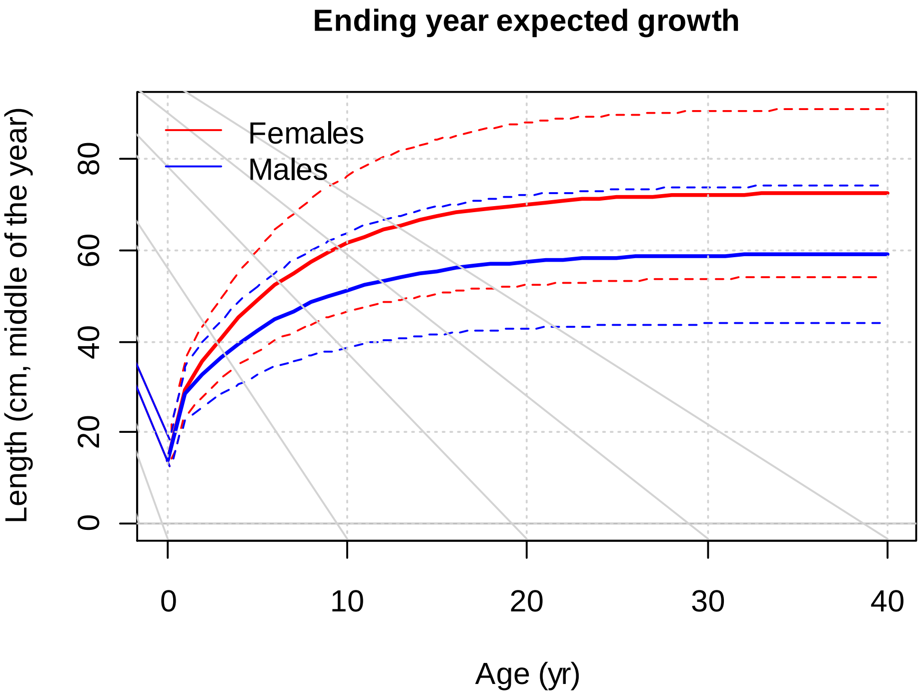
Modeling growth in Stock Synthesis

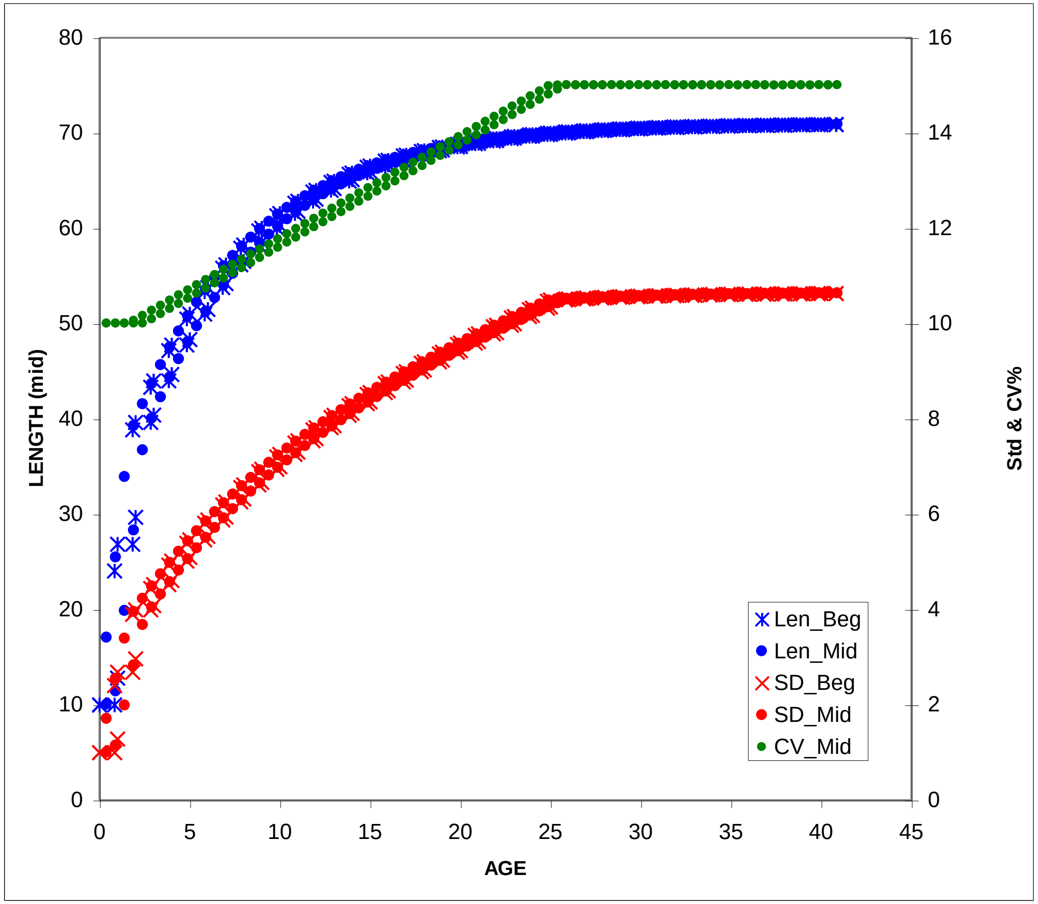


Growth curves

- The von Bertalanffy, parameterized in terms of,
  - length at a given young age,
  - length at a given old age (or optionally L_∞)
  - growth rate parameter, K
- Growth increment is modeled as a function of current length, current year's L_∞ and K
  - allow for temporal changes in growth without individuals shrinking

Growth example

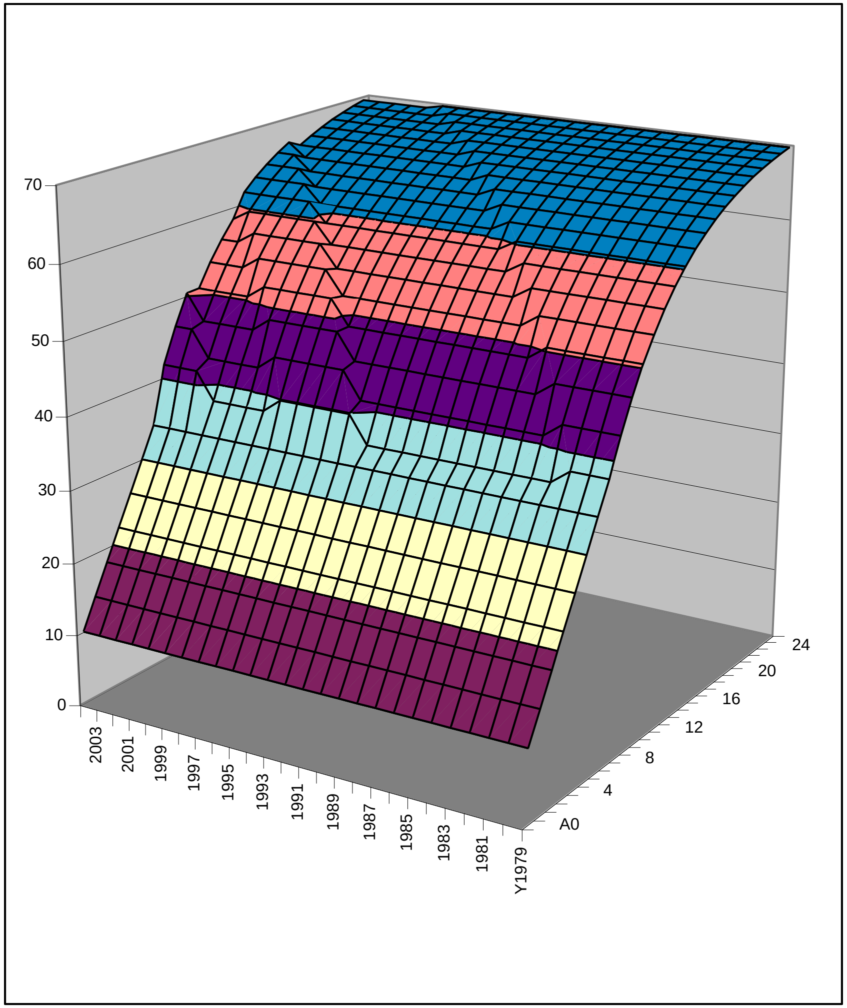
- Example showing:
  - Two birth seasons
  - CV = F(A)
  - Season durations:
    10 months
    & 2 months

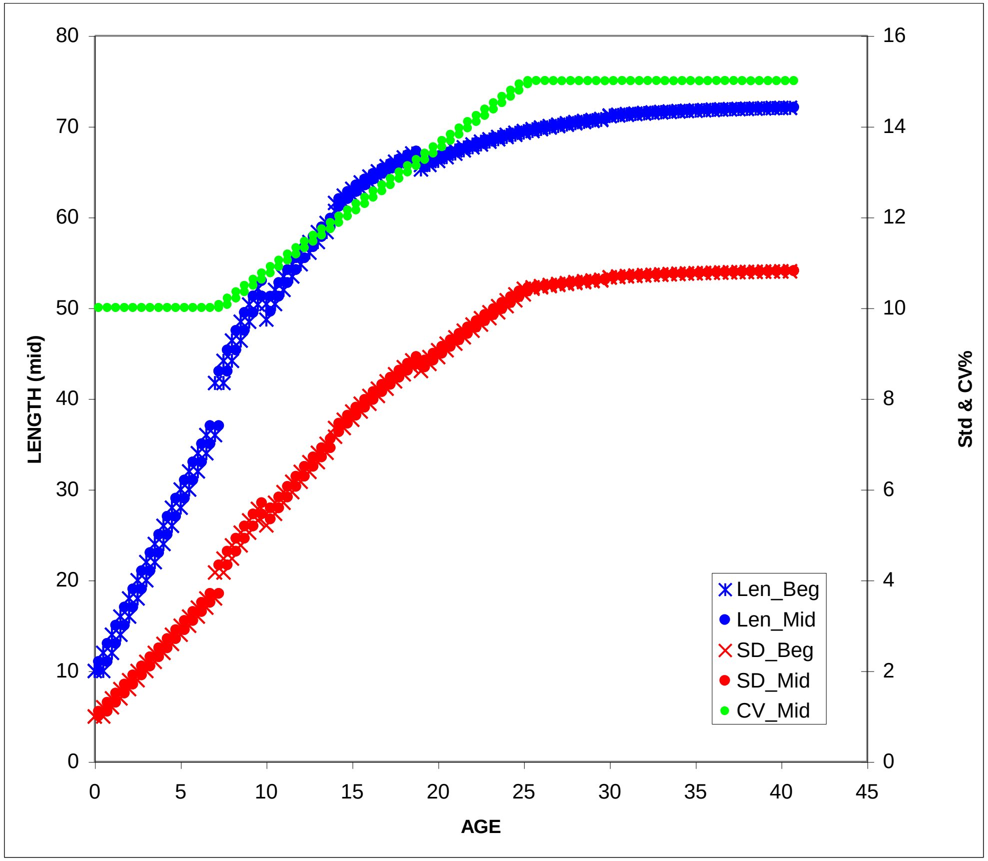


Additional growth options

- Cohort-specific growth
  - Create as time-varying adjustment to the CGD parameter which has a base value of 1.0
  - Acts as multiplier on K
  - allows variation in growth rates between cohorts
  - may be due to intra-cohort density dependence (not modeled explicitly), genetics, or other factors
- Schnute's generalized growth curve (a.k.a. Richards curve)
  - has additional parameter that generalizes the von Bertalanffy curve
- Age-specific K

Cohort Growth Deviation





Age-Specific K

Parameter value is a simple multiplier on the K for the previous age; so creates a random walk

………….

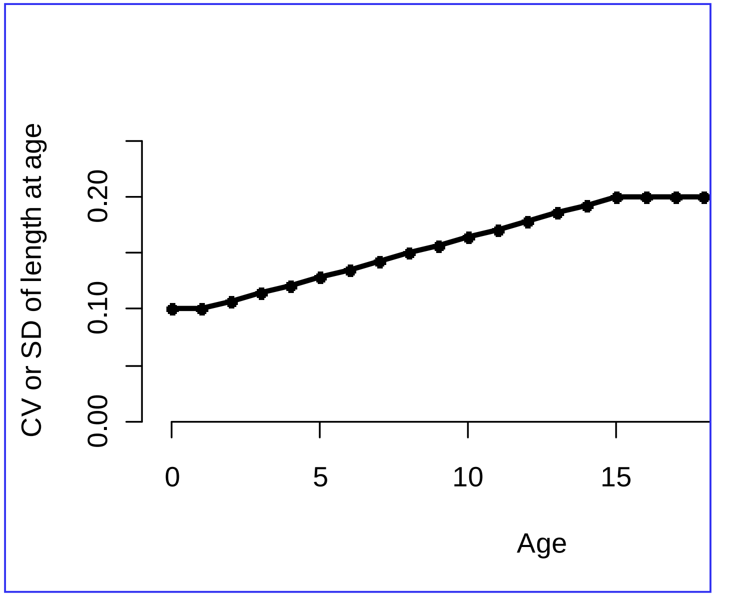
```
3 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_speciific_K; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
5 # number of K multipliers to read
3  5  7  9  11
```

………

```
#_growth_parms
#_LO    HI     INIT    PRIOR   PR_type SD     PHASE
0.05    0.15    0.1     0.1     -1      0.8     -1      0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
10      45      30      30      -1      10      1       0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
40      250     200     200     -1      10      1       0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.001   0.5     0.1     0.1     -1      0.8     -2      0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.01    3       1       1       -1      0.8     3       0 0 0 0 0 0 0 # Age_K_Fem_GP_1_a_3
0.01    3       1       1       -1      0.8     3       0 0 0 0 0 0 0 # Age_K_Fem_GP_1_a_5
0.01    3       1       1       -1      0.8     3       0 0 0 0 0 0 0 # Age_K_Fem_GP_1_a_7
0.01    3       1       1       -1      0.8     3       0 0 0 0 0 0 0 # Age_K_Fem_GP_1_a_9
0.01    3       1       1       -1      0.8     3       0 0 0 0 0 0 0 # Age_K_Fem_GP_1_a_11
```

Variation of length at age

- Several linear functions are available to model the variation of length at age
  - CV as a function of length at age
  - CV as a function of age
  - SD as a function of length at age
  - SD as a function of age
- Dogleg pattern uses growth A_{min} and A_{max}

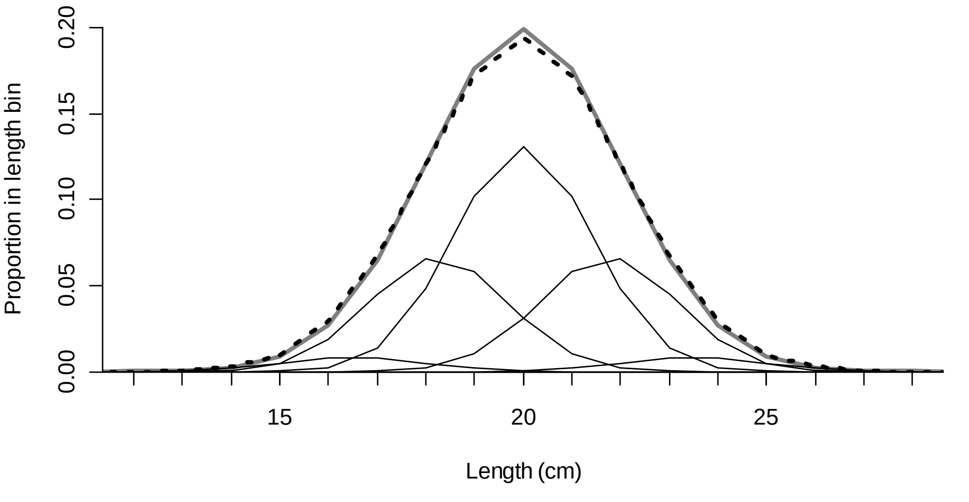


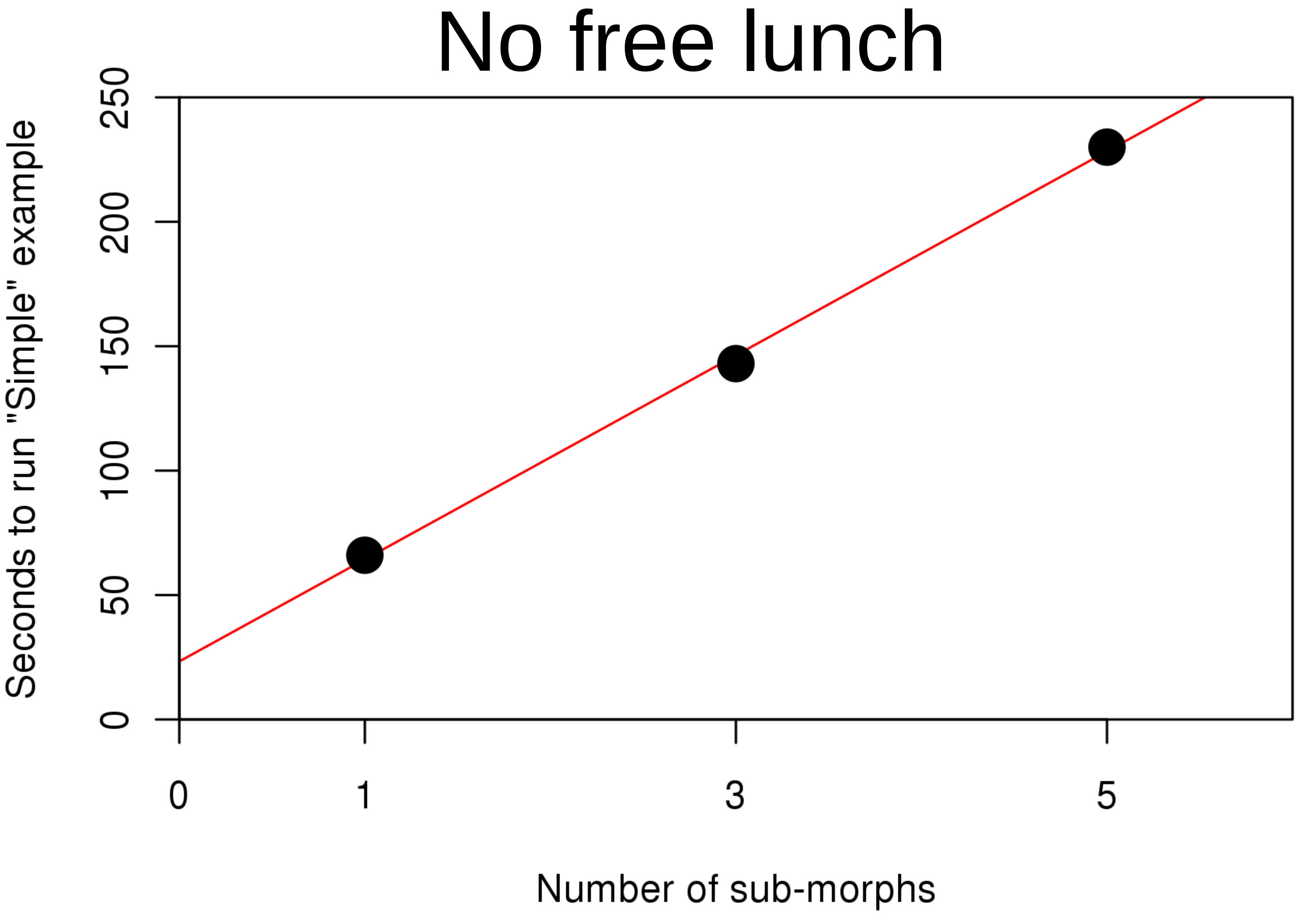
Growth patterns

- Can be used to model the difference in growth among sub-populations
- In a multi-area model, the distribution of recruitment among areas and growth patterns is controlled by estimable parameters
- When an individual changes areas, it maintains the growth parameters of its specified growth pattern

Growth platoons for size-survivorship

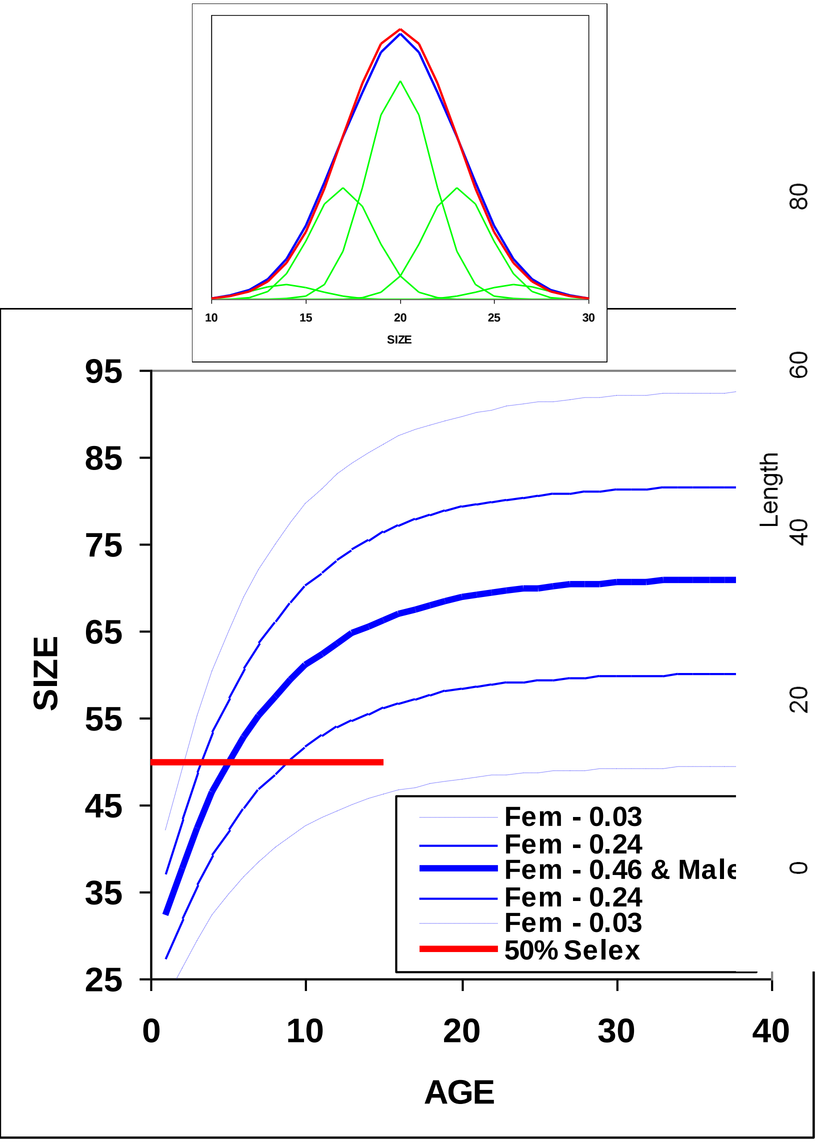
- 3 or 5 platoons (morphs) nested within growth patterns and genders
- Used to account for the effect of size specific selectivity in the population size structure at age by dividing cohort into components with different size-at-age
- Size selectivity then causes different F-at-age for the different morphs

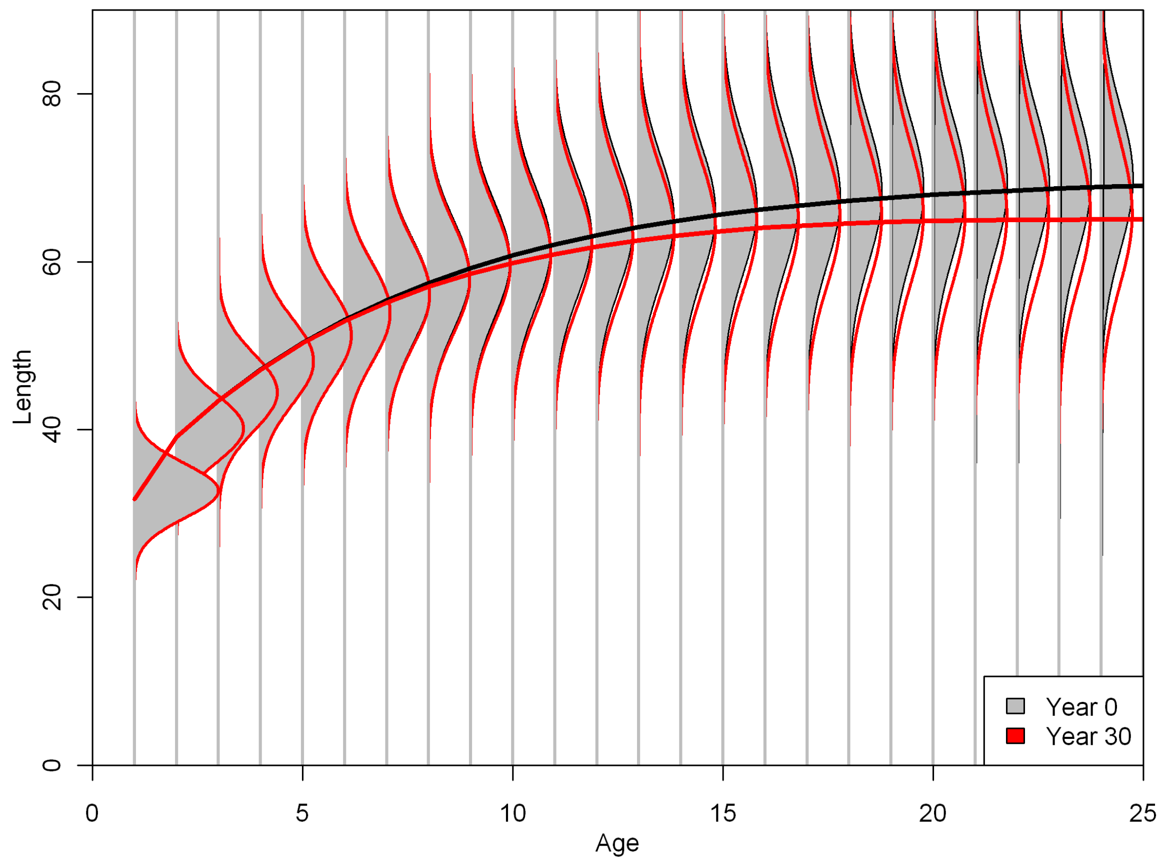




No free lunch
Seconds to run "Simple" example
0
50
100
150
200
250
0
1
3
5
Number of sub-morphs

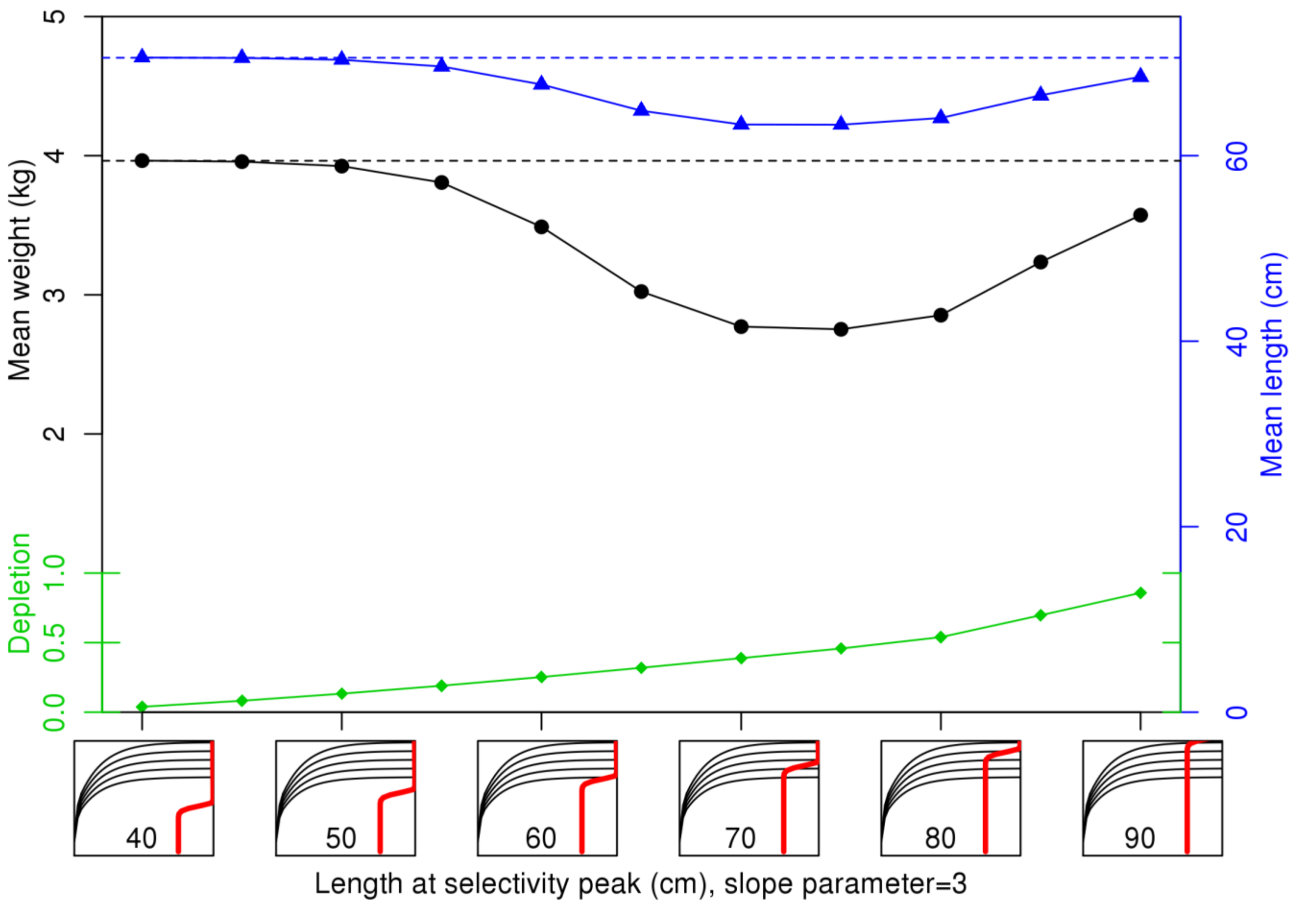
Length-Specific Survivorship



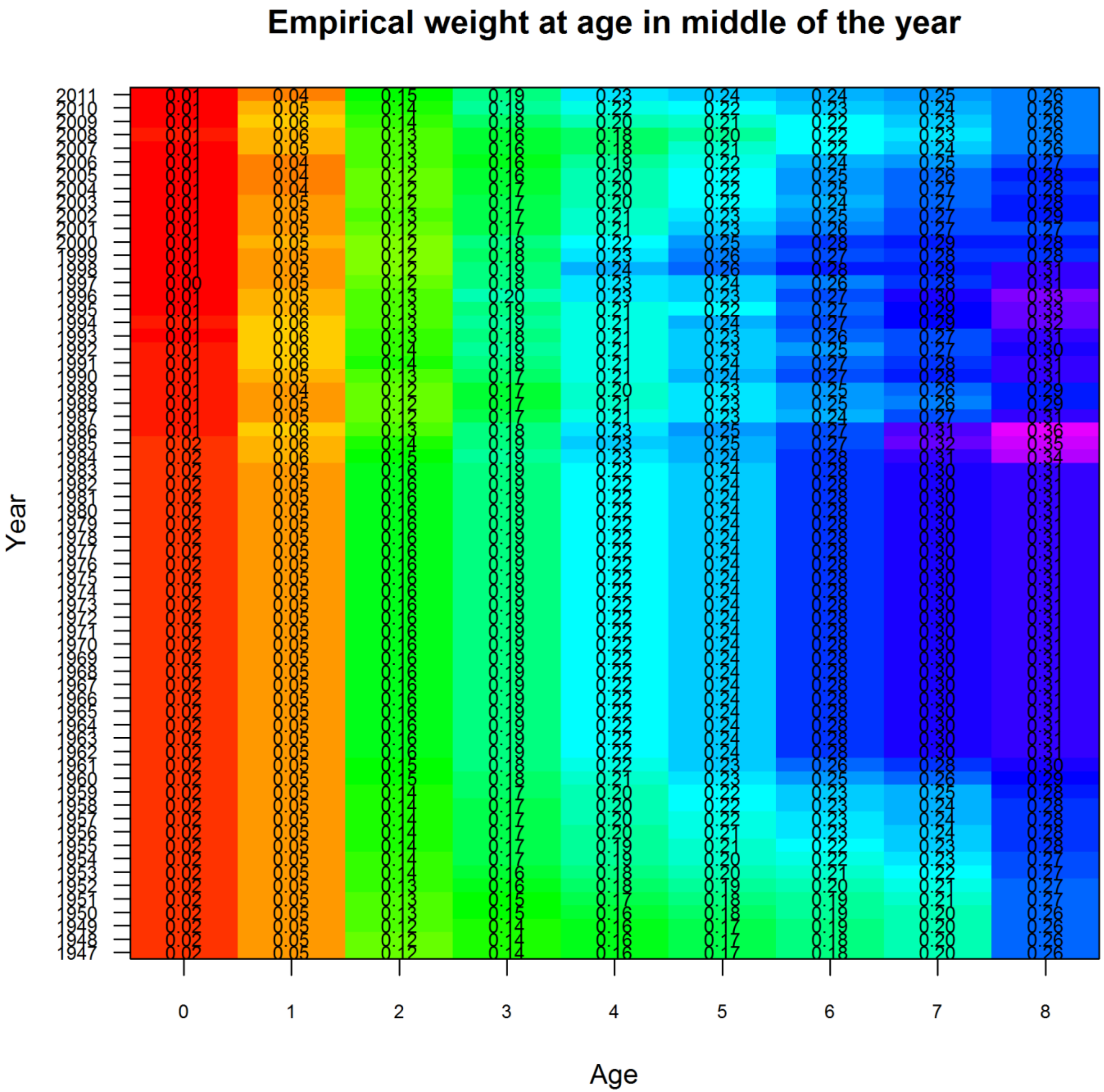


Growth morph example

Interaction between selectivity and mean weight and length (at age 30)



Empirical weight at age (NS Herring)



Data Needs

- Distinct length modes in length comp data
- Mean length (or body wt)-at-age data
- Conditional age-at-length data

Growth Estimation Notes

- If there is an existing set of growth parameters, consider using as priors and let SS update
- Be alert for existing growth curve to be half year shifted along age axis compared to SS' time stanzas
- CAAL data is voluminous and will slow the model