Gmacs update

The Gmacs team

Major updates

- Selectivity and retention
  - Much greater flexibility in specifying selectivity parameters, bounds and priors
  - Added parametric selectivity type as option (i.e. 1 parameter per size-class)
- Size-compositions
  - Allows any combination of size-compositions to be fitted simultaneously (e.g. males and females fitted together in the multinomial)
  - Added Dirichlet distribution
- Additional CV for surveys/CPUE
  - With bounds, priors, etc
- Adding prior specification for all parameters, working towards a proper Bayesian model
- Multiple model scripts
  - Example of application and plotting for SMBKC

Minor updates

- Simulation mode operational but incomplete
  - Needs work in size-composition simulation and unit testing
- Many fixes to gmr plotting functions, core model code and code structure, documentation, reference list, GitHub repository and support code (e.g. Makefiles), Wiki (i.e. user manual)
- Updated BBRKC input files to include 1 more year of data (thanks Jie)
  - BBRKC model still wierd
- Began application to SMBKC (thanks Jie)

Selectivity and retention

- A major overhaul of the selectivity and retention code was done
- Improved prior and bound specification
  - Special case with uniform prior (this has been repeated throughout Gmacs)
  - Removed the mirror feature but may need to figure out how to put this back in
- Added parametric selectivity (i.e. 1 parameter per size-class)
- Unit testing to ensure that this additional flexibility did not slow down the code

Selectivity and retention

```
##                                                                                                    ##
## SELECTIVITY CONTROLS                                                                               ##
##     Each gear must have a selectivity and a retention selectivity. If a uniform                    ##
##     prior is selected for a parameter then the lb and ub are used (p1 and p2 are                   ##
##     ignored)                                                                                       ##
## LEGEND                                                                                             ##
##     sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,                      ##
##               4 = double normal (NIY)                                                              ##
##     gear index: use +ve for selectivity, -ve for retention                                         ##
##     sex dep: 0 for sex-independent, 1 for sex-dependent                                            ##
## ------------------------------------------------------------------------------------------------- ##
## ivector for number of year periods or nodes                                                        ##
## Gear-1    Gear-2    Gear-3    Gear-4
   1         1         2         1         # selectivity periods
   1         0         1         1         # sex specific selectivity
   3         3         3         3         # male selectivity type
   3         3         3         3         # female selectivity type
## Gear-1    Gear-2    Gear-3    Gear-4
   1         1         1         1         # retention periods
   1         0         0         0         # sex specific retention
   3         2         2         2         # male   retention type
   2         2         2         2         # female retention type
   1         0         0         0         # male   retention flag (0 = no, 1 = yes)
   0         0         0         0         # female retention flag (0 = no, 1 = yes)
##                                                                                                    ##
## gear  par   sel                                                phz    start  end                  ##
## index index par sex  ival  lb    ub     prior p1     p2     mirror period period                 ##
## ------------------------------------------------------------------------------------------------- ##
## Selectivity P(capture of all sizes)
# Gear-1
   1     1     1   1    100    5    185    0      10    200    3     1975   2014
   1     2     2   1    120    5    185    0      10    200    3     1975   2014
   1     3     1   2     80   60    150    0      10    200    3     1975   2014
   1     4     2   2     95   60    150    0      10    200    3     1975   2014
# Gear-2
   2     5     1   0    110    5    185    0      10    200    3     1975   2014
   2     6     2   0    150    5    185    0      10    200    3     1975   2014
# Gear-3
   3     7     1   1     74   60    150    0       1    200   -3     1975   1981
   3     8     2   1     95   60    150    0       1    200   -3     1975   1981
   3     9     1   1     95   60    200    0       1    200   -3     1982   2014
   3    10     2   1    140   60    200    0       1    200   -3     1982   2014
   3    11     1   2     90   60    200    0       1    200   -3     1975   1981
   3    12     2   2    160   60    200    0       1    200   -3     1975   1981
   3    13     1   2    100   60    200    0       1    200   -3     1982   2014
   3    14     2   2    170   60    200    0       1    200   -3     1982   2014
# Gear-4
   4    15     1   1     70    1    200    0       1    200    4     1975   2014
   4    16     2   1     90    1    200    0       1    200    4     1975   2014
   4    17     1   2    110    1    200    0       1    200    4     1975   2014
   4    18     2   2    190    1    200    0       1    200    4     1975   2014
##                                                                                                    ##
## Retained
# Gear-1
  -1    19     1   1    133    1    700    0      1    900   -4     1975   2014
  -1    20     2   1    137    1    700    0      1    900   -4     1975   2014
  -1    21     1   2    591    1    700    0      1    900   -3     1975   2014
  -1    22     2   2     11    1    700    0      1    900   -3     1975   2014
# Gear-2
  -2    23     1   0    595    1    700    0      1    900   -3     1975   2014
  -2    24     2   0     10    1    700    0      1    900   -3     1975   2014
# Gear-3
  -3    25     1   0    590    1    700    0      1    900   -3     1975   1981
  -3    26     2   0     10    1    700    0      1    900   -3     1982   2014
# Gear-4
  -4    27     1   0    580    1    700    0      1    900   -3     1975   2014
  -4    28     2   0     20    1    700    0      1    900   -3     1975   2014
##                                                                                                    ##
```

Selectivity and retention

```
## ------------------------------------------------------------------------------------------ ##
## SELECTIVITY CONTROLS                                                                       ##
##     Each gear must have a selectivity and a retention selectivity. If a uniform            ##
##     prior is selected for a parameter then the lb and ub are used (p1 and p2 are           ##
##     ignored)                                                                               ##
## LEGEND                                                                                     ##
##     sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,              ##
##               4 = double normal                                                            ##
##     gear index: use +ve for selectivity, -ve for retention                                 ##
##     sex dep: 0 for sex-independent, 1 for sex-dependent                                    ##
## ------------------------------------------------------------------------------------------ ##
## ivector for number of year periods or nodes                                                ##
## Gear-1    Gear-2    Gear-3    Gear-4
   1         1         2         1         # selectivity periods
   1         0         1         1         # sex specific selectivity
   3         3         3         3         # male selectivity type
   3         3         3         3         # female selectivity type
## Gear-1    Gear-2    Gear-3    Gear-4
   1         1         1         1         # retention periods
   1         0         0         0         # sex specific retention
   3         2         2         2         # male   retention type
   2         2         2         2         # female retention type
   1         0         0         0         # male   retention flag (0 = no, 1 = yes)
   0         0         0         0         # female retention flag (0 = no, 1 = yes)
## ------------------------------------------------------------------------------------------ ##
```

Selectivity

```
## ------------------------------------------------------------------------------------------------ ##
## gear  par   sel                                                 phz    start  end               ##
## index index par sex  ival  lb    ub     prior p1     p2        mirror period period            ##
## ------------------------------------------------------------------------------------------------ ##
## Selectivity P(capture of all sizes)
# Gear-1
   1     1     1   1    100    5    185    0      10    200     3      1975   2014
   1     2     2   1    120    5    185    0      10    200    -1      1975   2014
   1     1     1   2     80   60    150    0      10    200     3      1975   2014
   1     2     2   2     95   60    150    0      10    200    -1      1975   2014
# Gear-2
   2     3     1   0    110    5    185    0      10    200     3      1975   2014
   2     4     2   0    150    5    185    0      10    200     3      1975   2014
# Gear-3
   3     5     1   1     74   60    200    0       1    200    -3      1975   1981
   3     6     2   1     95   60    200    0       1    200    -3      1975   1981
   3     7     1   1     95   60    200    0       1    200    -3      1982   2014
   3     8     2   1    140   60    200    0       1    200    -3      1982   2014
   3     5     1   2     90   60    200    0       1    200    -3      1975   1981
   3     6     2   2    160   60    200    0       1    200    -3      1975   1981
   3     7     1   2    100   60    200    0       1    200    -3      1982   2014
   3     8     2   2    170   60    200    0       1    200    -3      1982   2014
# Gear-4
   4     9     1   1     70    1    200    0       1    200     4      1975   2014
   4     10    2   1     90    1    200    0       1    200    -4      1975   2014
   4     9     1   2    110    1    200    0       1    200     4      1975   2014
   4     10    2   2    190    1    200    0       1    200    -4      1975   2014
## ------------------------------------------------------------------------------------------------ ##
```

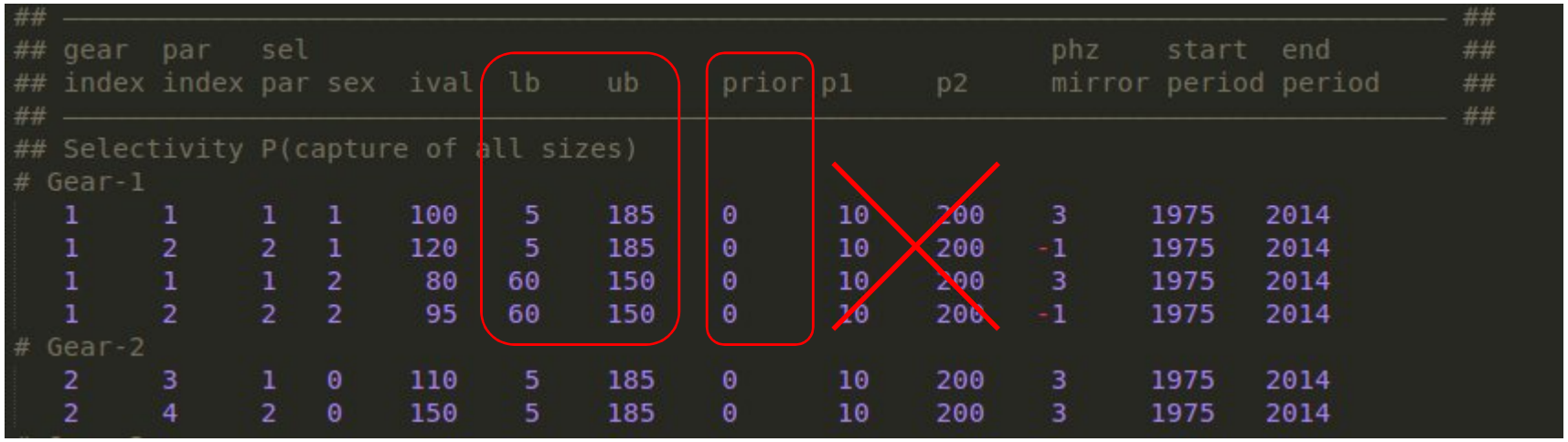
Selectivity

```
## ------------------------------------------------------------------------------------------------ ##
## gear  par   sel                                                  phz    start  end              ##
## index index par sex  ival  lb    ub     prior p1     p2        mirror period period           ##
## ------------------------------------------------------------------------------------------------ ##
## Selectivity P(capture of all sizes)
# Gear-1
   1     1     1   1    100    5    185    0      10     200     3      1975   2014
   1     2     2   1    120    5    185    0      10     200    -1      1975   2014
   1     1     1   2     80   60    150    0      10     200     3      1975   2014
   1     2     2   2     95   60    150    0      10     200    -1      1975   2014
# Gear-2
   2     3     1   0    110    5    185    0      10     200     3      1975   2014
   2     4     2   0    150    5    185    0      10     200     3      1975   2014
```

Single period of sex-specific selectivity for Gear-1, with selectivity type 3 (logistic95) for both sexes

```
## ------------------------------------------------------------------------------------------------ ##
## SELECTIVITY CONTROLS
##    -Each gear must have a selectivity and a retention selectivity
## LEGEND sel type: 1 = coefficients, 2 = logistic, 3 = logistic95, 4
##        gear index: use +ve for selectivity, -ve for retentio
##        sex dep: 0 for sex-independent, 1 for sex-dependent.
## ------------------------------------------------------------------------------------------------ ##
## ivector for number of year periods or nodes
## Gear-1   Gear-2   Gear-3   Gear-4
   1        1        1        1        # Selectivity periods
   1        0        1        1        # sex specific selectivity
   3        3        3        3        # male   selectivity type
   3        3        3        3        # female selectivity type
```

Selectivity



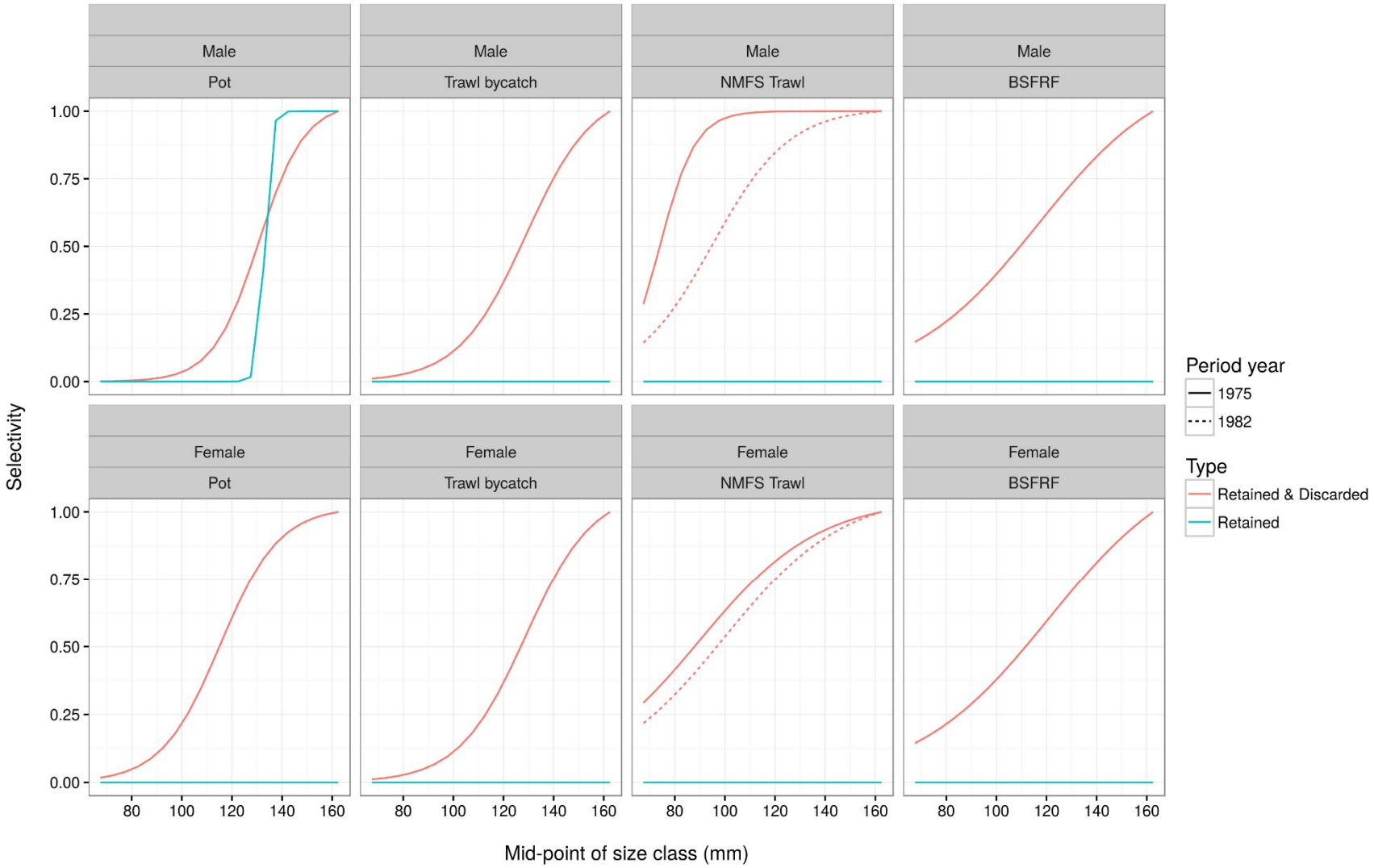
```
## ------------------------------------------------------------------------------------------ ##
## gear  par   sel                                                 phz    start  end          ##
## index index par sex  ival  lb    ub     prior p1     p2        mirror period period       ##
## ------------------------------------------------------------------------------------------ ##
## Selectivity P(capture of all sizes)
# Gear-1
   1     1     1   1    100    5    185    0     10     200       3      1975   2014
   1     2     2   1    120    5    185    0     10     200      -1      1975   2014
   1     1     1   2     80   60    150    0     10     200       3      1975   2014
   1     2     2   2     95   60    150    0     10     200      -1      1975   2014
# Gear-2
   2     3     1   0    110    5    185    0     10     200       3      1975   2014
   2     4     2   0    150    5    185    0     10     200       3      1975   2014
```

- Uniform prior used so lb and ub are used and p1 and p2 are ignored
- This feature has been extended throughout Gmacs

Retention

```
## ------------------------------------------------------------------------ ##
## Retained
# Gear-1
  -1     11    1   1    133   50    200    0      1    900   -4     1975   2014
  -1     12    2   1    137   50    200    0      1    900   -4     1975   2014
  -1     13    1   2    591    1    700    0      1    900   -3     1975   2014
  -1     14    2   2     11    1    700    0      1    900   -3     1975   2014
# Gear-2
  -2     15    1   0    595    1    700    0      1    900   -3     1975   2014
  -2     16    2   0     10    1    700    0      1    900   -3     1975   2014
# Gear-3
  -3     17    1   0    590    1    700    0      1    900   -3     1975   1981
  -3     18    2   0     10    1    700    0      1    900   -3     1982   2014
# Gear-4
  -4     19    1   0    580    1    700    0      1    900   -3     1975   2014
  -4     20    2   0     20    1    700    0      1    900   -3     1975   2014
## ------------------------------------------------------------------------ ##
```

Selectivity and retention



Size-compositions

- Major overhaul of size-composition code
- Allows any combination of size-compositions to be fitted simultaneously (e.g. males and females fitted together in the multinomial)
  - The composition aggregator
- Added the Dirichlet distribution as an option

Size-compositions: aggregator

```
## ------------------------------------------------------------------------------------------------------------ ##
## OPTIONS FOR SIZE COMPOSTION DATA                                                                             ##
##     One column for eacdh matrix                                                                              ##
## LIKELIHOOD OPTIONS:
##   -1) Multinomial with estimated/fixed sample size
##   -2) Robust approximation to multinomial
##   -3) logistic normal (NIY)
##   -4) multivariate-t (NIY)
##   -5) Dirichlet
## AUTO TAIL COMPRESSION:
##   - pmin is the cumulative proportion used in tail compression.
## ------------------------------------------------------------------------------------------------------------ ##
 2   2   2   2   2   2   2   2   2   # Type of likelihood
 0   0   0   0   0   0   0   0   0   # Auto tail compression (pmin)
 1   1   1   1   1   1   1   1   1   # Initial value for effective sample size multiplier
-4  -4  -4  -4  -4  -4  -4  -4  -4   # Phz for estimating effective sample size (if appl.)
 1   2   2   3   3   4   4   4   5   # Composition aggregator
## ------------------------------------------------------------------------------------------------------------ ##
```

Size-compositions: Dirichlet

```
## ------------------------------------------------------------------------- ##
## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX)
## ------------------------------------------------------------------------- ##
## LIKELIHOOD OPTIONS:
##   -1) Multinomial with estimated/fixed sample size
##   -2) Robust approximation to multinomial
##   -3) logistic normal (NIY)
##   -4) multivariate-t (NIY)
##   -5) Dirichlet
## AUTOTAIL COMPRESSION:
##   - pmin is the cumulative proportion used in tail compression.
## ------------------------------------------------------------------------- ##
 5   5   5   # Type of likelihood
 0   0   0   # Auto tail compression (pmin)
 1   1   1   # Initial value for effective sample size multiplier
 4   4   4   # Phz for estimating effective sample size (if appl.)
 1   2   3   # Composition aggregator
## ------------------------------------------------------------------------- ##
```

Size-compositions: Dirichlet

$$\lambda_{\ell,t} = N_{\ell,t} S_{\ell,t}$$

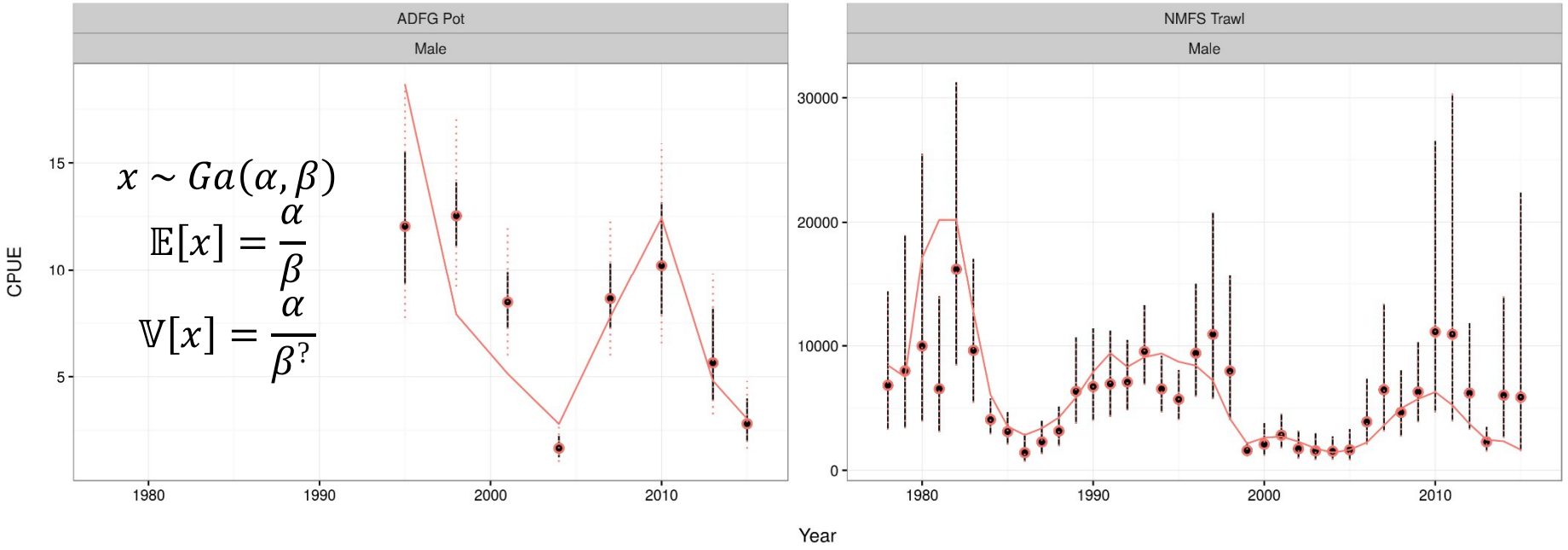
$$(Q_\ell)_t = \frac{\lambda_{\ell,t}}{\sum_\ell \lambda_{\ell,t}} \text{ where } \sum_\ell (Q_\ell)_t = 1 \; \forall t$$

$$(P_\ell)_t \sim Dirichlet(\alpha_0 \alpha_t (Q_\ell)_t) \text{ where } \sum_\ell (P_\ell)_t = 1 \; \forall t$$

Small values of α_0 will result in a “sloppy” (high variance) distribution, while a large α_0 will result in the expected value of $(P_\ell)_t$ strongly concentrated towards $(Q_\ell)_t$.

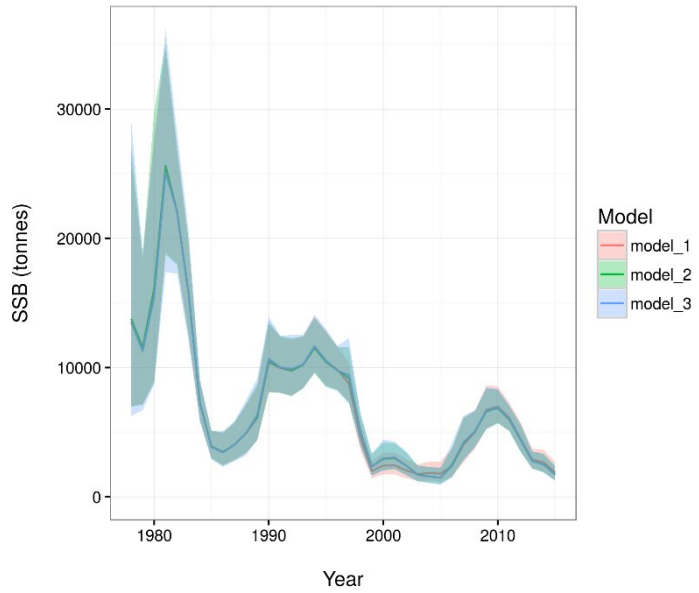
Additional CV for surveys/CPUE

```
## ------------------------------------------------------------------ ##
## ADDITIONAL CV FOR SURVEYS/INDICES                                  ##
##    If a uniform prior is selected for a parameter then the lb and ub are used (p1   ##
##    and p2 are ignored). ival must be > 0                           ##
## LEGEND                                                             ##
##    prior type: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma          ##
## ------------------------------------------------------------------ ##
## ival        lb        ub        phz   prior     p1      p2
   0.0001      0.0       10.0      -4    4         1.0     100   # NMFS
   0.001       0.0001    10.0       4    4         1.0     100   # ADF&G
## ------------------------------------------------------------------ ##
```



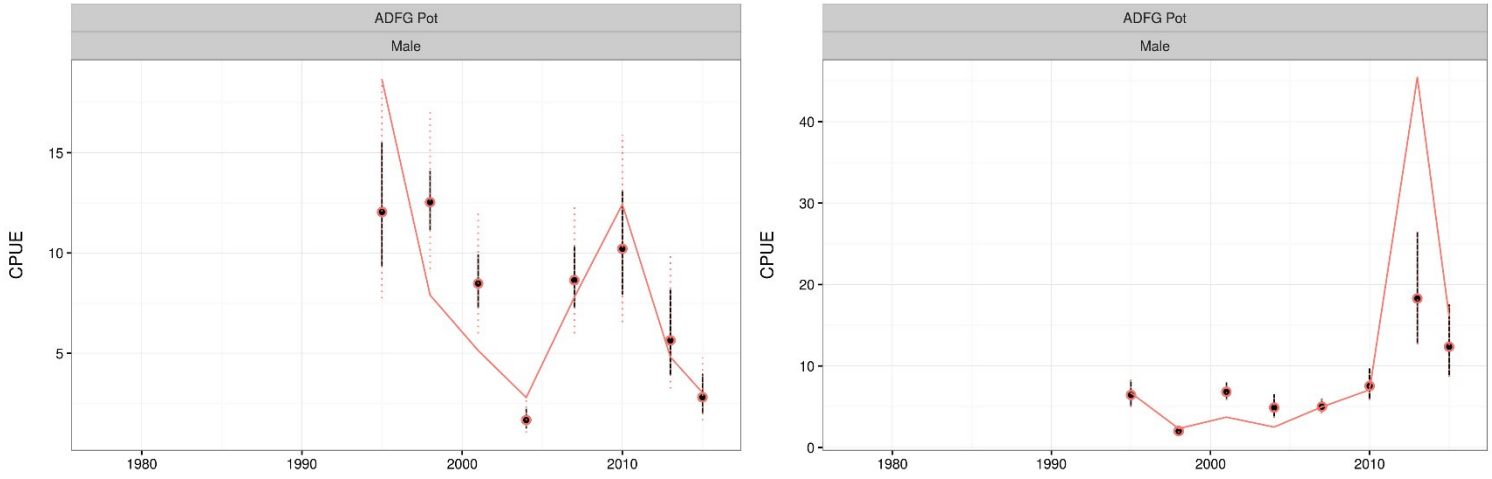
Multiple model scripts

- Makefile
  - Typing make -j N at the command line will run all models within independent directories and produce plots showing the different models using the R package gmr
- Example using SMBKC
  - In a different presentation



Simulation mode

- Use the command *gmacs -ainp gmacs.par -sim 123* where *gmacs.par* contains the parameter values and *123* is the random number seed
- This part of the code is unfinished
  - Need to complete section that simulates size composition data and needs unit testing



Other stuff

- I want to remove analytic q and specify as a parameter?
- Do we want to use Francis iterative re-weighting?
- The continuous F argument
- I need to figure out Makefiles that work on windows
- What else do we want?
- Anything we don’t want?