishery age bins |  | I | fsh\_age\_bins |
| Number of years with weight-at-age data |  | I | nyrs\_wt\_at\_age |
| Years with weight-at-age data |  | I | yrs\_wt\_at\_age |
| Weight-at-age data |  | D | wt |
| Number of years in the BT survey data |  | I | nyrs\_srv\_biom |
| Years in the BT survey data |  | I | yrs\_srv\_biom |
| BT survey standard error |  | F | srv\_biom\_se |
| Number of years in the BT survey age or length composition data |  | I | nyrs\_srv\_age |
| Years in the BT survey age composition data |  | I | yrs\_srv\_age |
| Method of calculating BT survey age type (age or length) |  | I | srv\_age\_type |
| Number of BT survey age bins |  | I | srv\_age\_bins |
| Sample size for BT survey age composition multinomial |  | I | srv\_age\_n |
| Observed survey BT size compositions |  | I | srv\_age\_sizes |
| Age transition matrix |  | I | age\_trans\_matrix |
| Number of years in the EIT survey data |  | I | n\_eit |
| Years in the BT survey data |  | I | yrs\_eit |
| Sample size for EIT survey age composition multinomial |  | I | eit\_age\_n |
| Number of years in the EIT selectivtiy data |  | I | nyrs\_eit\_sel |
| Years in the BT selectivity data |  | I | yrs\_eit\_sel |
| Sample size for EIT survey age composition multinomial |  | I | eit\_sel |
| Sex specific mortality and weight-at-age: 1 for combined, 2: for seperate |  | I | mf\_type |
| Proportion |  | I | propMorF |
| Observed catch-at-age |  | I | obs\_catch |
| Estimated catch-at-age |  | E | obs\_catch\_hat |
| Observed total catch |  | D | tc\_obs |
| Estimated total catch |  | D | tc\_hat |
| Estimated total yield |  | E | tc\_obs |
| Observed fishery age composition |  | I | fsh\_age\_obs |
| Estimated fishery age composition |  | E | fsh\_age\_hat |

**Table 4.** Components of the likelihood function for each species of age in year .

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Equation | Data source |  |
| **Data components** |  |  |  |
| BT survey biomass |  | NMFS annual EBS BT survey | T4.1 |
| BT survey age composition |  | NMFS annual EBS BT survey | T4.2 |
| EIT survey biomass |  | Pollock acoustic trawl survey | T4.3 |
| EIT survey age composition |  | Pollock acoustic trawl survey | T4.4 |
| Total catch |  | Fishery observer data | T4.5 |
| Fishery age composition |  | Fishery observer data | T4.6 |
| **Penalties** |  |  |  |
| Fishery selectivity |  |  | T4.7 |
| **Priors** |  |  |  |
|  |  |  | T4.8 |
|  |  |  | T4.9 |
|  |  |  | T4.10 |
|  |  |  |  |

# References

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