Gmacs Example Stock Assessment

Athol R. Whitten, James N. Ianelli, André E. Punt

May 2015

Introduction

Gmacs is a generalized size-structured stock assessment modeling framework [more here on Gmacs]. Crab stocks of Alaska are managed by the North Pacific Fisheries Management Council NPFMC. Some stocks are assessed with integrated size-structured assessment models of the form described by Punt, Huang, and Maunder (2013). Currenlty, each stock is assessed using a stock-specific assessment model. The Gmacs project aims to provide software that will allow each stock to be assessed inside a single modelling framework.

Gmacs is used here to develop an assessment model for the Bristol Bay Red King Crab (BBRKC) stock. This analysis serves as a test-case for the development of Gmacs: the example assessment is intended to match closely with a model scenario presented to the Spring 2014 BSAI Crab Plan Team Meeting by Zheng and Siddeek (2014).

Together, the Gmacs-BBRKC model and this report serve as the first example of what should follow for other crab stocks: that is, direct model comparisons to (1) test the efficacy of Gmacs, and (2) determine whether Gmacs can be used in practice to closely match the outputs of existing ADFG stock assessment models.

Summary of analytical approach

Information here on the model, the history, and specifications (current and old).

ADFG-BBRKC

Gmacs-BBRK

How Gmacs deals with retention and selectivity: this is an important part to add, as there.

Comparison of Data and Model Specifications

ADFG

Survey Data

Catch Data

Weight and Fecundity

For the length-weight relationships, Jie's data file `rk7513s1.dat` has information on the weight-at-length parameters for BBRKC. He suggests we use the 'new' parameters listed (see line 339 onwards): these parameters were estimated by NMFS.

Fecundity-at-length is a little more complicated: This information was provided by Jie:

From Jie: Fecundity-at-length depends on clutch fullness, which changes from year to year. Right now, we do not use fecundity in the management, so no fecundity is used in the model. The "fecundity" used in Andre's simplified model looks like the male mean weight by length with the "old" parameters". If GMACS needs fecundity, maybe just input mean weight by length of mature females, or mature males (please use "new" parameters). As to the maturity by length, right now, it is 0 for lengths less than 90 mm and 1 for lengths 90 or larger for females and 0 for lengths less than 120mm and 1 for lengths greater than 119 mm for males. In the future, I plan to estimate maturity by length for females over time to improve estimation of growth.

Gmacs

The data and model specifications used in the Gmacs-BBRKC model are very similar to those used in the '4nb' scenario developed by Zheng and Siddeek (2014), herein referred to as the ADFG-BBRKC model.

Parameterization of the Bristol Bay red king crab

Population Dynamics

Comparison tables of two different model approaches could be done by

Life History Trait	Parameter	ADFG Value	Gmacs Value	Comments
Natural Mortality	M	Fixed	Fixed	M is fixed in both models

Fishery Dynamics

Specification	Parameter	ADFG Value	Gmacs Value	Comments
No. Fleets		5	5	

There are five separate fishing fleets accounted for in the ADFG model:

Comparison of Model Results

The results of the ADFG-BBRKC model are compared here to the results of the Gmacs-BBRKC model.

Gmacs Results

We need to be able to produce a table of the comparative likelihoods (by component) of the alternative models. For best practice, just try and do what we do with SS models for SESSF stocks anyway. See the pink link report, and enter a section for each of those, and see if we can emulate a report of that type.

In what follows, we demonstrate the use of the `gmr` package to process the output of the Gmacs-BBRKC model and produce plots that can be used in assessment reports.

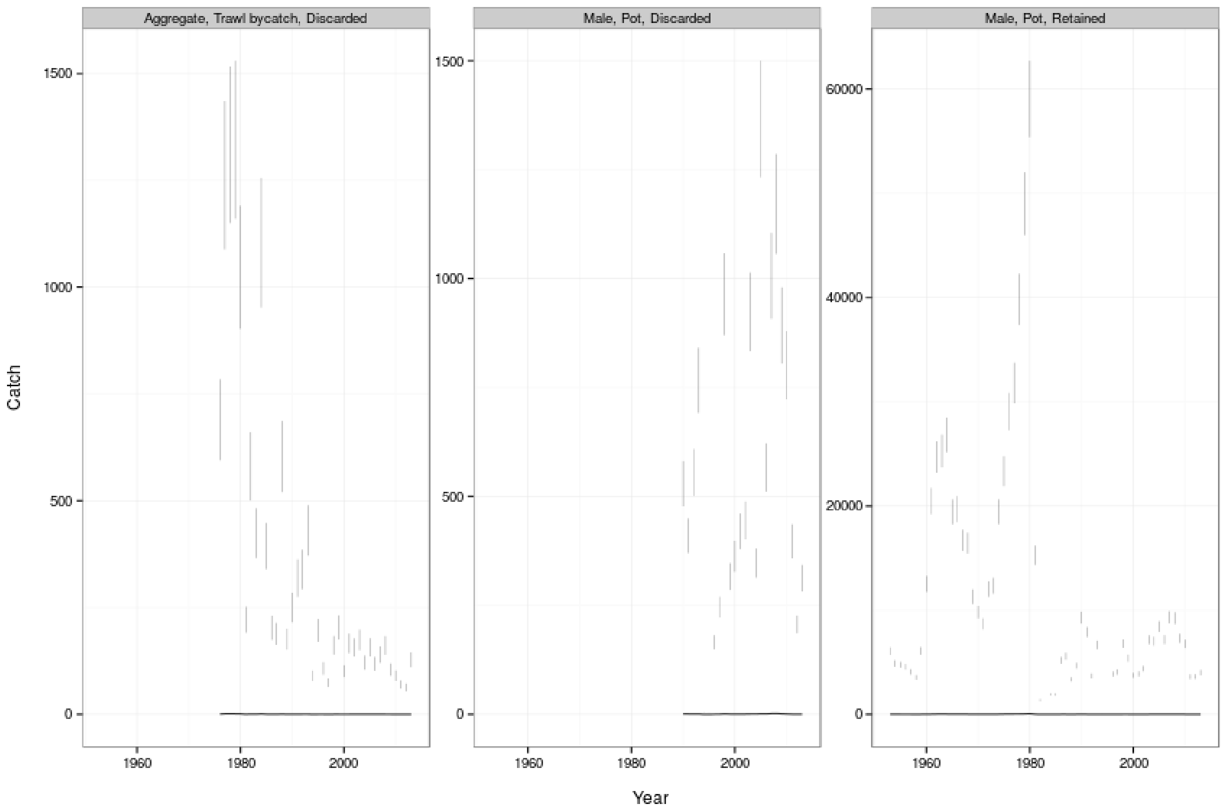


Figure 1: Catch.

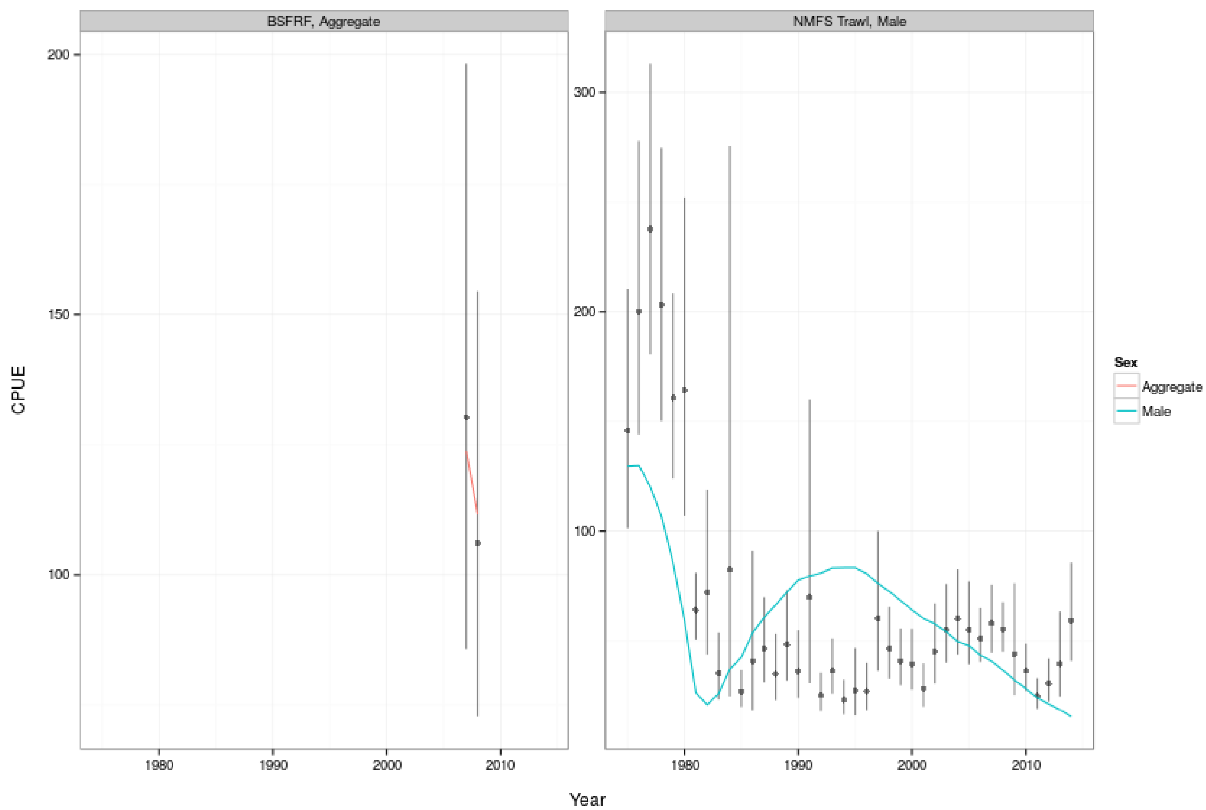


Figure 2: Survey biomass.

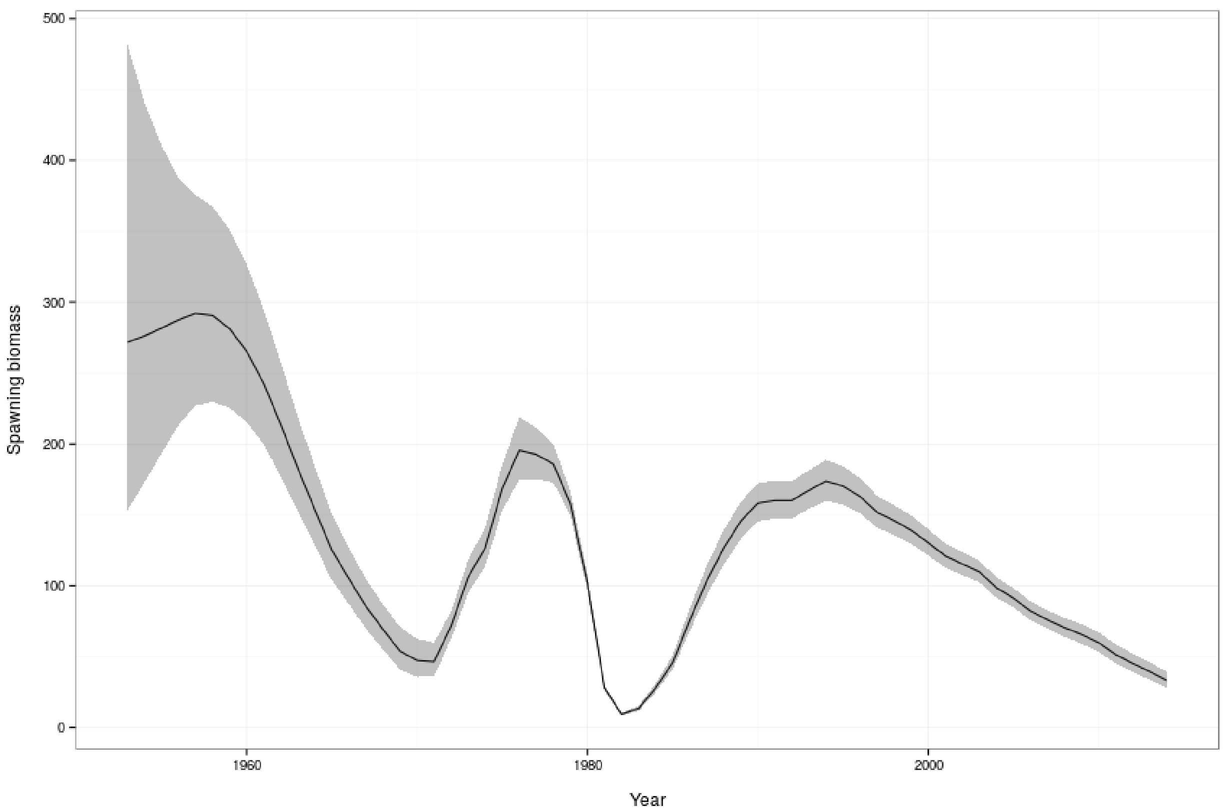


Figure 3: Spawning stock biomass.

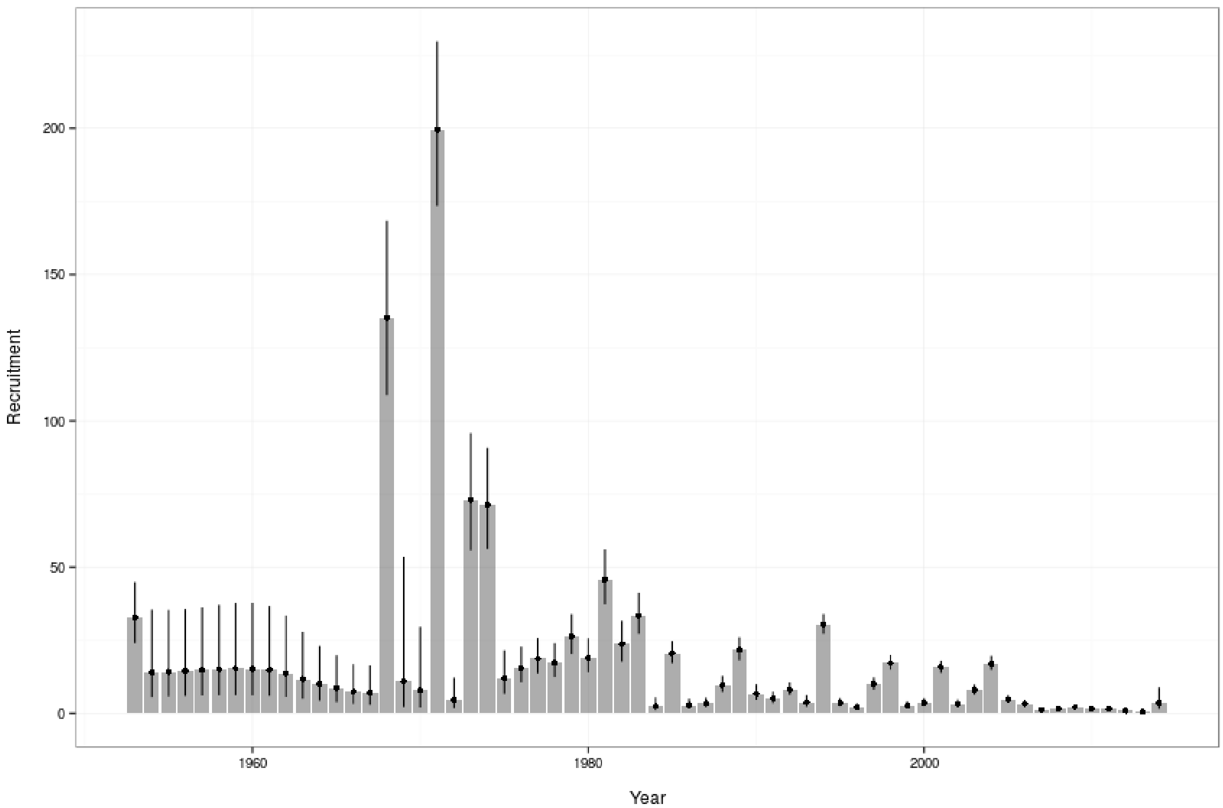


Figure 4: Recruitment.

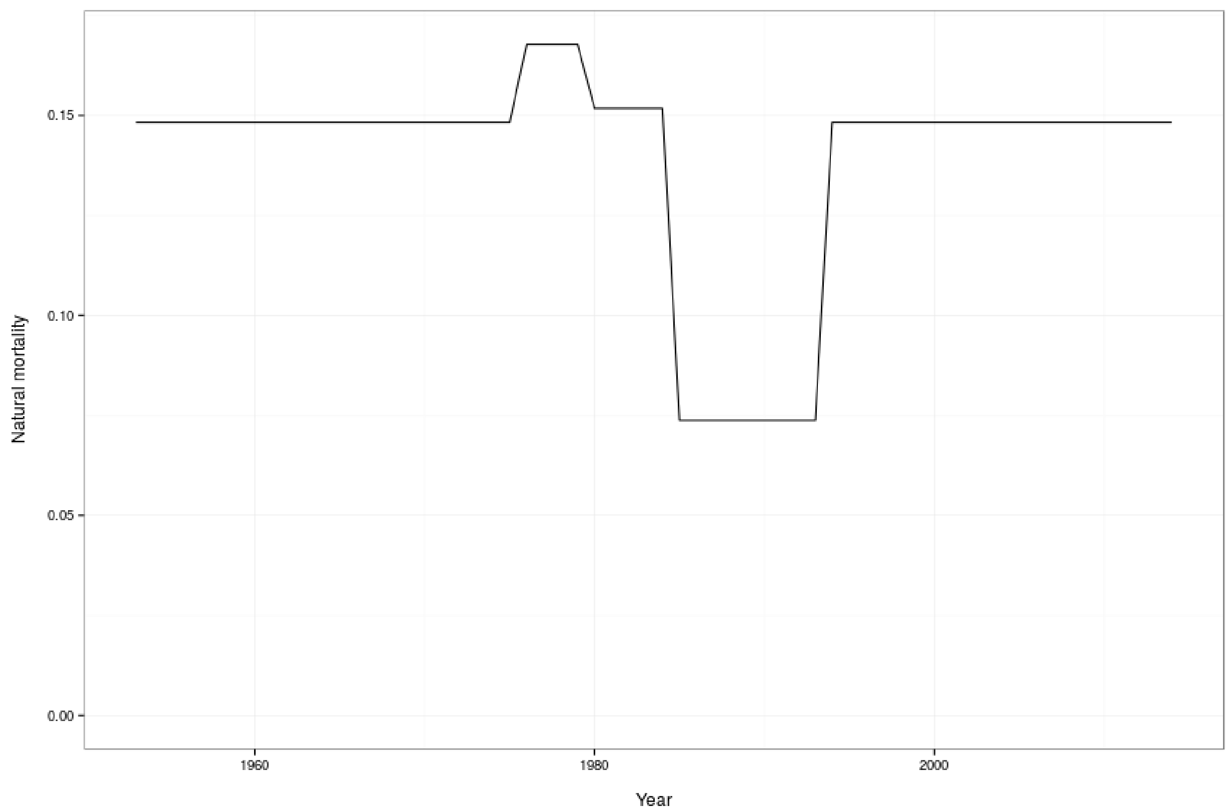


Figure 5: Time-varying natural mortality.

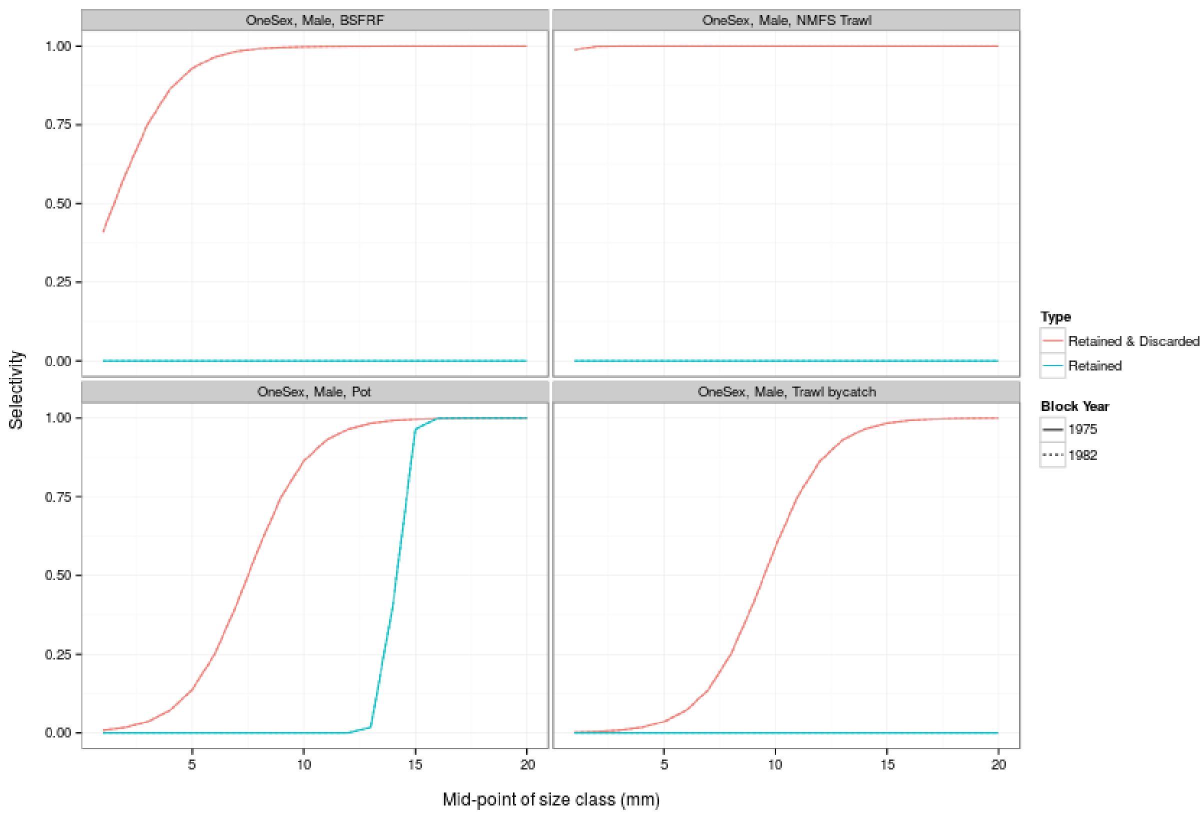


Figure 6: Selectivity.

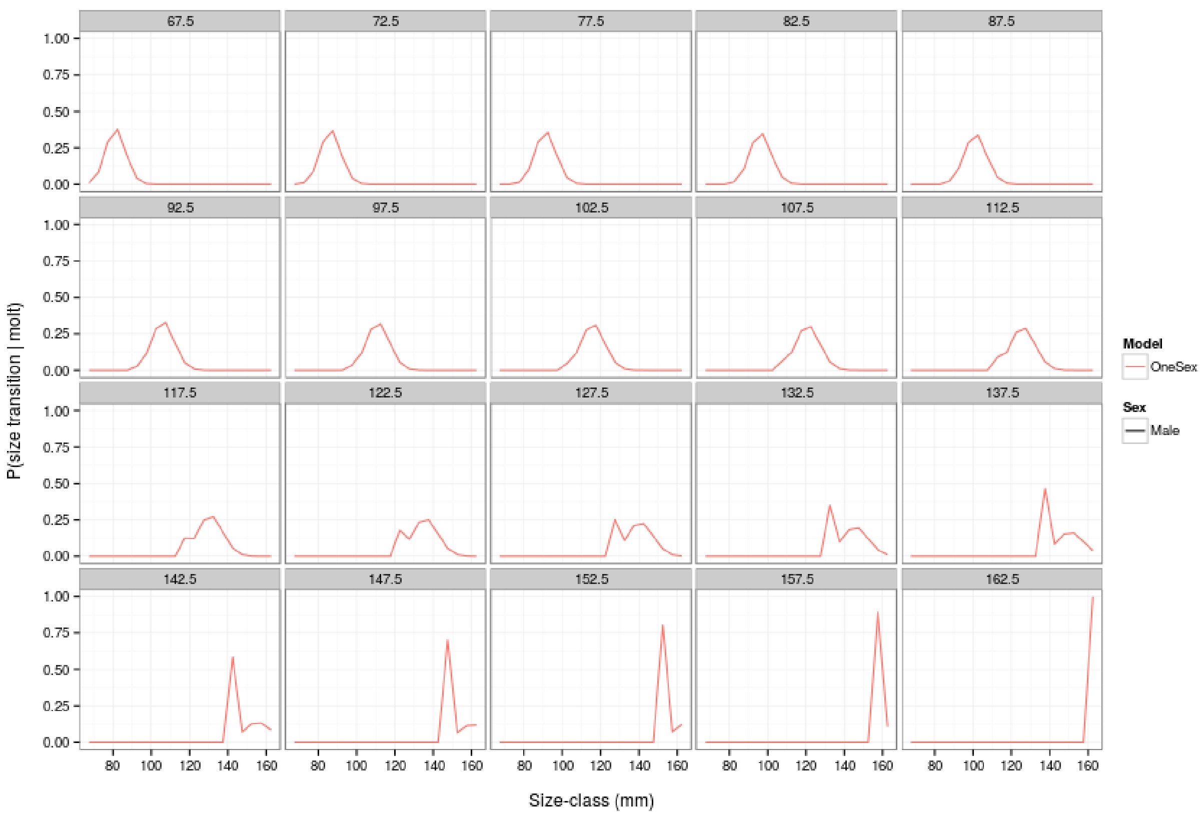


Figure 7: Probability of size transition.

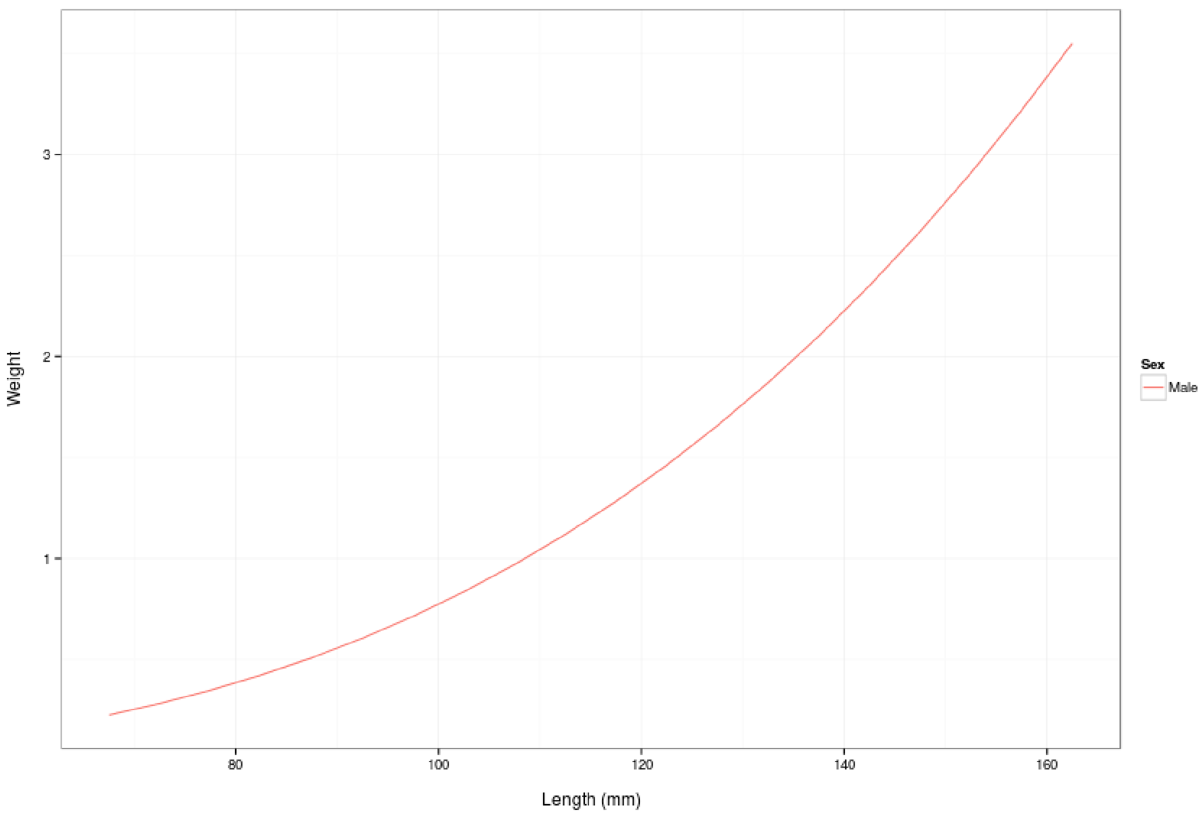


Figure 8: Relationship between length (mm) and weight (kg) by sex.

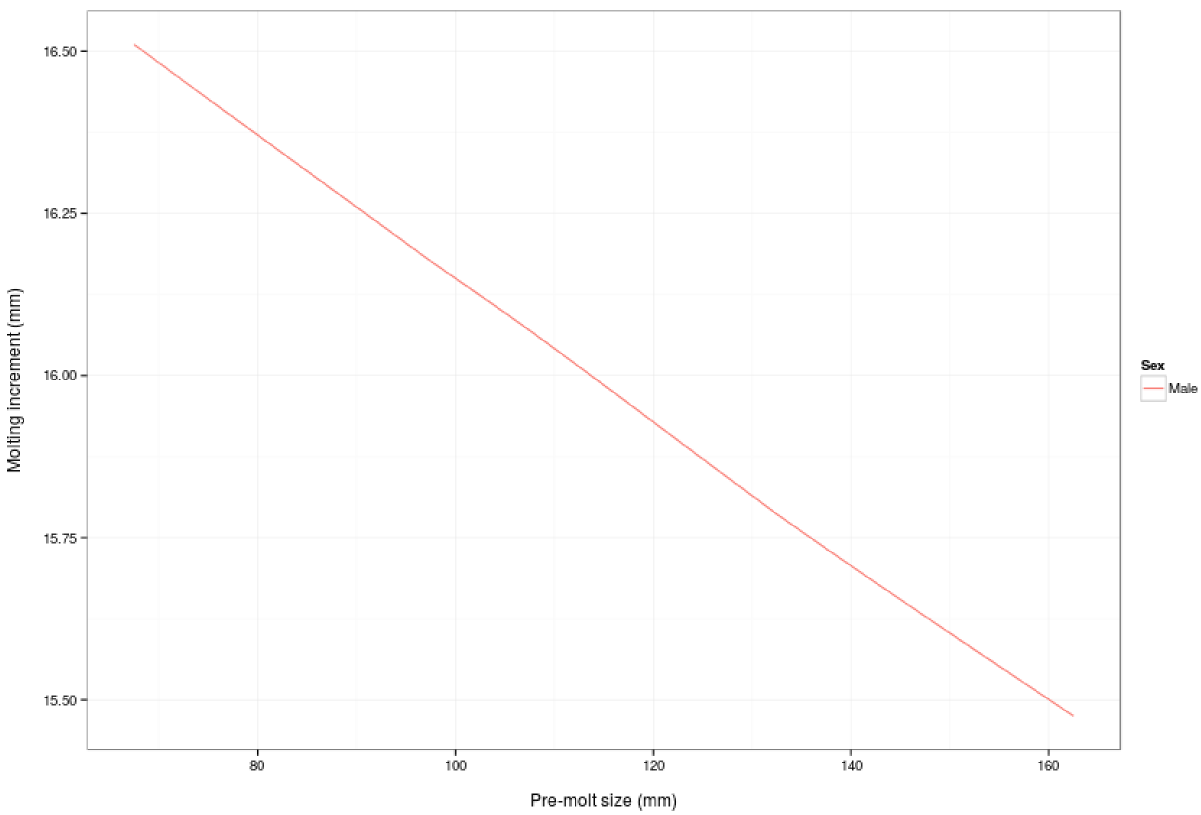
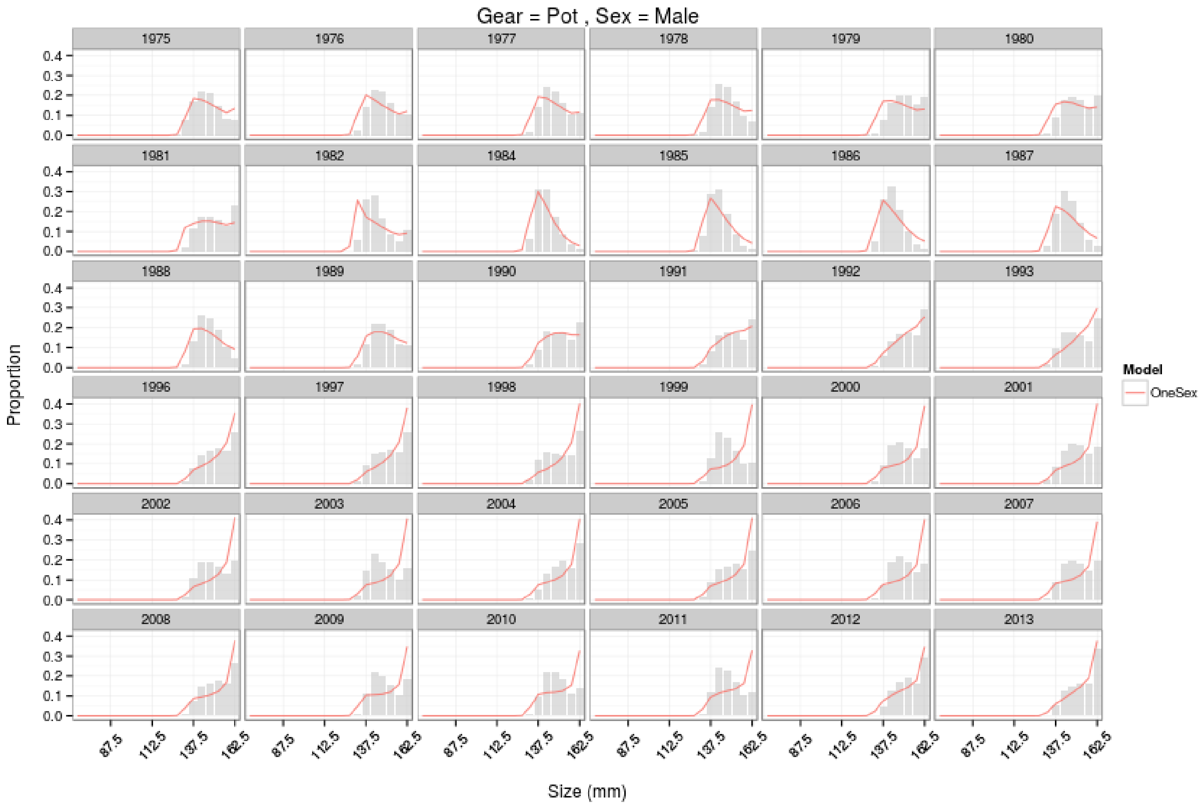
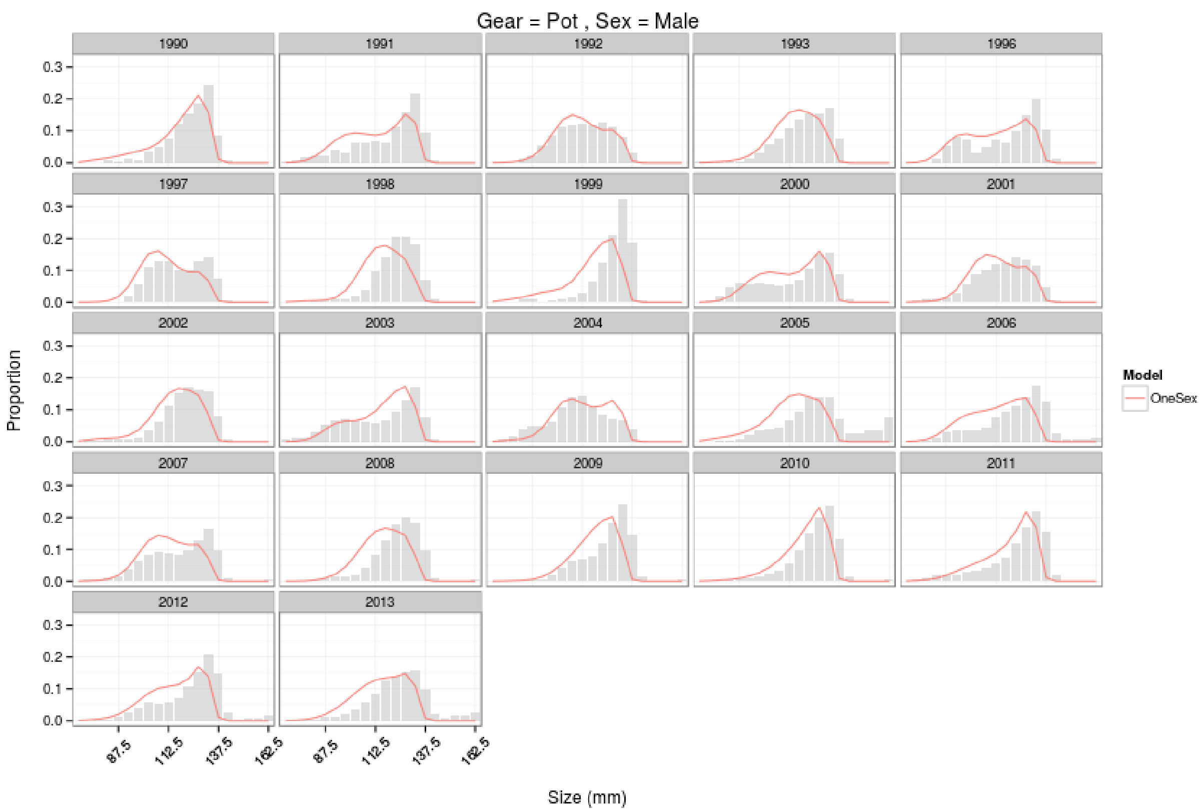


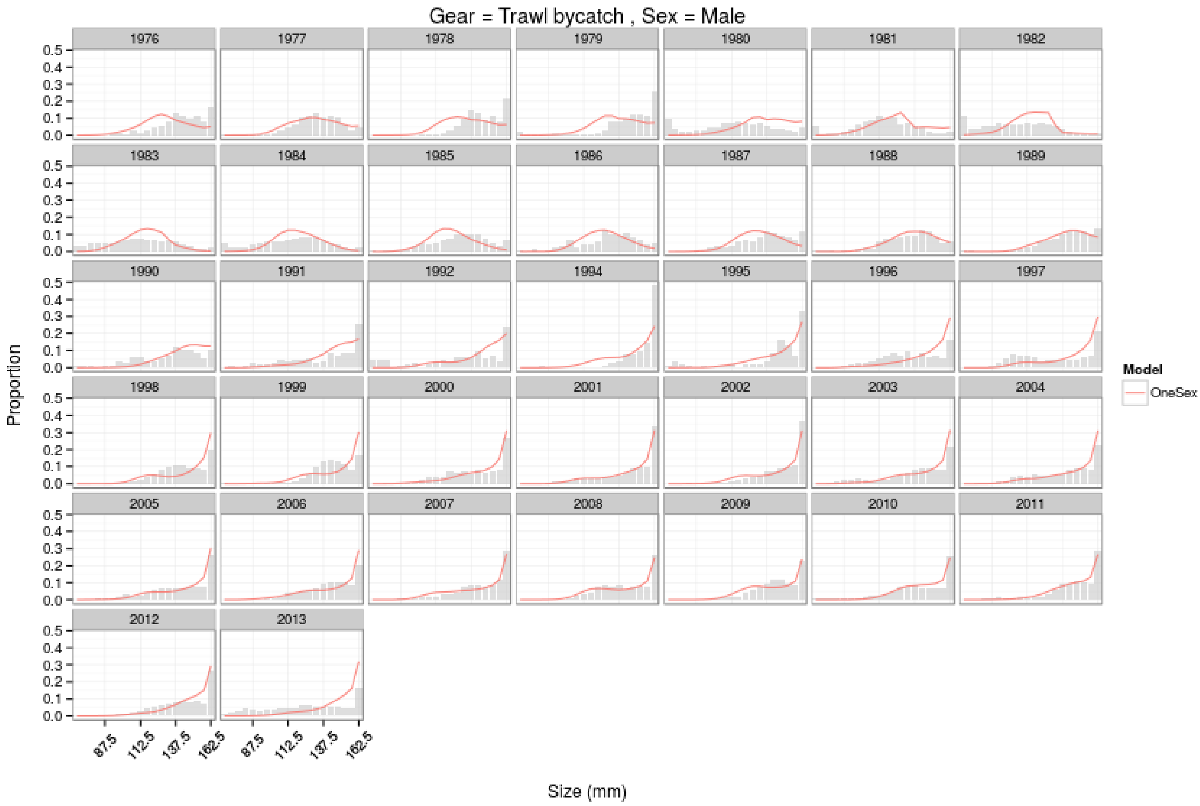
Figure 9: Growth increment.

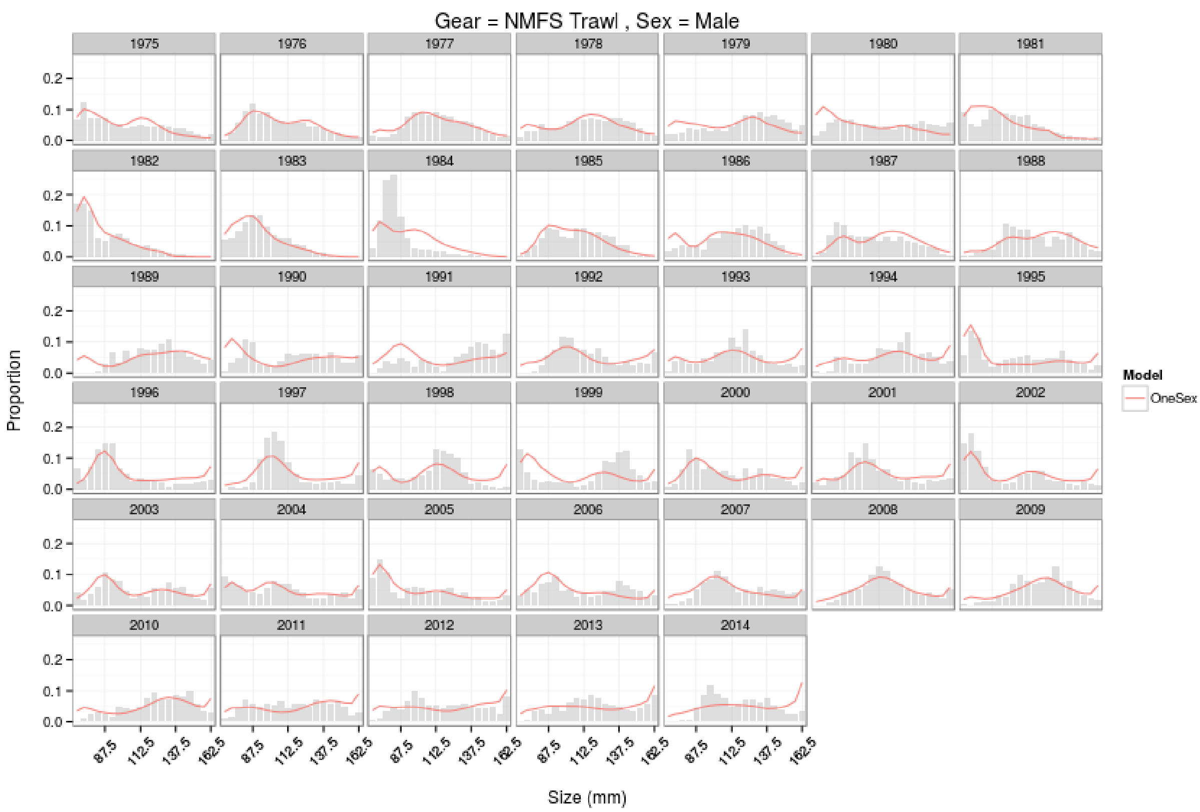


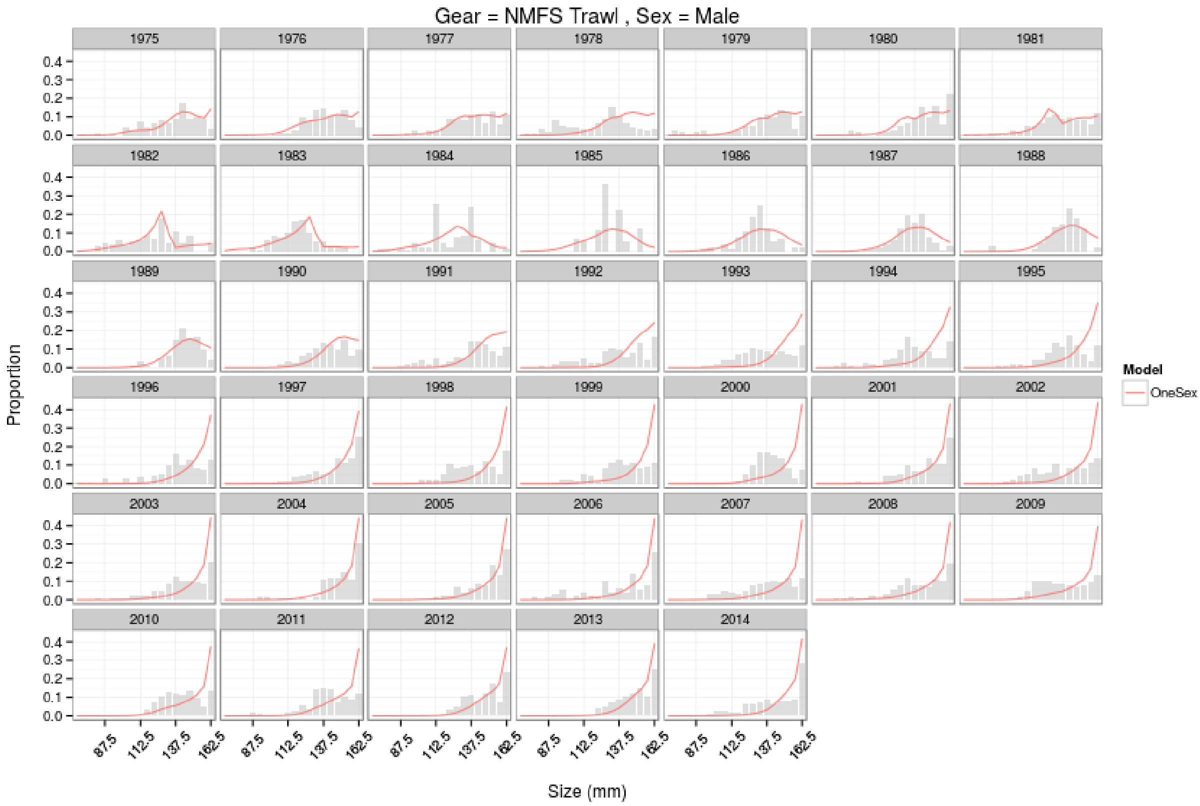
Gear = Pot , Sex = Male
1975
1976
1977
1978
1979
1980
1981
1982
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
0.0
0.1
0.2
0.3
0.4
Proportion
87.5
112.5
137.5
162.5
Size (mm)
Model
OneSex



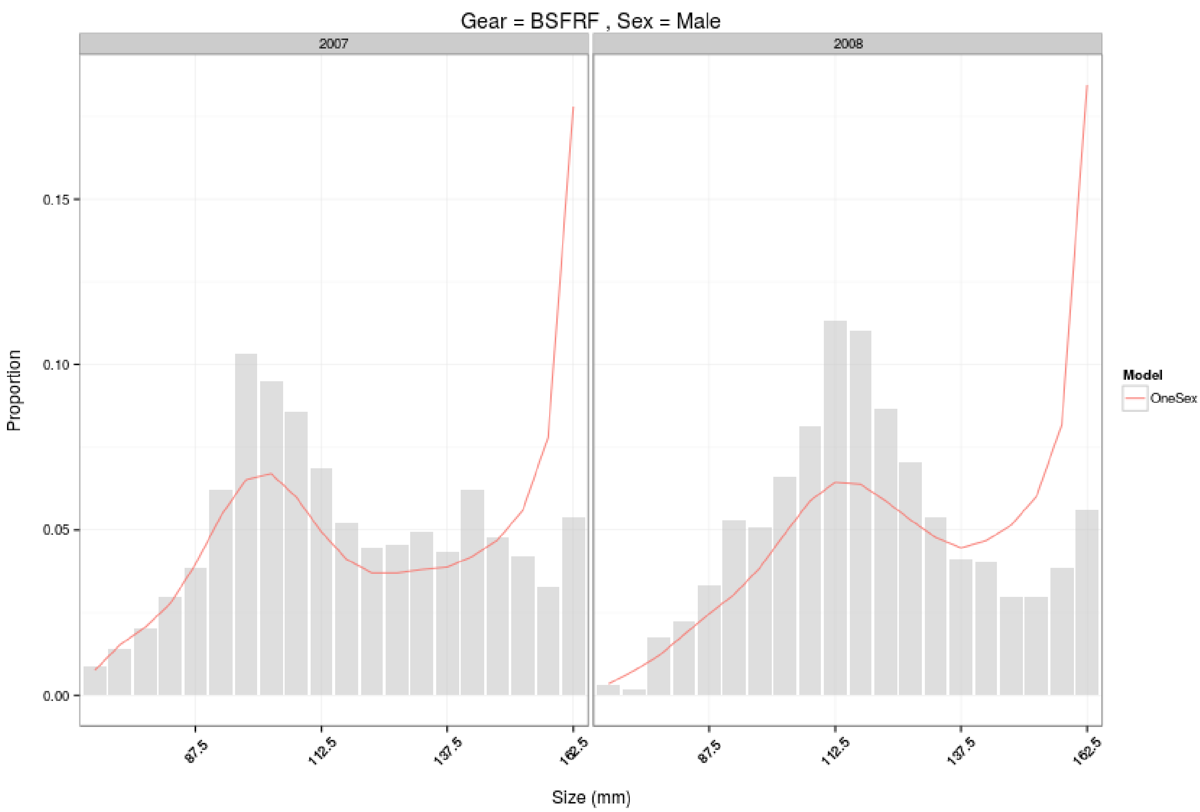
Gear = Pot , Sex = Male
1990
1991
1992
1993
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
0.0
0.1
0.2
0.3
Proportion
87.5
112.5
137.5
162.5
Size (mm)
Model
OneSex


Gear = Trawl bycatch , Sex = Male
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
0.5
0.4
0.3
0.2
0.1
0.0
Proportion
87.5
112.5
137.5
162.5
Size (mm)
Model
OneSex


Gear = NMFS Trawl , Sex = Male
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
0.2
0.1
0.0
Proportion
87.5
112.5
137.5
162.5
Size (mm)
Model
OneSex



Gear = NMFS Trawl , Sex = Male
Proportion
Size (mm)
Model
OneSex



Gear = BSFRF , Sex = Male
2007
2008
Proportion
Size (mm)
Model
OneSex

Comparison of Assessment Processes

File Description

- The `*.tpl` file is working, it builds and the `*.exe` file runs successfully.
- The main `*.dat` file is read in as expected (comments within).
- There is a second data file `rksize13s.dat` with sample sizes for various rows of size-comp data. See lines 81-87 of `*.tpl`.
- Input sample sizes appear to be capped to the constant numbers entered in the main data file under 'number of samples' or 'sample sizes' (variously).
- There is a third data file `tc7513s.dat` specifically for data from the tanner crab fishery (with red crab bycatch).
- There is a standard control file `*.ctl` with internal comments.
- There is an excel spreadsheet which can be used to read in the model output files and display related plots (it's a bit clunky).
- There are two batch files in the model directory: `clean.bat` and `scratch.bat`. The 'clean' batch file deletes files related to a single model run. The 'scratch' batch file deletes all files relating to the model build and leaves only source and data files.

Discussion

This discussion will focus on the challenges in developing a Gmacs version of the BBRKC model: those met, and those yet to be met.

References

Punt, A. E., T. Huang, and M. N. Maunder. 2013. "Review of Integrated Size-Structured Models for Stock Assessment of Hard-to-Age Crustacean and Mollusc Species." *ICES Journal of Marine Science* 70 (1) (January): 16–33. doi:10.1093/icesjms/fss185. http://icesjms.oxfordjournals.org/cgi/doi/10.1093/icesjms/fss185.

Zheng, J., and M.S.M Siddeek. 2014. "Bristol Bay Red King Crab Stock Assessment in Spring 2014." *Alaska Department of Fish and Game*: 149.