Appendix comparing aspects of gmacs configured to be similar to that of Zheng et al. 2014

The following summarizes the outcome of some comparisons between the existing Bristol Bay red king crab (BBRKC) stock assessment model [@zheng_bristol_2014] (Zheng et al. 2014) and an emulated version using the gmacs platform. Since the BBRKC model from Zheng et al. (2014) treats recruits by sex along with sex-specific natural mortality and fishing mortality, results from the male components are compared with results from a `gmacs` model implementation tuned to male-only data.

Size specific schedules

Mean weight-at-length

The mean weight-at-length (w_ℓ) of crabs is defined in grams and the carapace length (ℓ, CL) in mm. The mean weight-at-length used in both models is nearly identical (Figure 1). The only difference between the two models is in the final length class (160mm) where the mean weight is greater in Zheng's model than in gmacs.

The length-weight relationships used in Zheng's model for males and females were

$$W = 0.000408L^{3.127956} \quad \text{immature females,}$$
$$W = 0.003593L^{2.666076} \quad \text{ovigerous females,}$$
$$W = 0.0004031L^{3.141334} \quad \text{males.}$$

Initial recruitment size distribution

Gmacs was configured to match the Zheng et al. (2014) model closely and this was achieved (Figure 2).

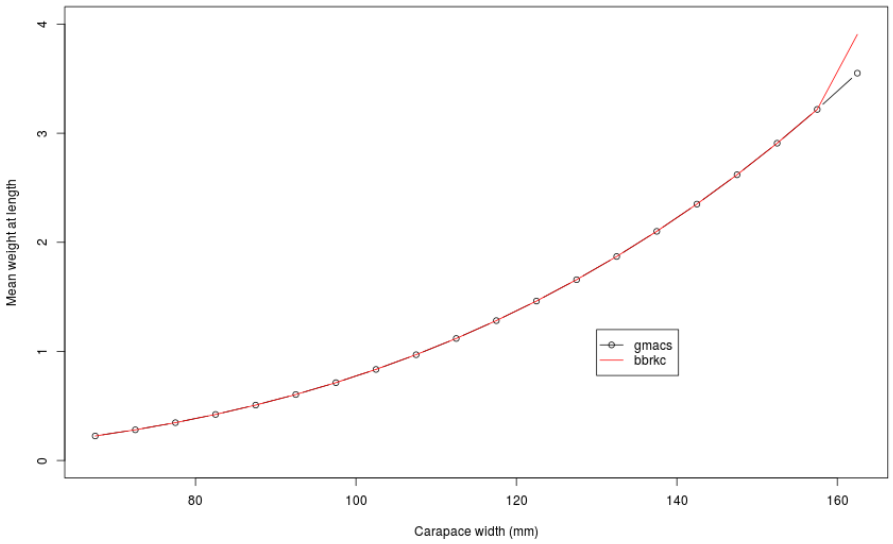


Figure 1: Mean weight-at-length.

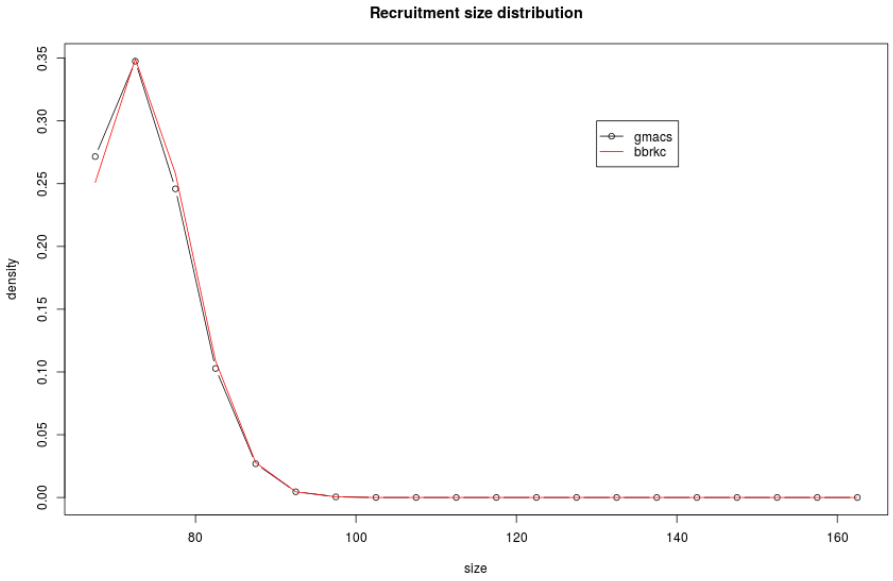


Figure 2: Length at recruitment.

Molting increment width

Options to fit relationship based on data was developed but for the BBRKC system, a size-specific vector was used to determine molt increments as show below (Figure 3).

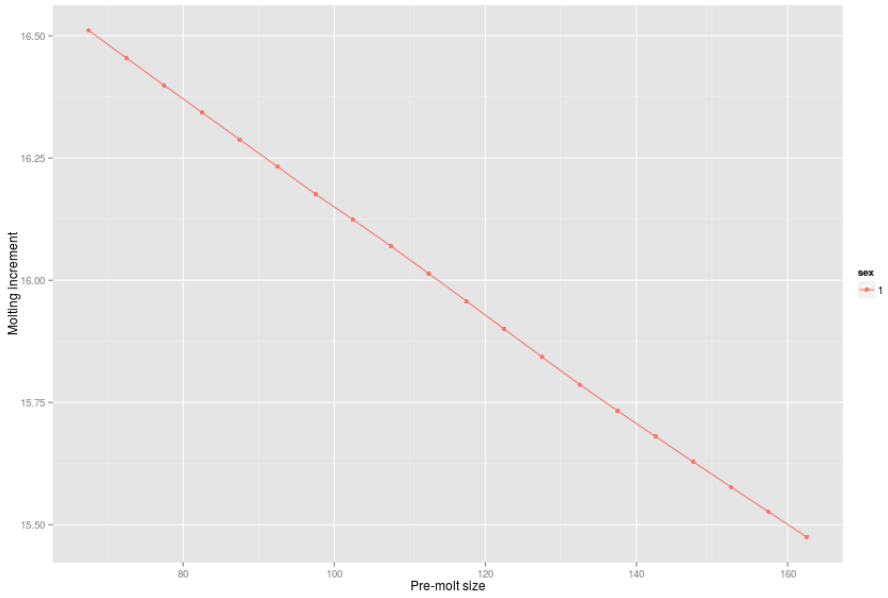


Figure 3: Growth increment.

Molting probability

Fixed parameters in gmacs were easily set to represent that assumed from Zheng et al. (2014) (Figure 4).

Transition processes

The first set of figures is the growth probabilities (for all crabs that molt) (Figure 5).

The second set of figures is the combination of growth and molting and represents the size transition (Figure 6).

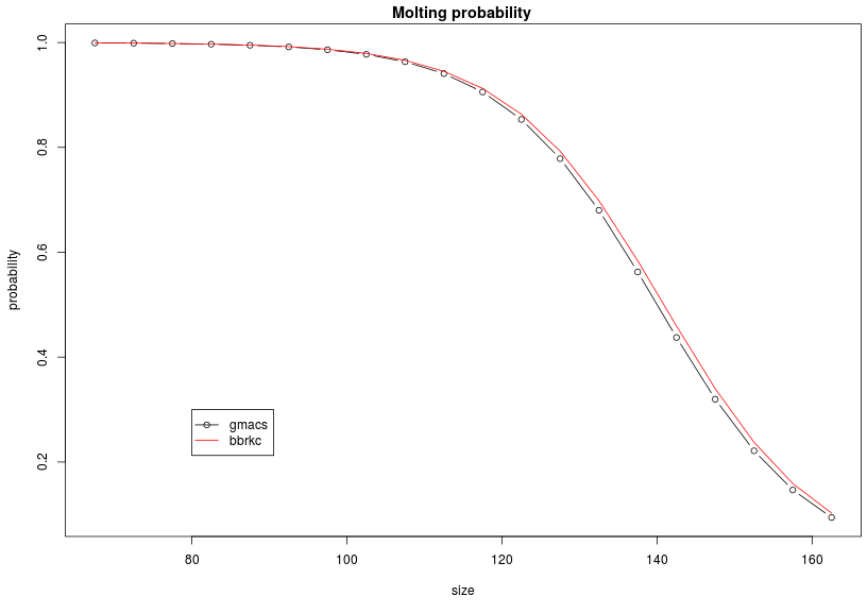


Figure 4: Molting probability.

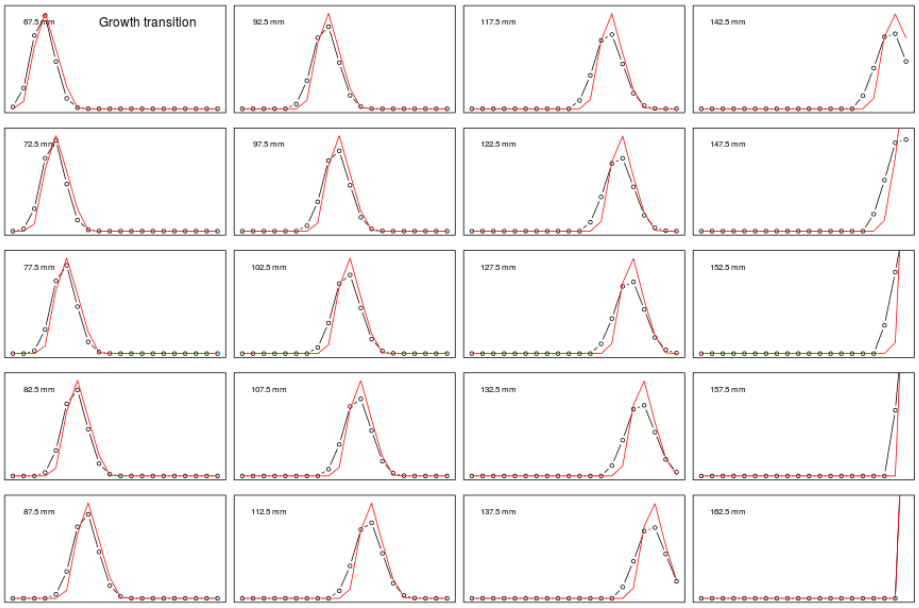


Figure 5: Growth transitions.

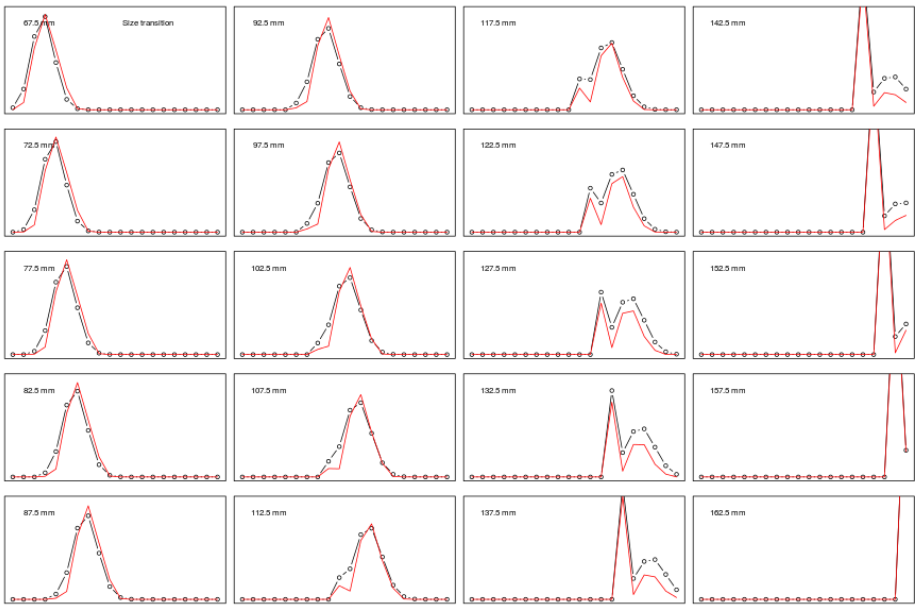


Figure 6: Growth transitions.

Numbers at length in 1975

The scale of these results differ significantly and may be related to the interaction with natural mortality estimates and how the initial population-at-lengths were established (the BBRKC model assumes all new-shell) (Figure 7).

Time series results/comparisons

Natural mortality

The figure below illustrates implementation of four step changes in M_t (freely estimated) in gmacs relative to the estimates from Zheng et al. 2014 (Figure 8).

Recruitment

Recruitment patterns are similar, but differences in natural mortality schedules will affect these matches. The figure below plots the values to have the same mean (Figure 9).

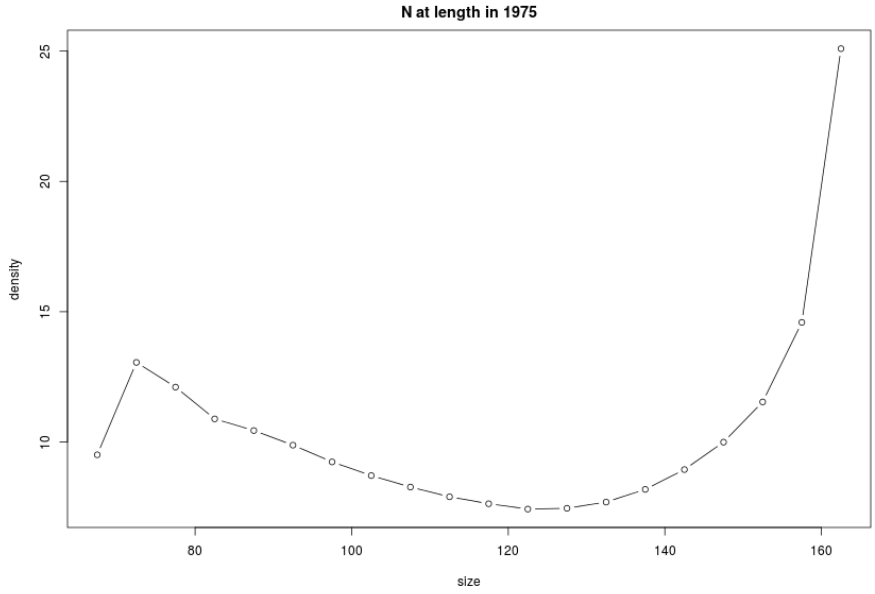


Figure 7: Initial numbers.

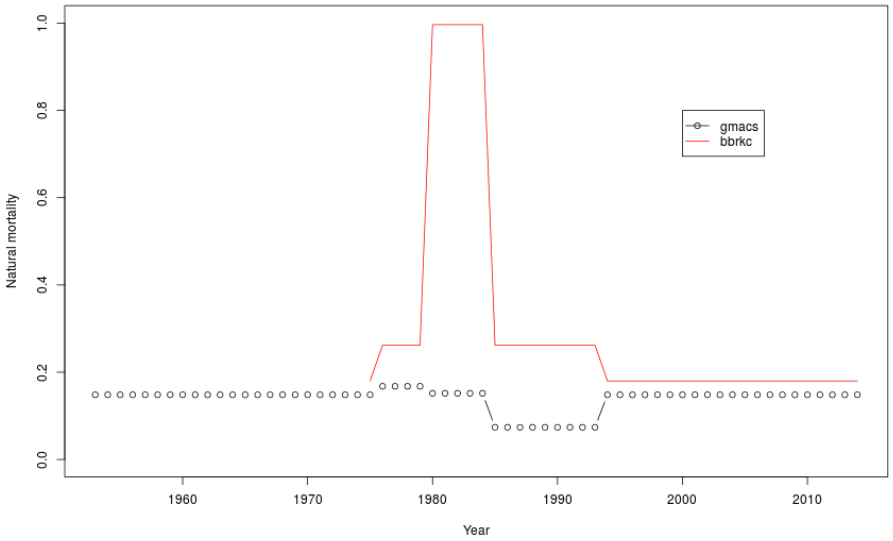


Figure 8: Time-varying natural mortality.

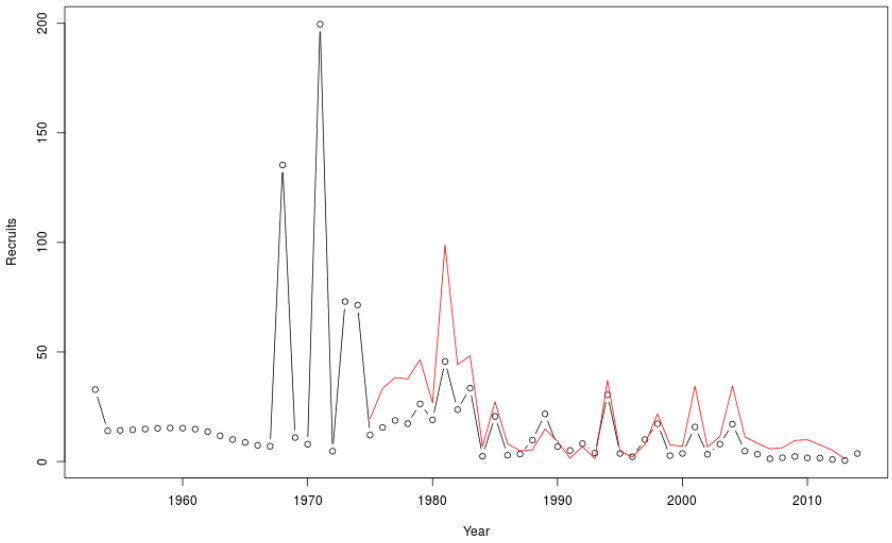


Figure 9: Recruitment (R_t).

Fit to survey abundance indices

The model fit to survey biomass (males) was better for the current model (at least visually) than for the current implementation of gmacs (Figure 10).

Estimated retained catch and discards, for whole period

This figure summarizes the observed (horizontal) and predicted (vertical) catches by gear type. Data for discard fisheries were read in with 100% mortality (as clarified in Table 1 of Zheng et al. 2014) (Figure 11).

Other diagnostics

Fit to size frequency data

The subsequent figures provide fits to the male BBRKC data based on gmacs (Figure **??**).

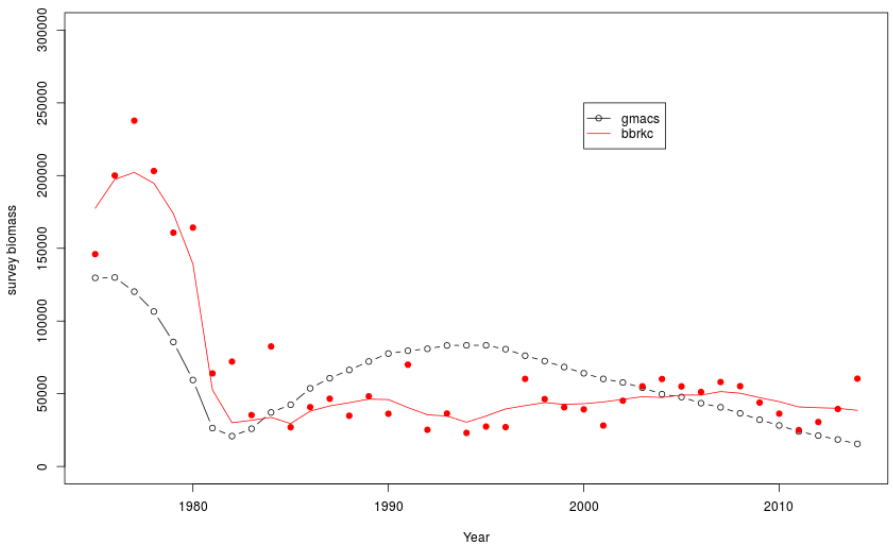


Figure 10: Survey biomass.

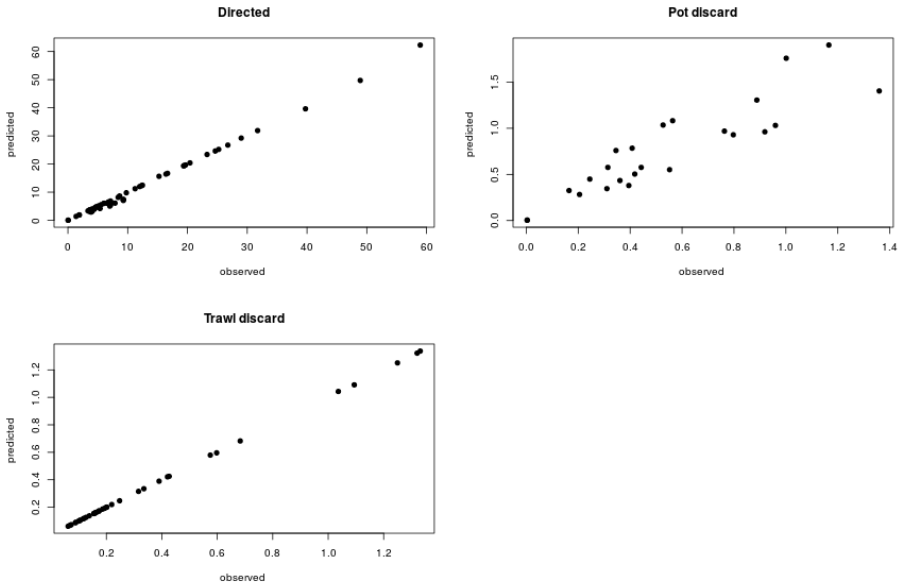
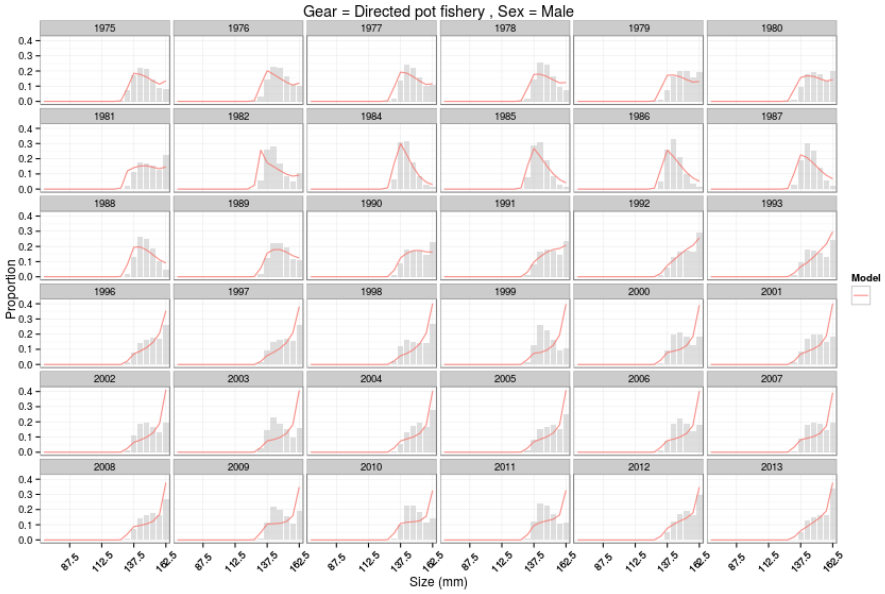
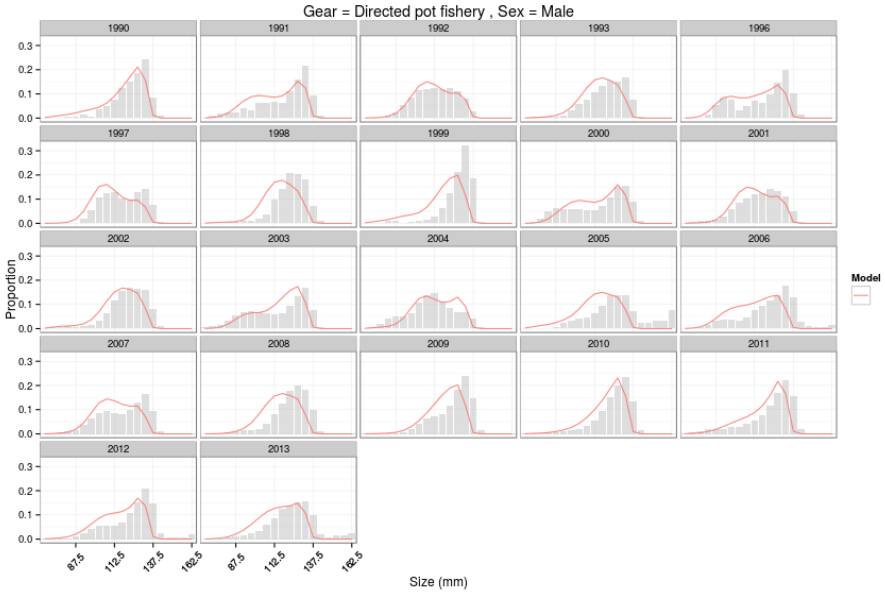
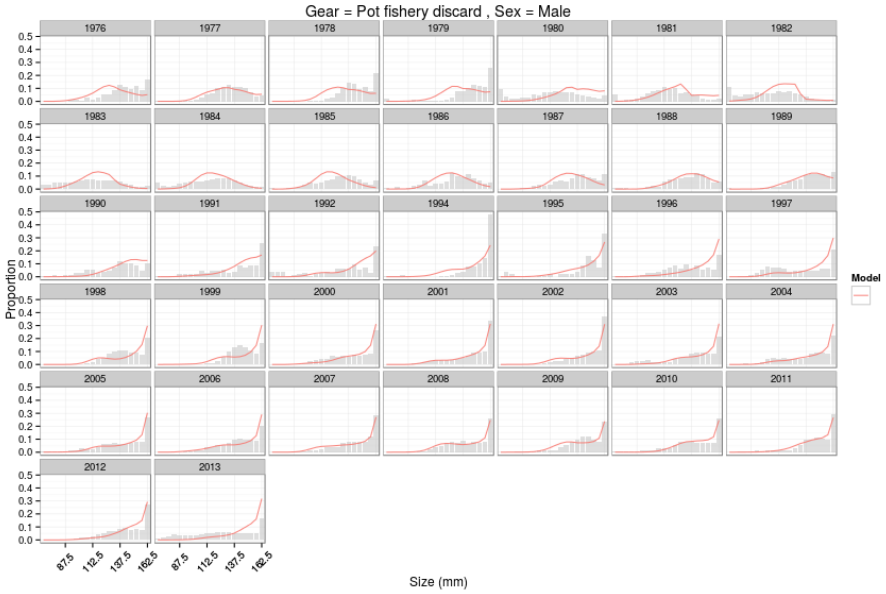
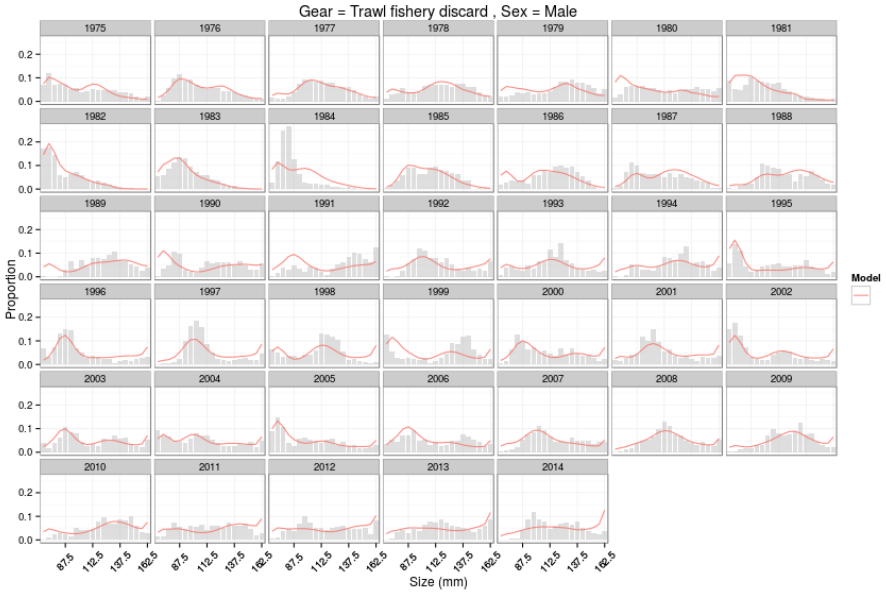


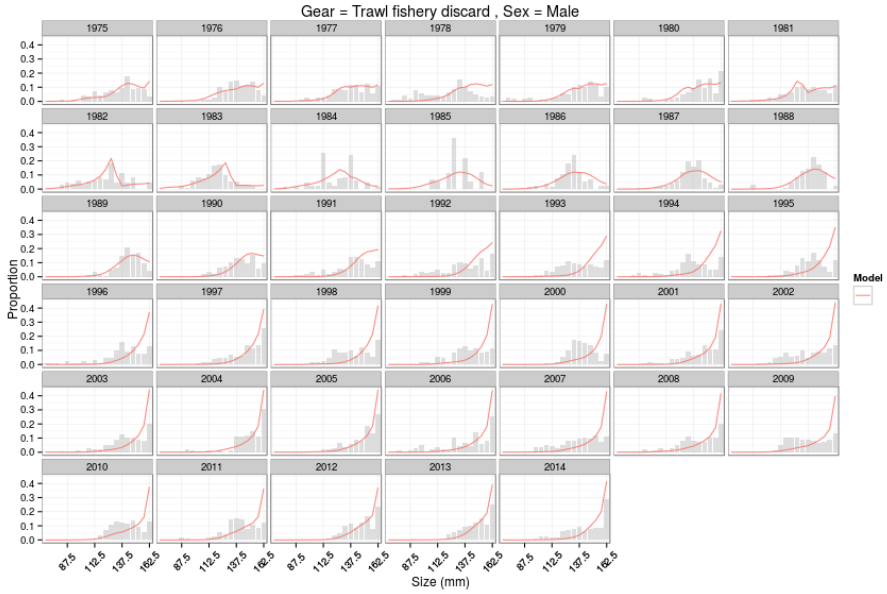
Figure 11: Fit to catch.

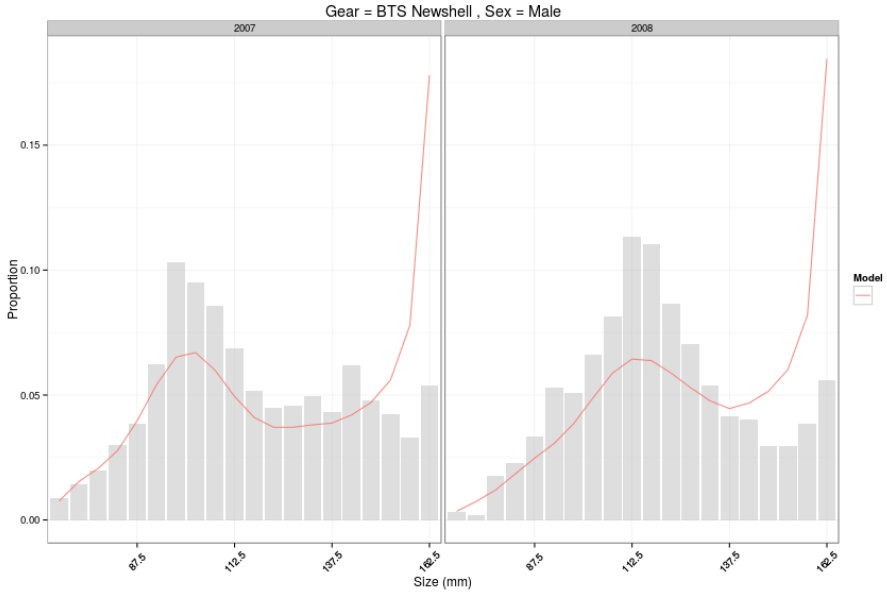

Gear = Directed pot fishery , Sex = Male
1975
1976
1977
1978
1979
1980
1981
1982
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Proportion
0.0
0.1
0.2
0.3
0.4
87.5
112.5
137.5
162.5
Size (mm)
Model


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


Gear = Pot fishery discard , 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
Proportion
0.0
0.1
0.2
0.3
0.4
0.5
87.5
112.5
137.5
162.5
Size (mm)
Model


Gear = Trawl fishery discard , 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
Proportion
0.0
0.1
0.2
87.5
112.5
137.5
162.5
Size (mm)
Model





Summary

Comparisons of actual likelihood function values and year-specific fits using the robust-multinomial would be the next step after selectivity issues are resolved. Subsequent to that, it would be worth exploring aspects of alternative model

specifications (e.g., constant natural mortality over time, time-varying selectivity, etc) to evaluate sensitivities.

References