

MFCL vs SS3

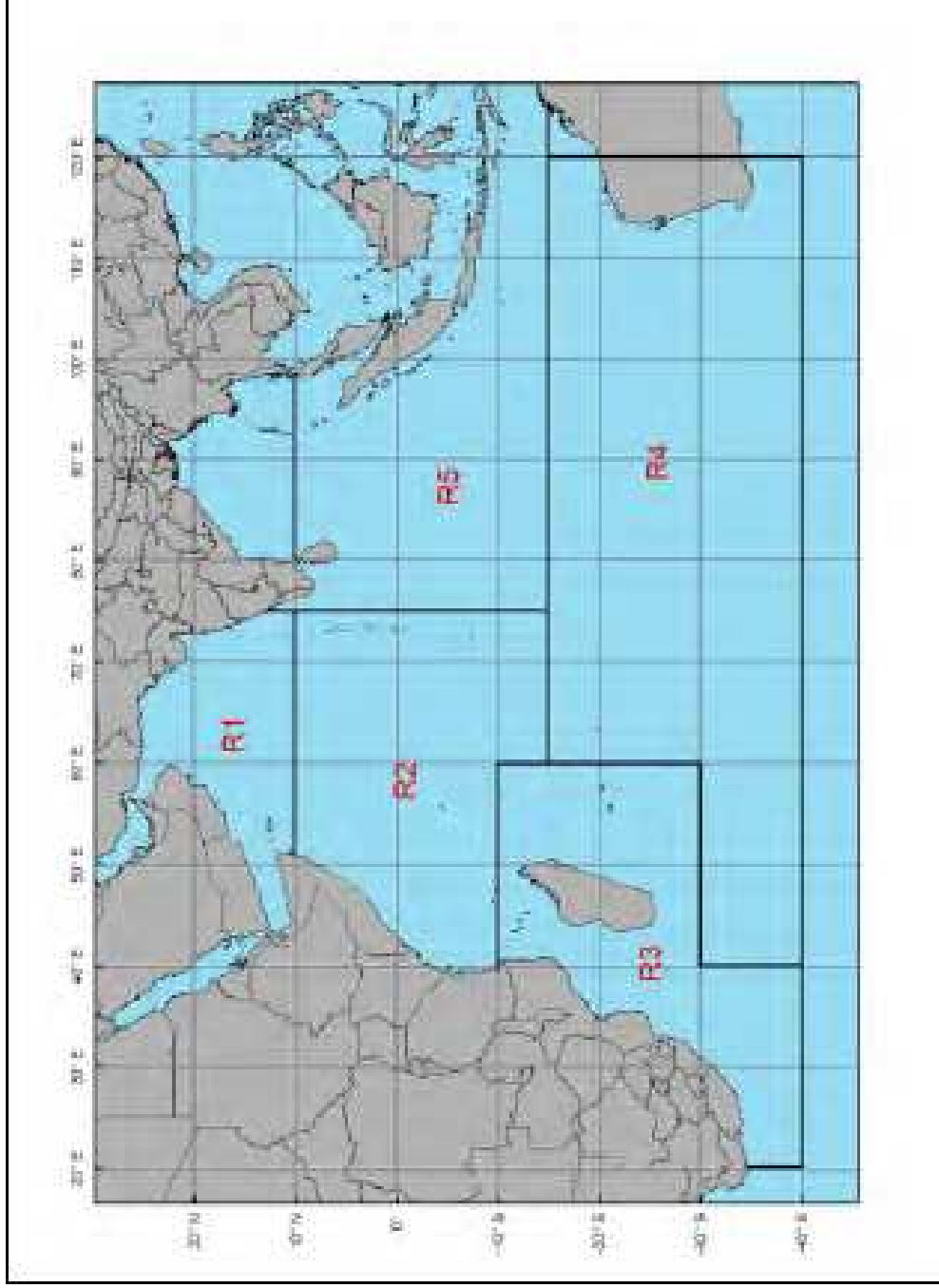
A comparison of the 2010 Indian Ocean yellowfin tuna assessment

Adam Langley

Introduction

- Application of SS3 for tuna assessments.
- Regional structure, multiple fisheries, movement dynamics, tagging data, fishery catch-at-length data.
- Translate 2010 YFT IO MFCL assessment into SS3 format (model structure, data sets, priors, penalties/weighting).
- SS3 model performance (efficiency, convergence, etc).
- Comparison of main model outputs.
- Comparability of outputs (MSY definitions, etc).
- Acknowledgements. Rick Methot and Ian Taylor.

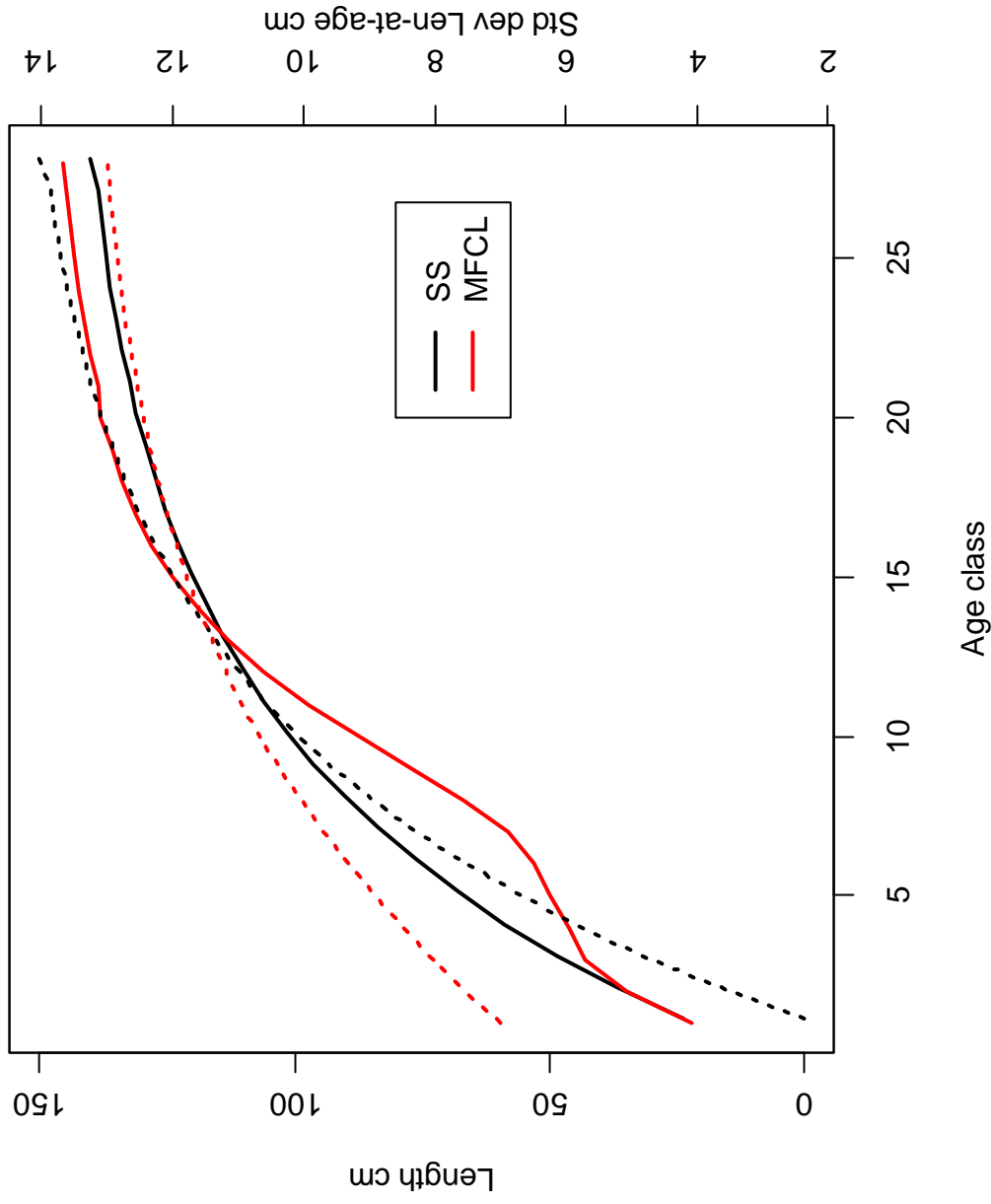
Spatial structure



Key structural assumptions

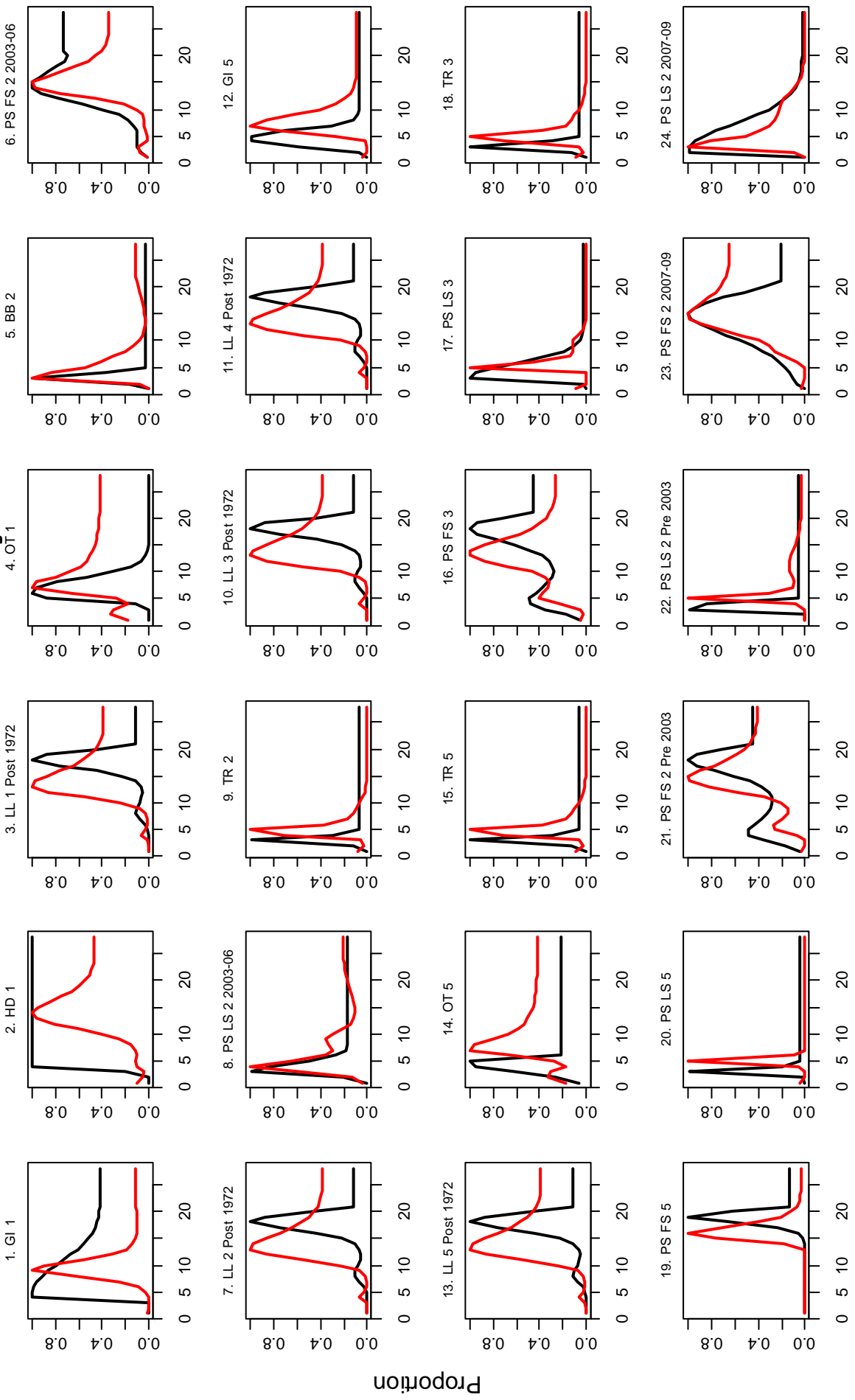
- Fixed natural mortality, growth, steepness (0.7).
- Growth – SS lacks flexibility of MFCL.
- Selectivity – modal structure can not be adequately fitted with double normal. Most problematic for PS FS fisheries. Cubic splines (new feature in SS).
- Initial F_s (fixed SS, estimated MFCL).
- Total recruit deviates 1972-2008
- Regional recruitment deviates (1977-2006).
- Tag reporting rates.
- LL CPUE share q among regions.
- SS catch equation $F_method\ 3=hybrid$
- (SS model option `prelim16`)

Growth



Can not duplicate the MFCL growth pattern in SS.

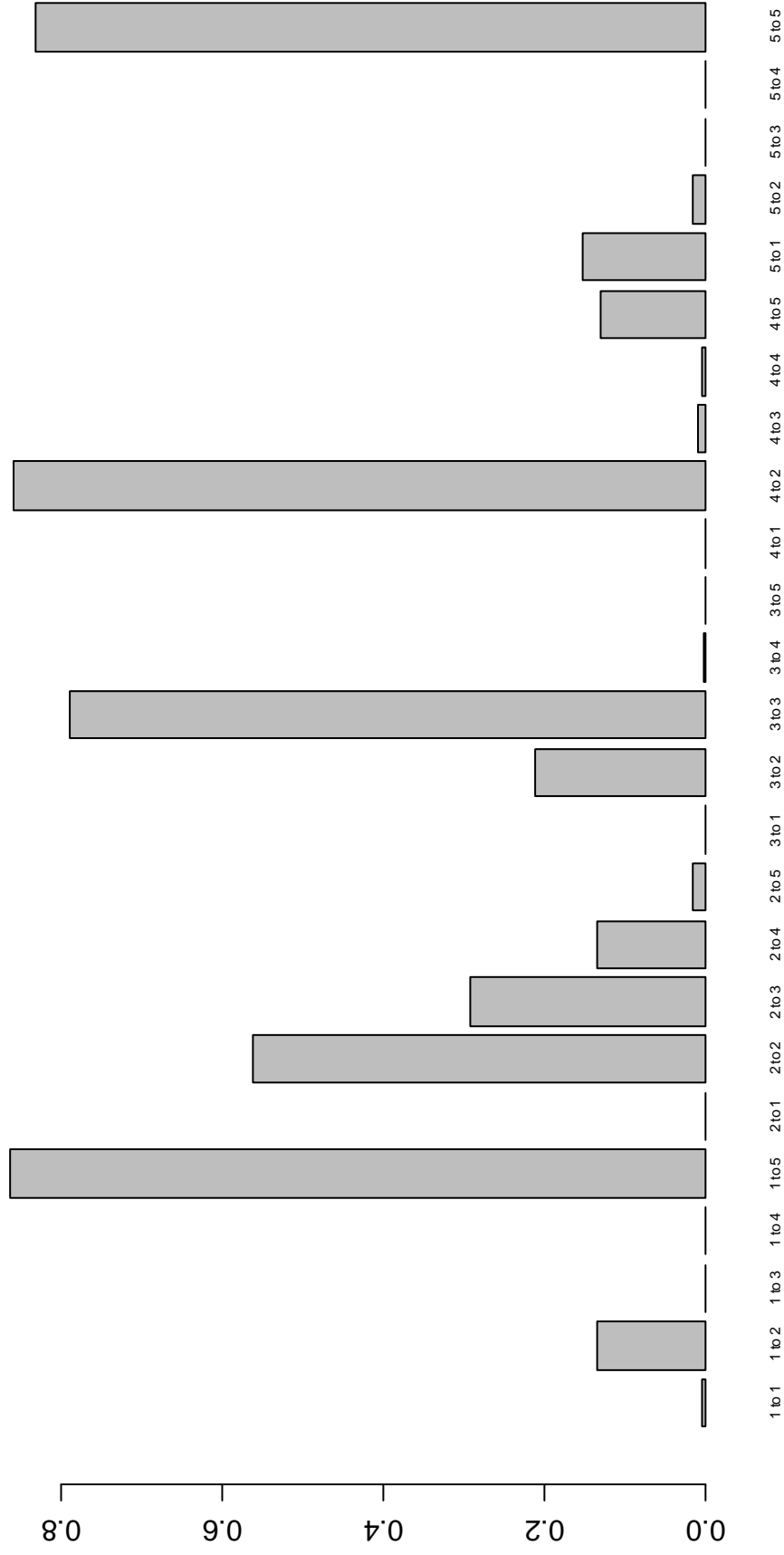
Selectivity



SS selectivity shifted to younger fish due to different growth (mean length-at-age).

SS cubic spline (5 node) for LL and PS FS, others double normal. Need to resolve problems

Movement coefs



Differences in parameterisation – SS not seasonal, recruit at 0 age, ramp (0,1 ages).
SS high movement from 3 to 2 and 2 to 3 – consistent with MFCL.
Recruitment in region 4 moving to 2 (differs from MFCL).

Movement - MFCL

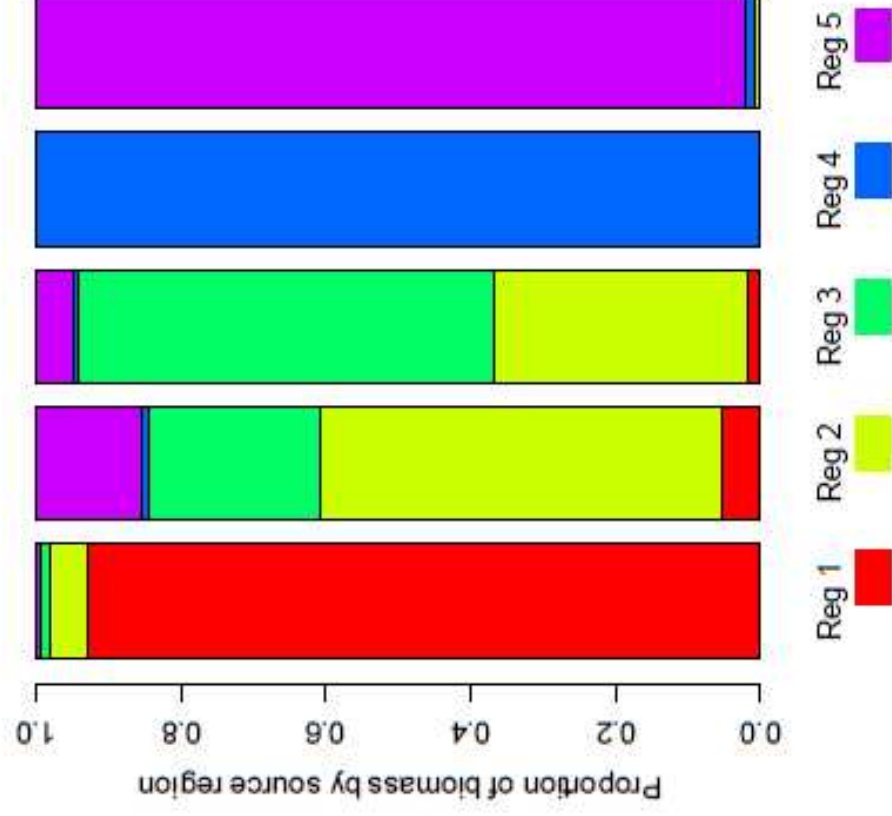
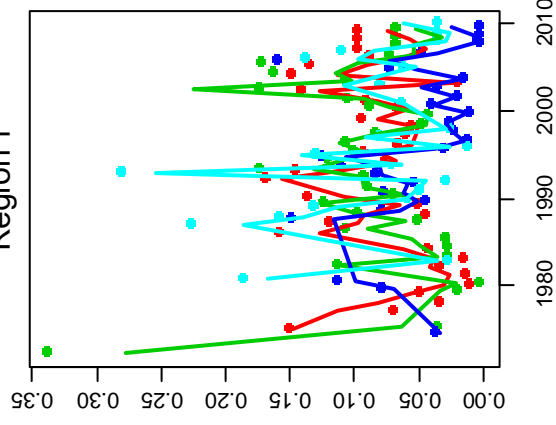


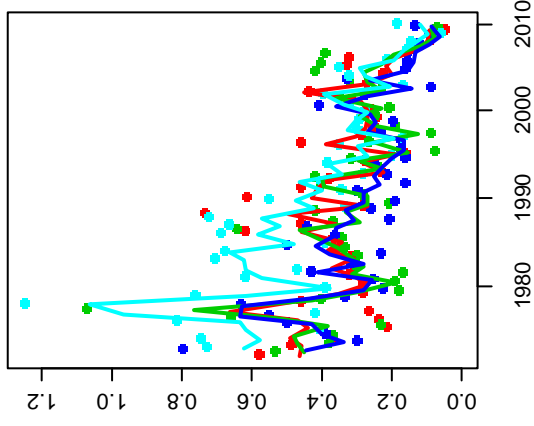
Figure 64. Proportional distribution of total YFT biomass (by weight) in each region (Reg 1–5) apportioned by the source region of the fish. The colour of the home region is presented below the corresponding label on the x-axis. The biomass distributions are calculated based on the long-term average distribution of recruitment among regions, estimated movement parameters, and natural mortality. Fishing mortality is not taken into account.

LL CPUE indices

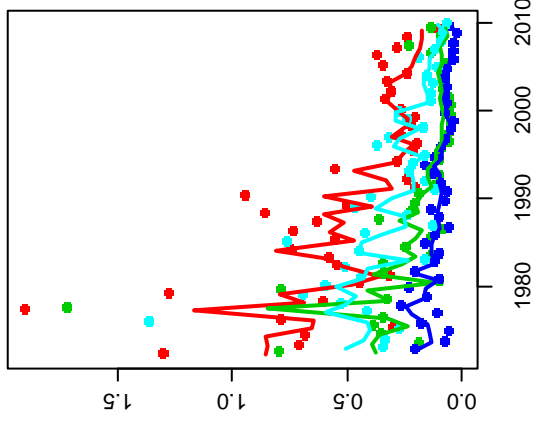
Region 1



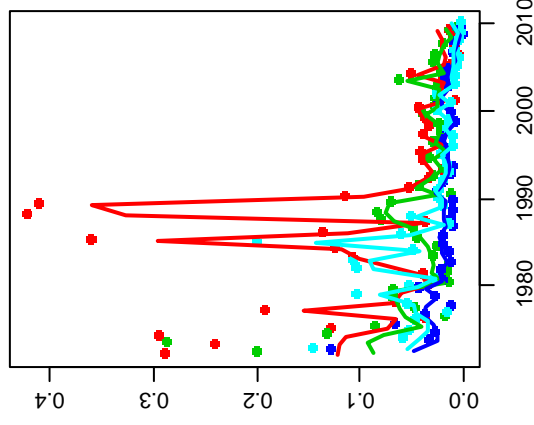
Region 2



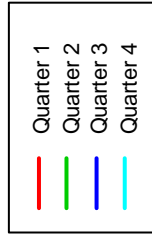
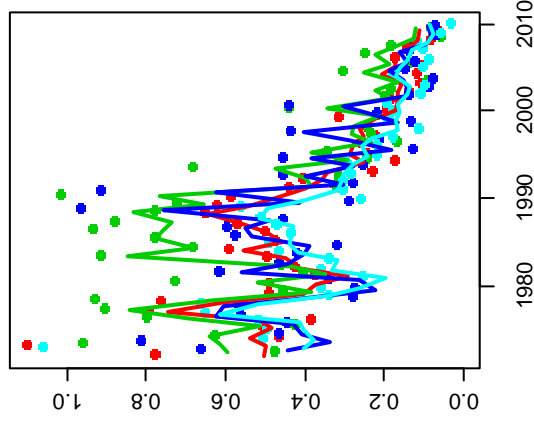
Region 3



Region 4

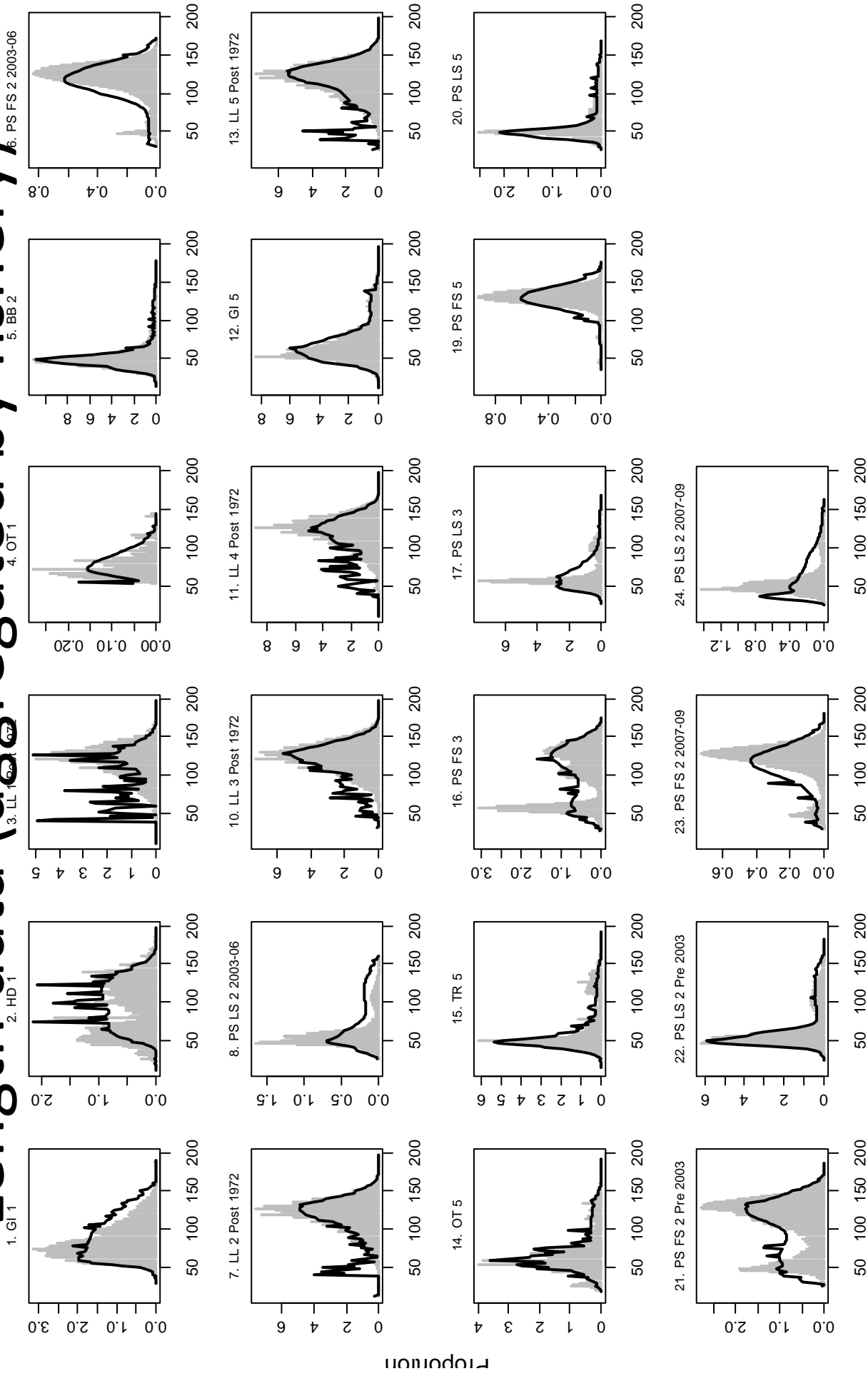


Region 5



MFCL has seasonal catchability deviates. Incorporated seasonal catchability in SS model by splitting LL CPUE index by season.

Length data (aggregated by fishery)



MFCL Length data (aggregated by fishery)

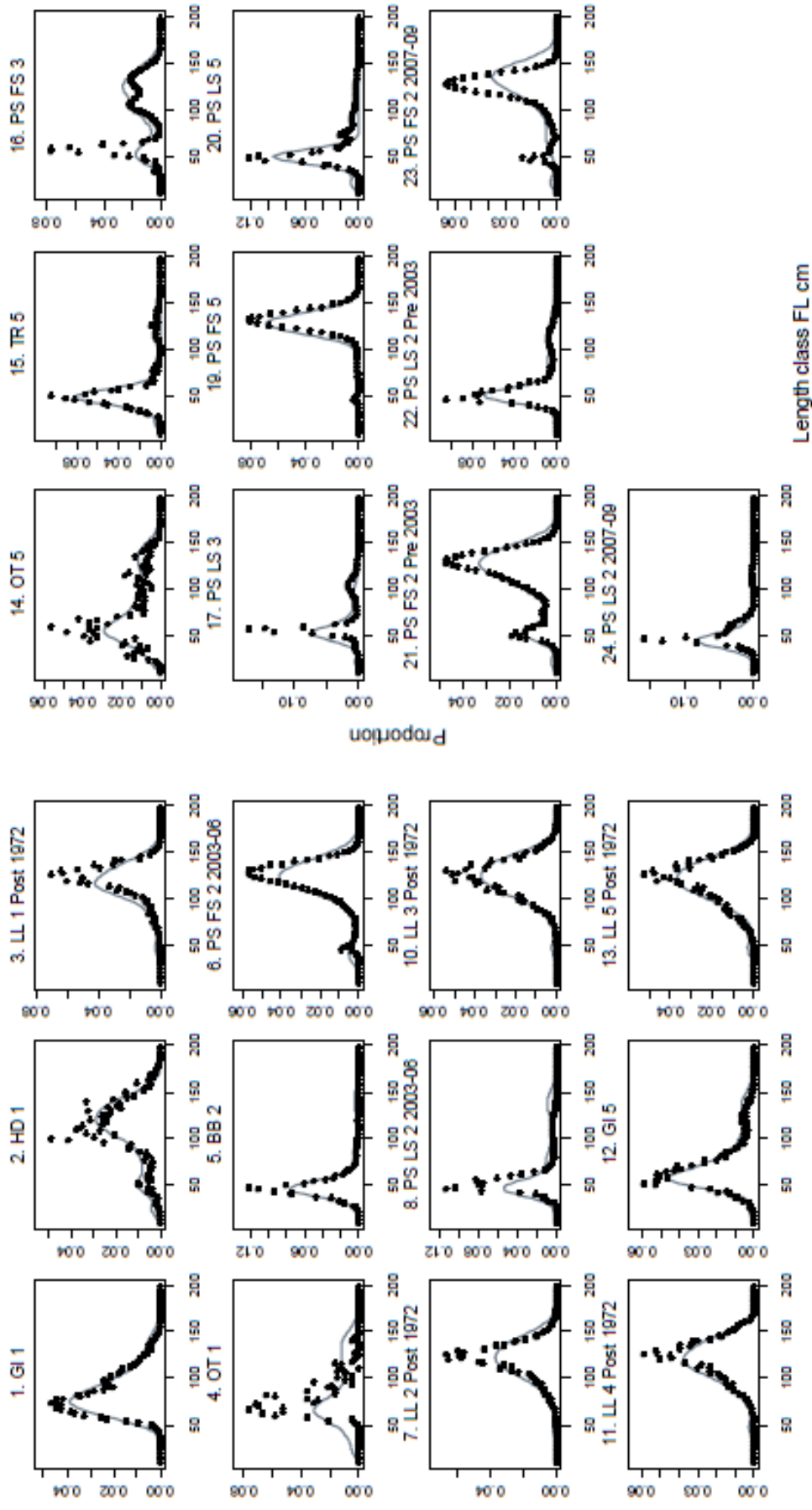
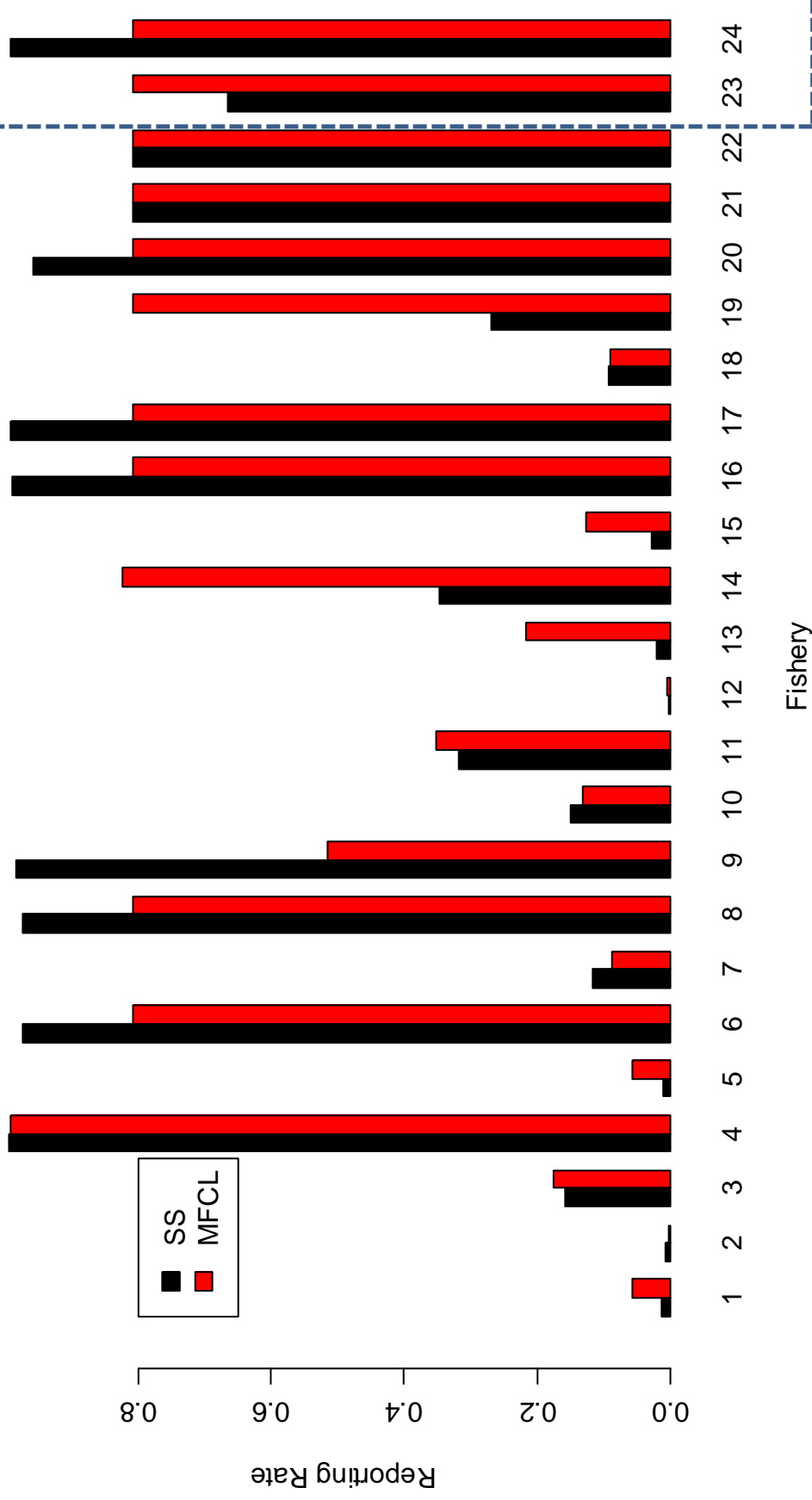


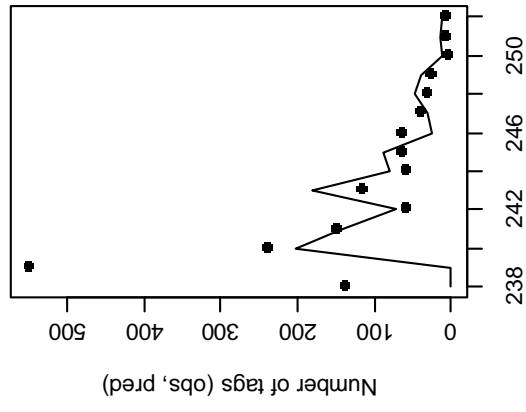
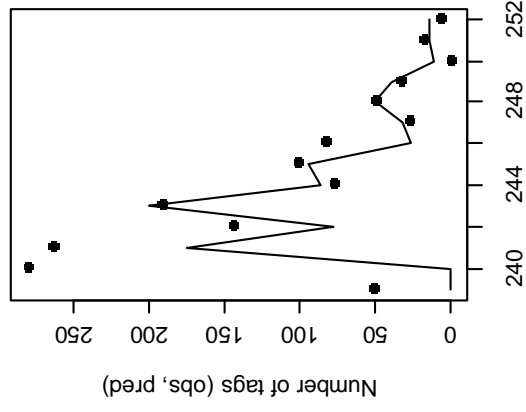
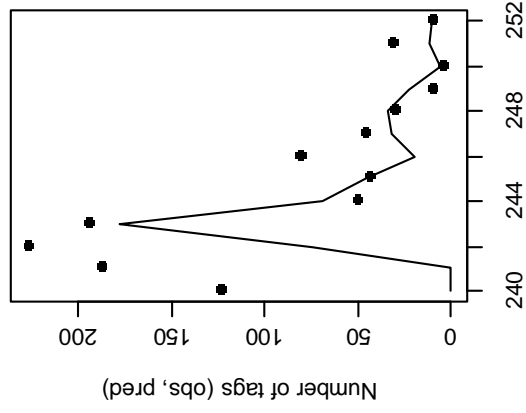
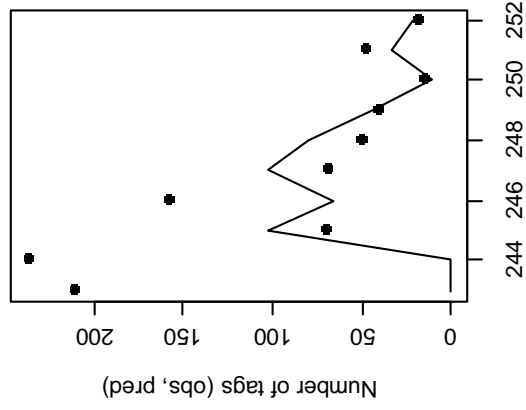
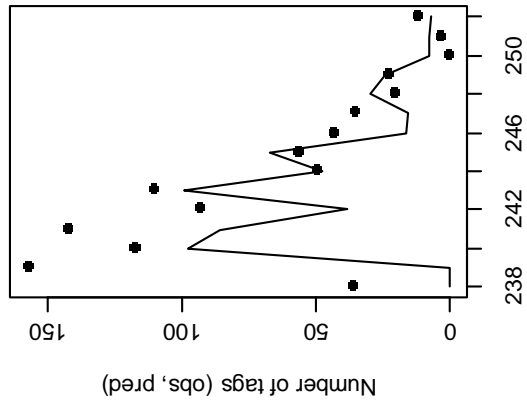
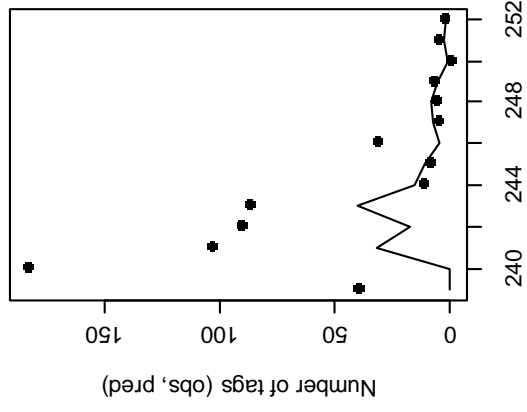
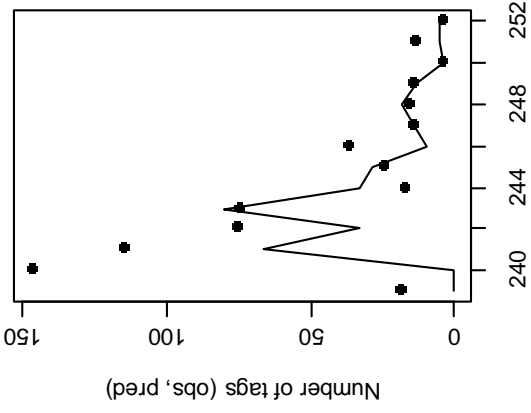
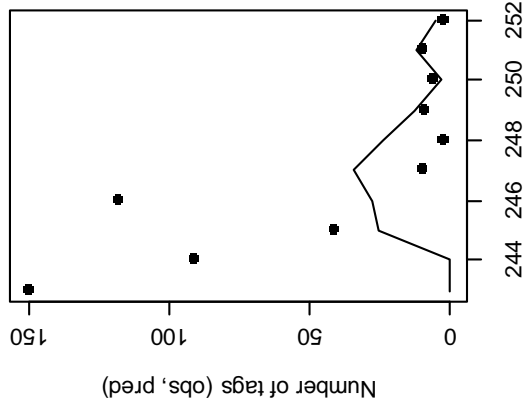
Figure 62. Observed (points) and predicted (line) YFT length frequencies (in cm) for each fishery aggregated over time.

Tag reporting rate (SS vs MFCL)

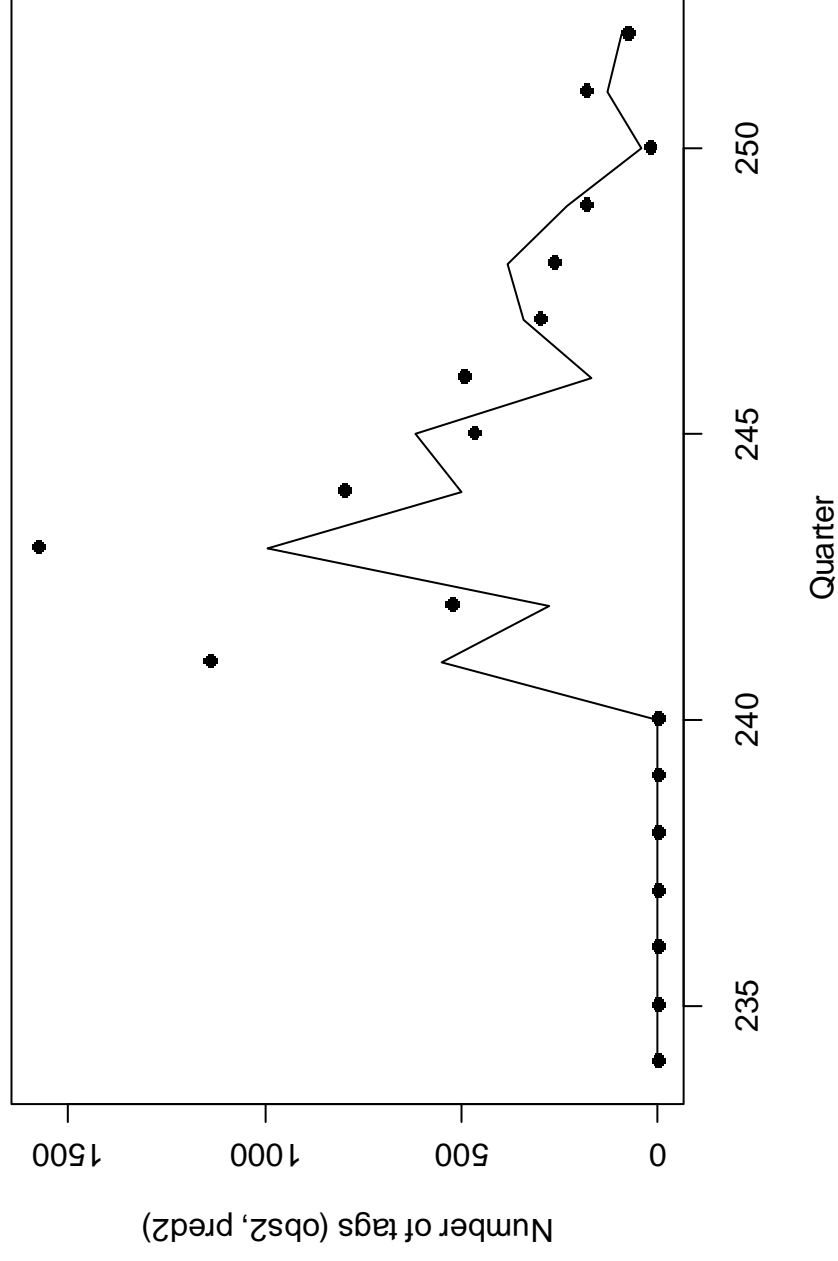


PS Fisheries 23 and 24 are the only fisheries with considerable numbers of recoveries. For MFCL, these fisheries share a reporting rate (equivalent to mean of SS reporting rates for the two fisheries).

Tag recoveries – main release groups

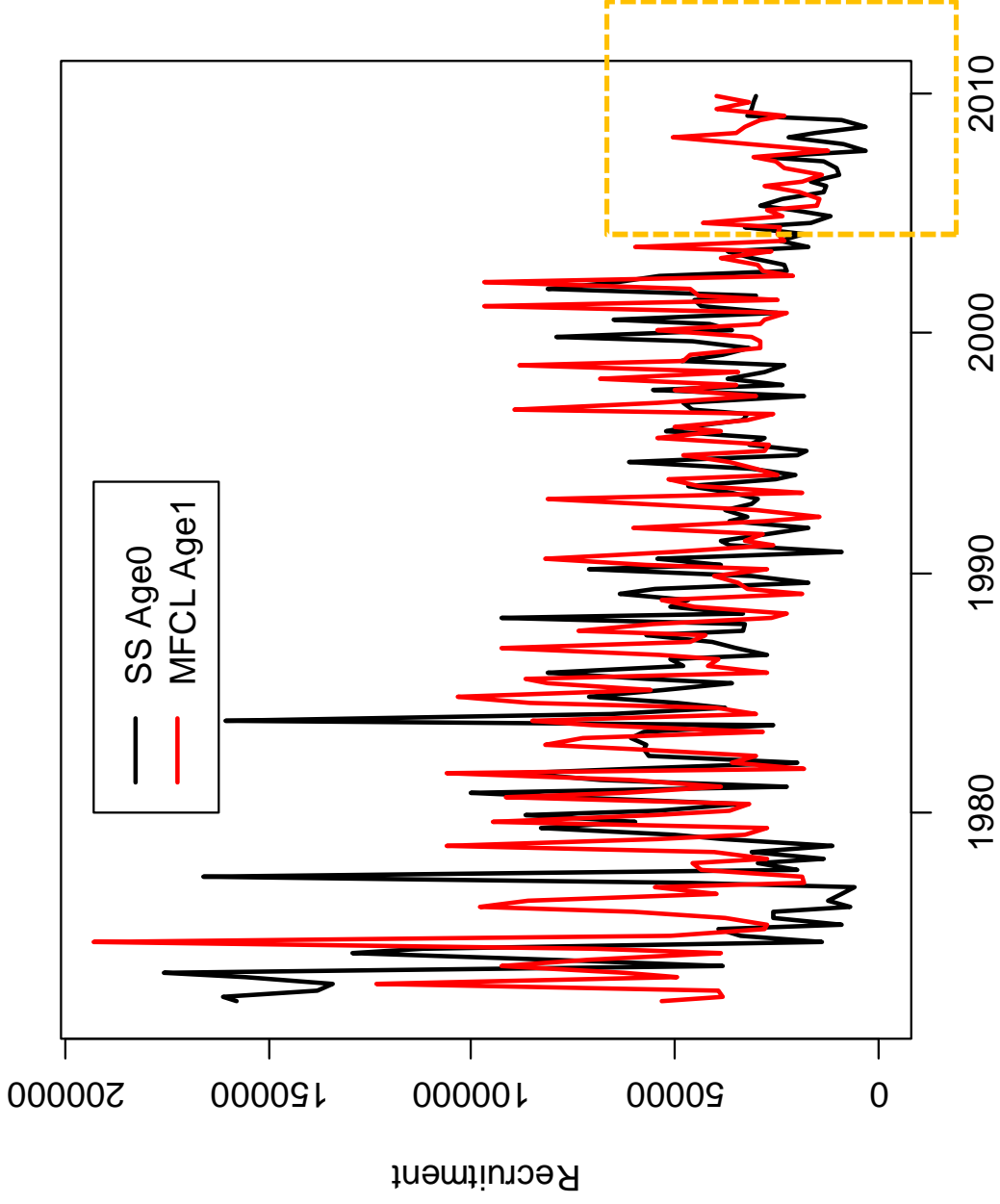


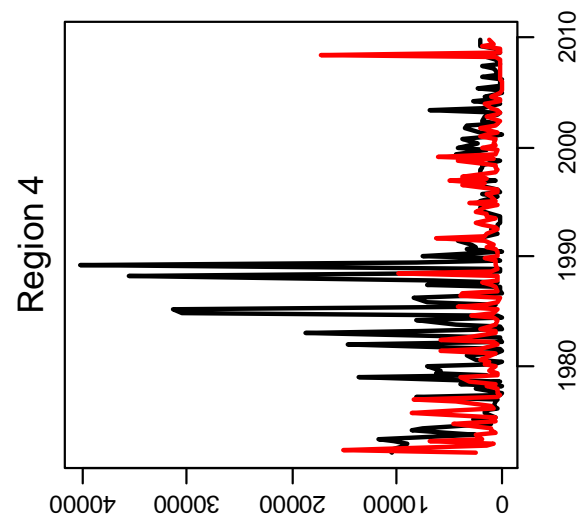
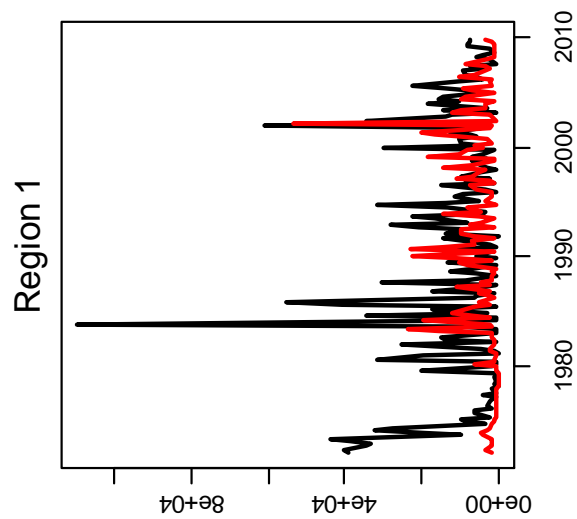
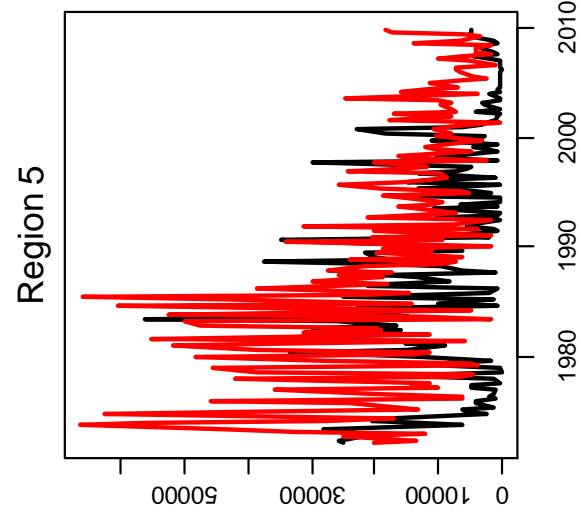
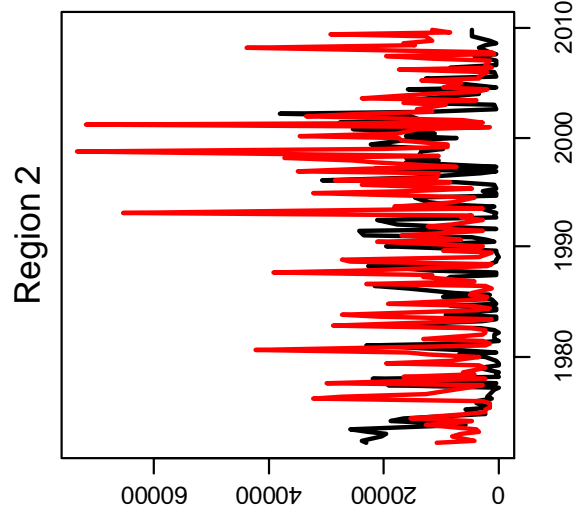
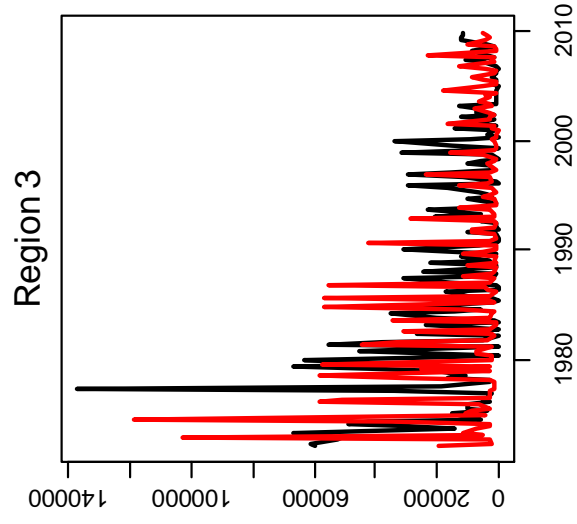
Tag recoveries (F23 and F24)



Fisheries were not operating before quarter 240 (= 1st Q 2007).

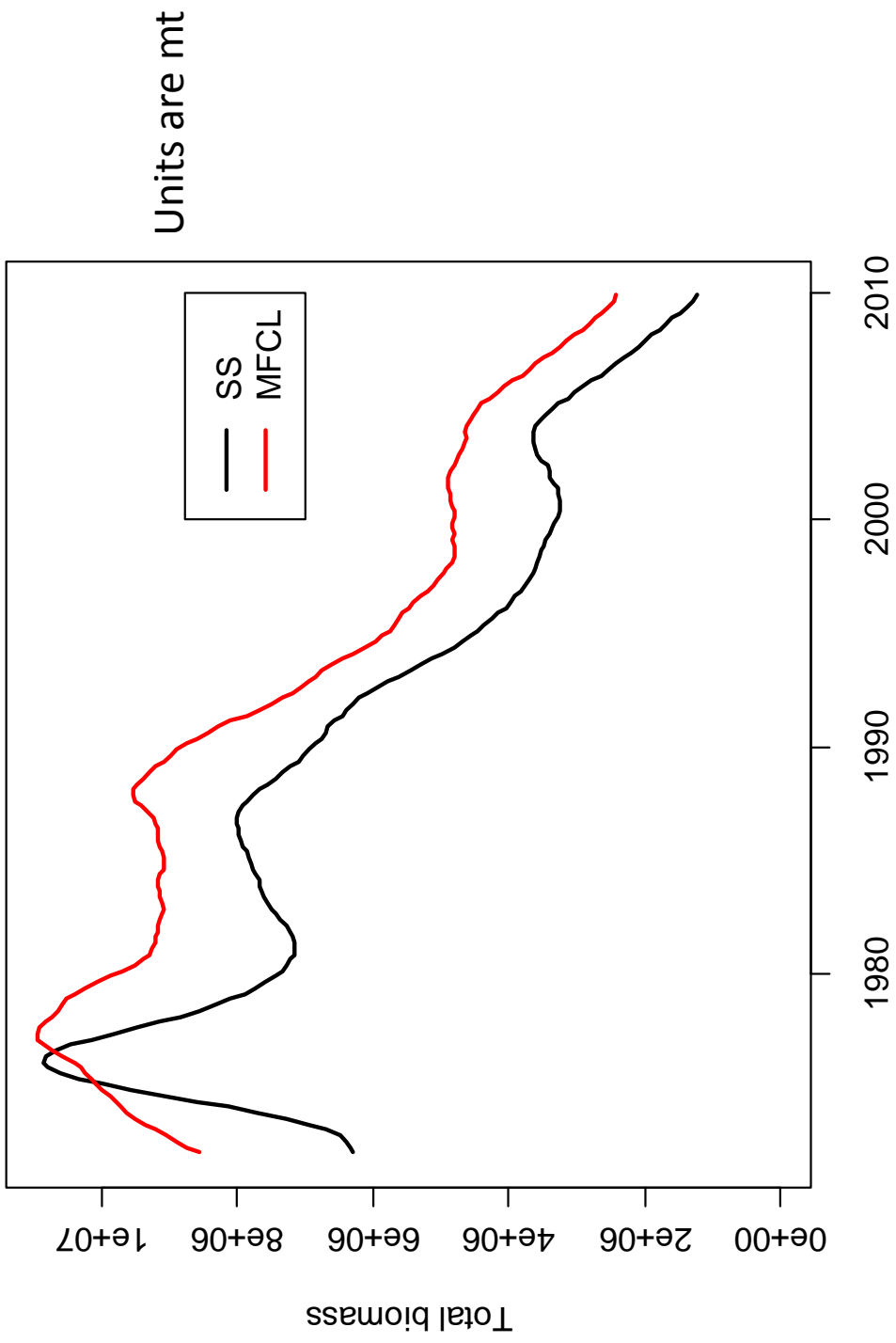
Recruitment (total)



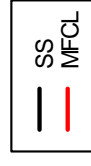
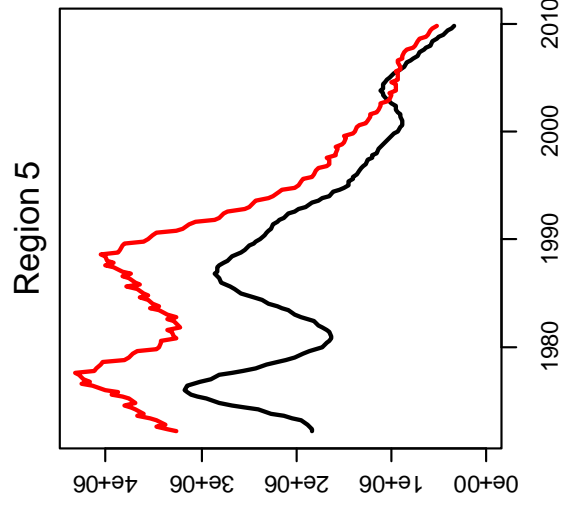
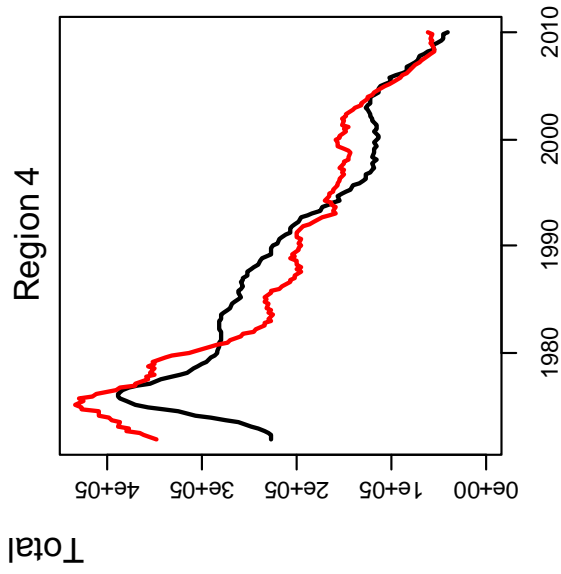
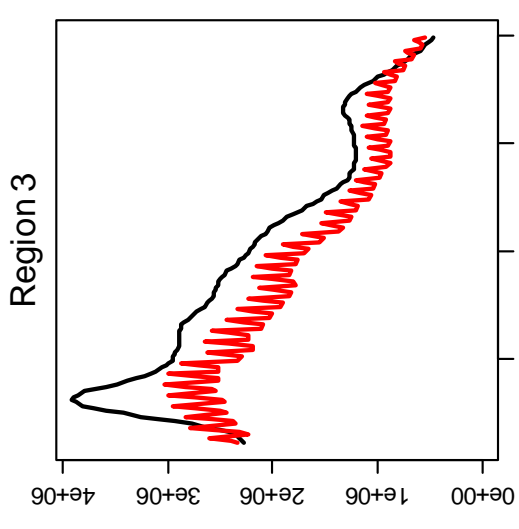
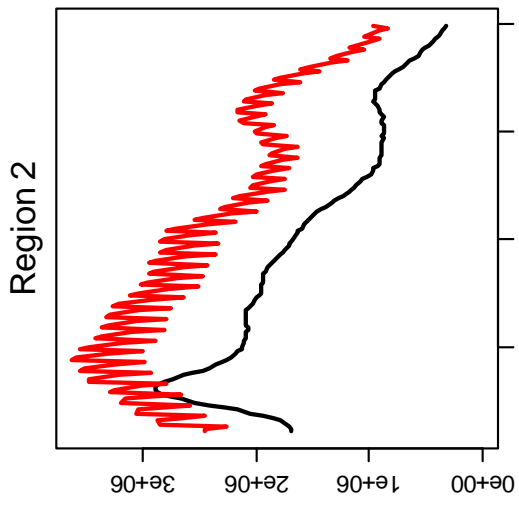
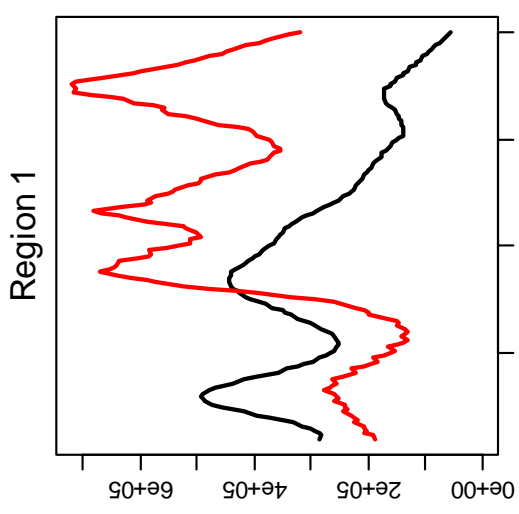


Recruitment (1000s of fish)

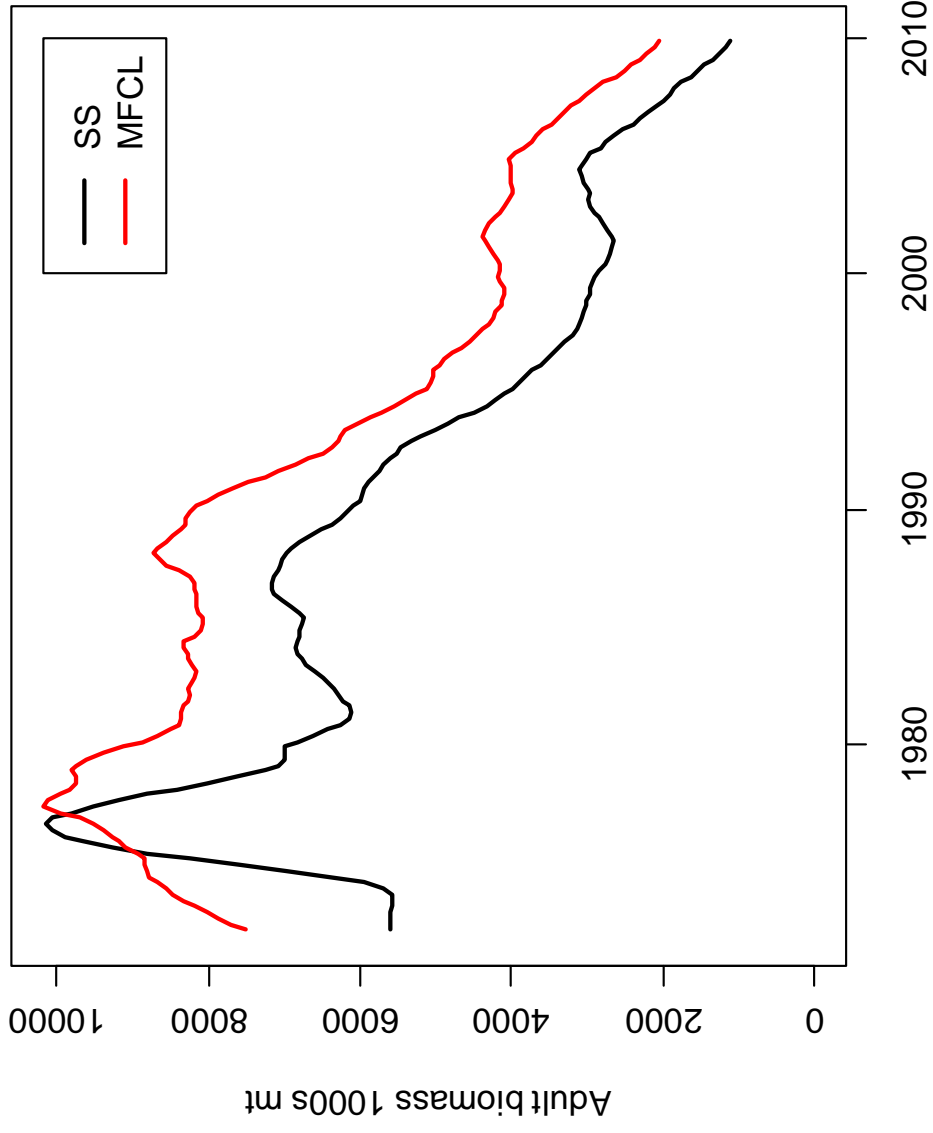
Total biomass



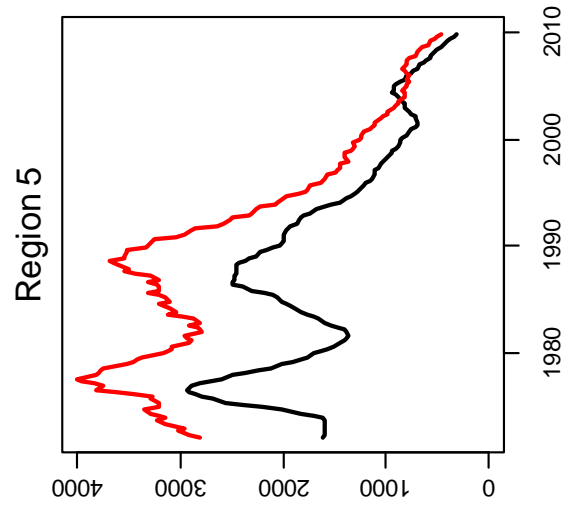
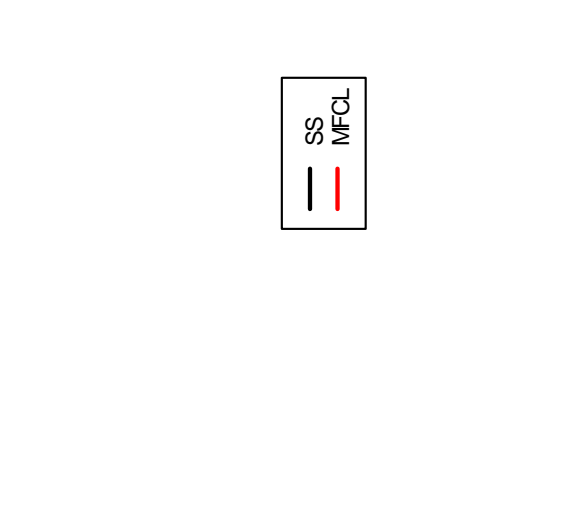
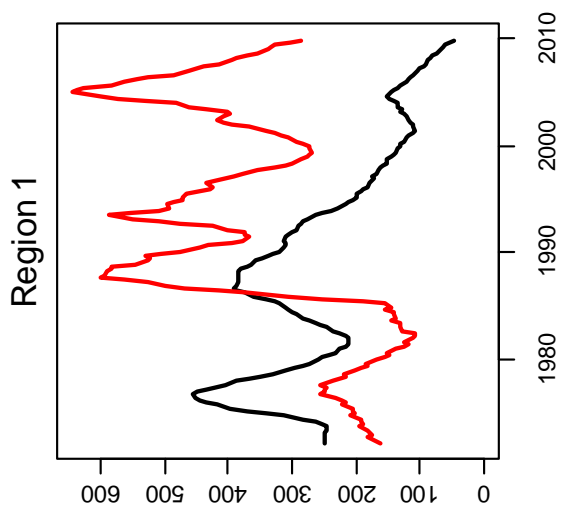
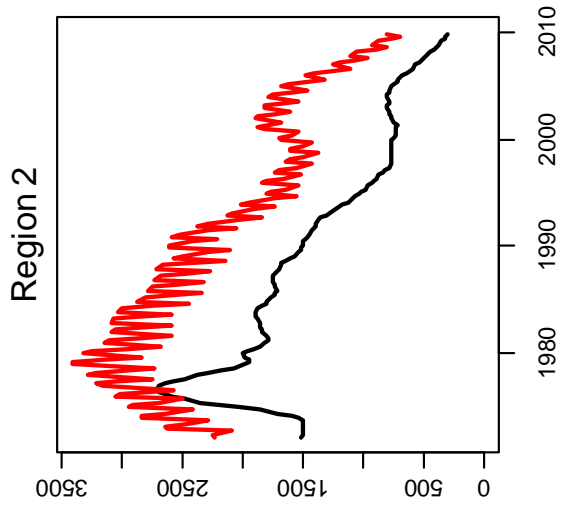
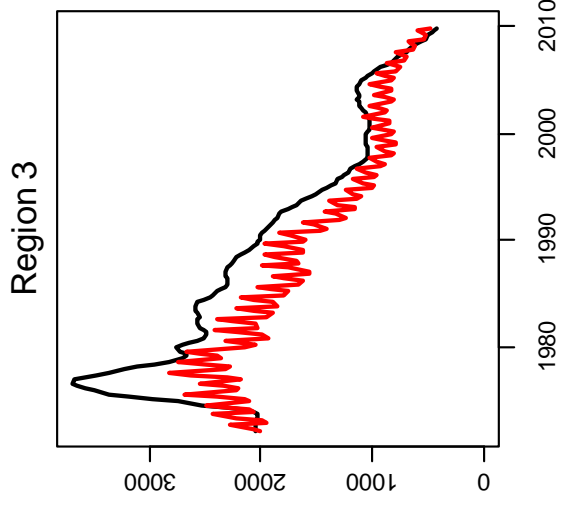
Total biomass



Spawning biomass



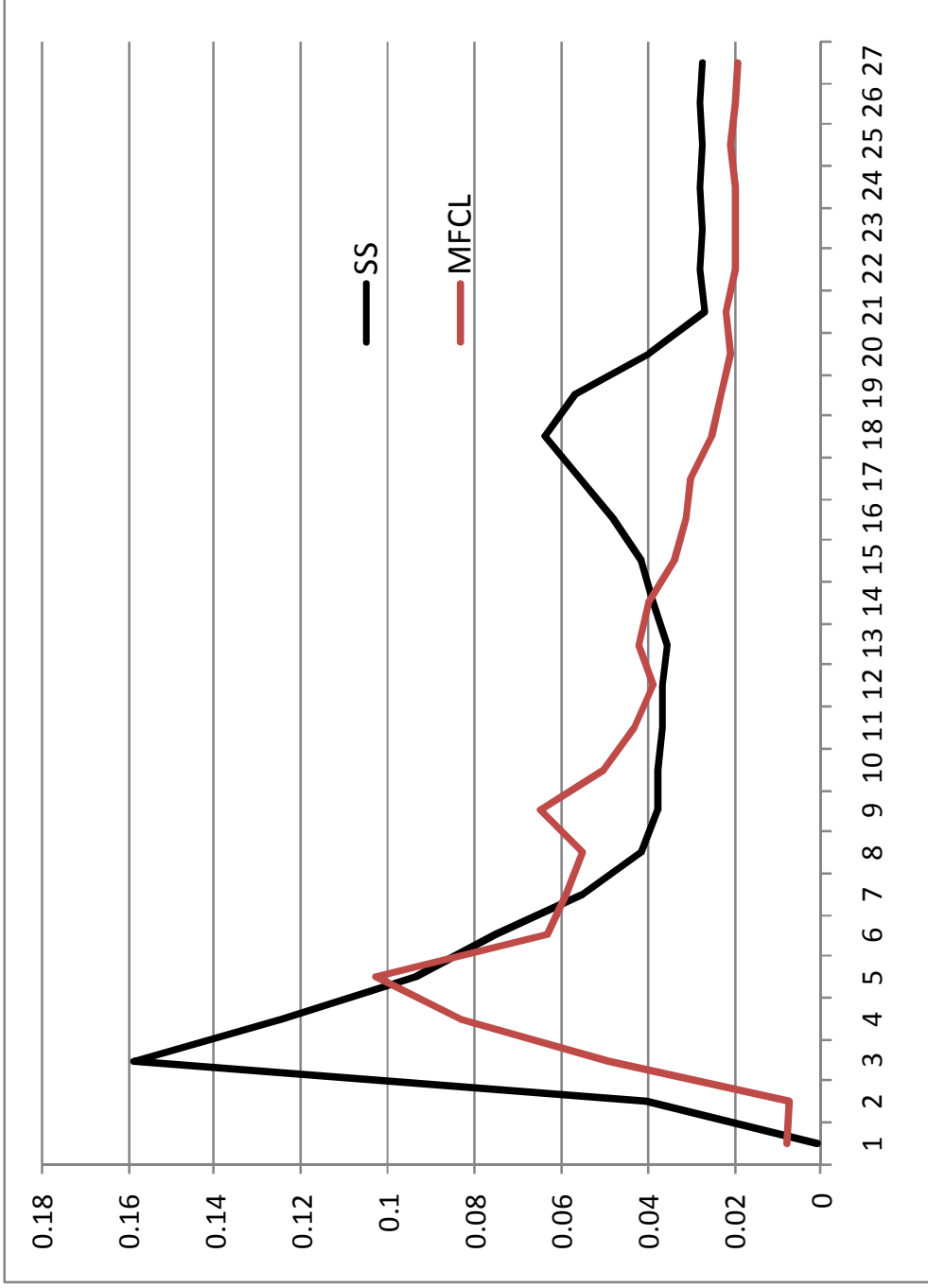
SS Age specific spawning OGIVE shifted to younger fish to account for faster initial growth.



SS MFCL

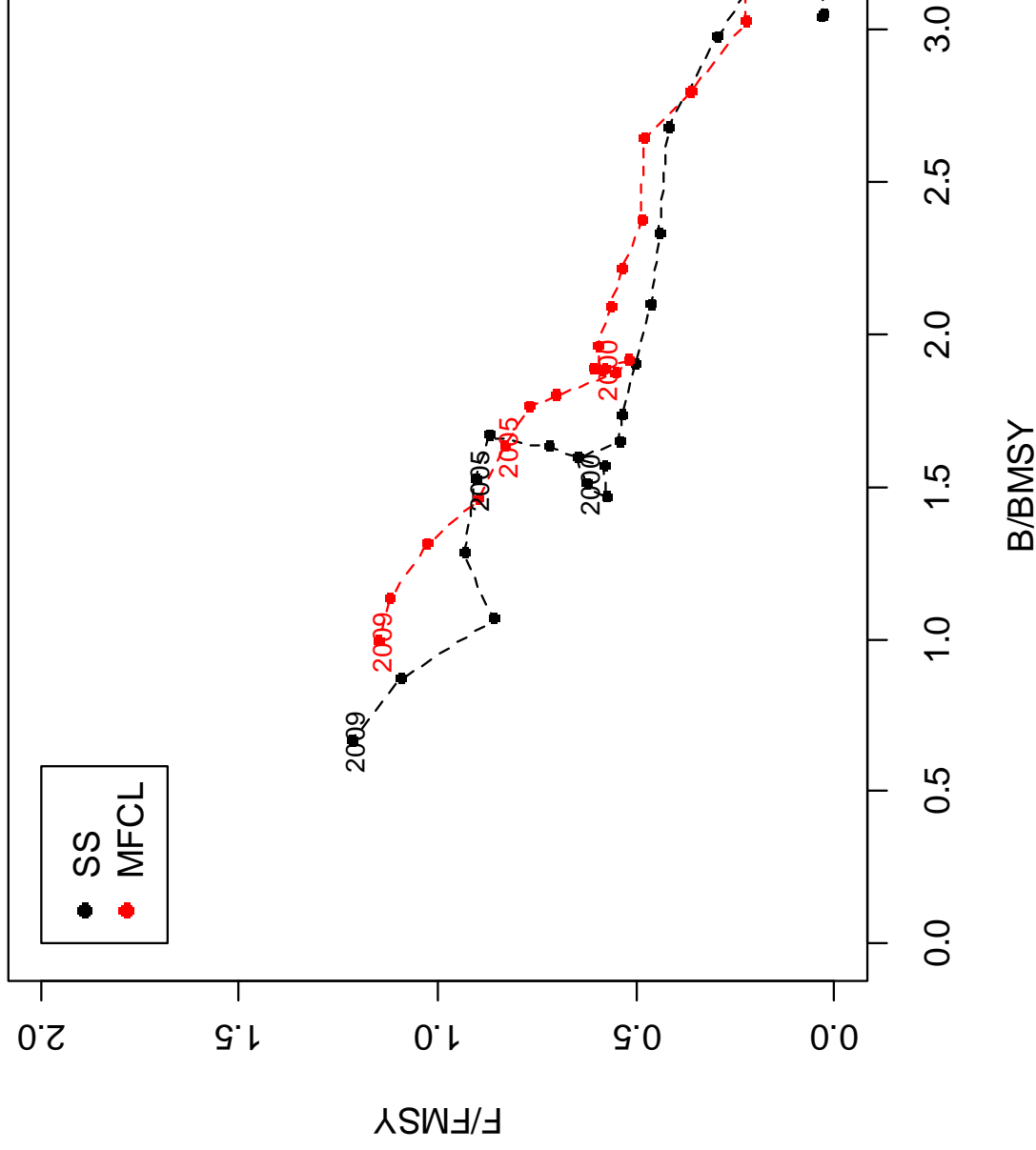
Adult biomass 1000s mt

Terminal F-at-age



Differences in F-at-age for younger age classes mainly attributable to differences in assumed growth.

Kobe plot



F_report_units = 1 (exploitation Bio). Exploitation based F.

Comparability of MSY based metrics between the two platforms.

MFCL MSY computed based on annual F-at-age matrix.

SS approach assumes constant selectivity over entire model period (benchmark was 2005-09).

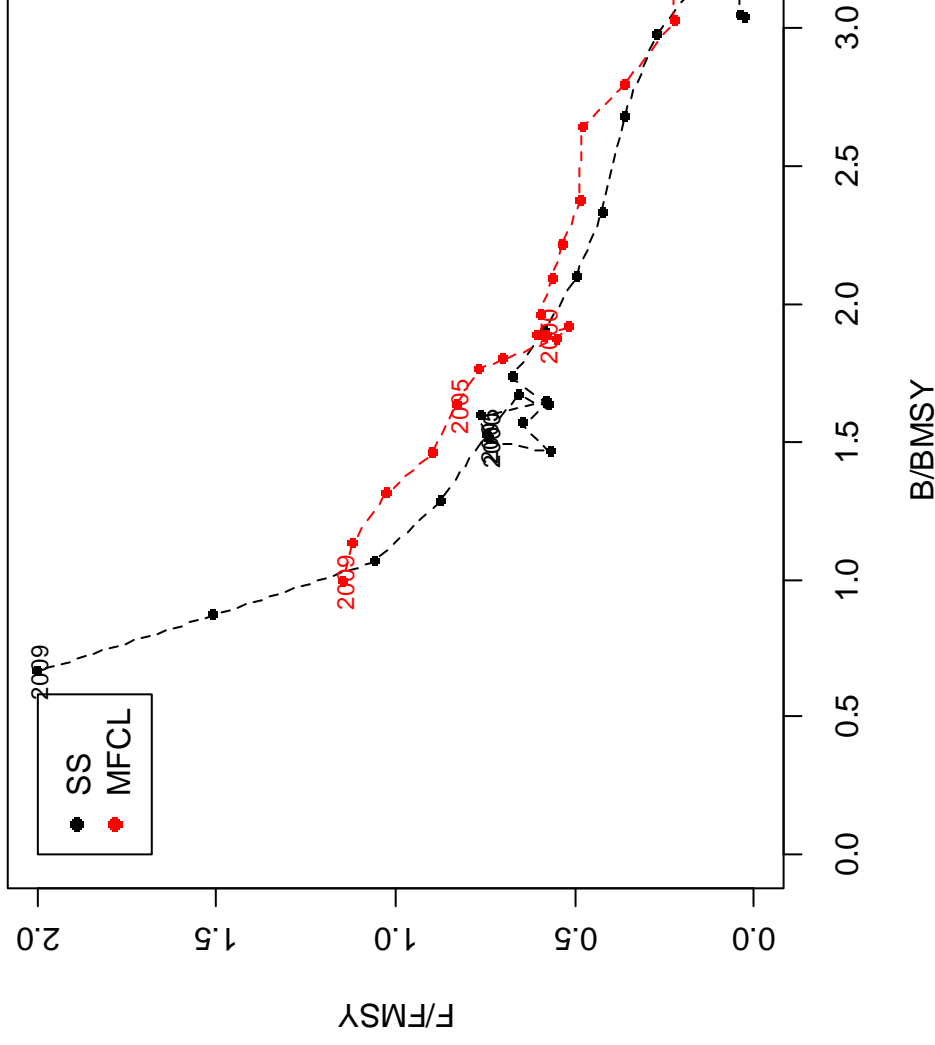
MSY
MFCL 292,840 mt
SS 363,573 mt
(difference probably attributable largely to growth assumptions).

Differences likely to be greater when steepness assumed low (0.7).

F based reference points.

- Definition of F used in MSY computation.
- Exploitation based F (F report = 1). *“Options 1 and 2 use total catch for the year and summary abundance at the beginning of the year, so combines seasons and areas. But if most catch occurs in one area and there is little movement between areas, this ratio is not informative about the F in the area where the catch is occurring.”*
- True F for range of ages (F report = 4). *“Option 4 is a real annual F calculated as a numbers weighted $F = Z - M$ for a specified range of ages (read below). This numbers sum is over all biology morphs and all areas for the beginning of the year, so subsumes any seasonal pattern.”*
- MFCL uses F-at-age matrix (not a single F).

Kobe plot 2



Comparability of MSY based metrics between the two platforms.

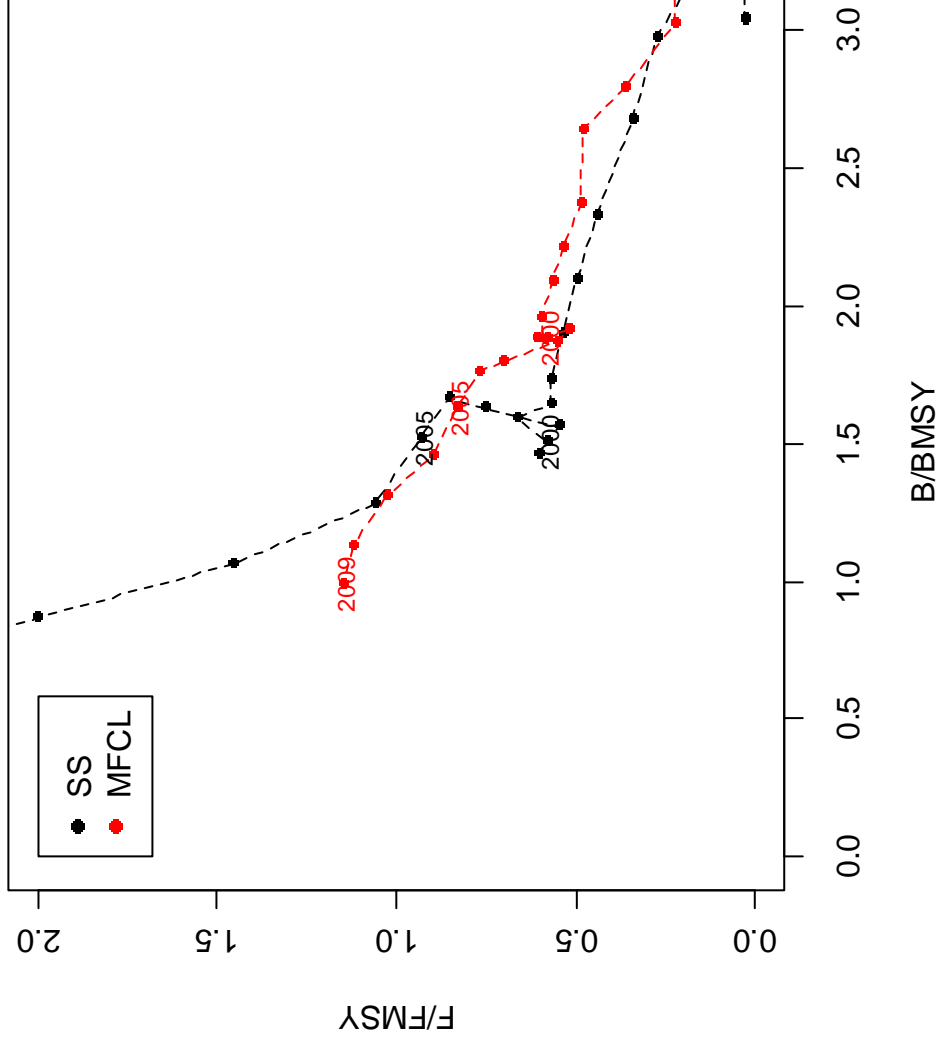
MFCL MSY computed based on annual F-at-age matrix.

SS approach assumes constant selectivity over entire model period (benchmark was 2005-09).

SS F determined by "True F" approach.

F_report_units = 4 (true F for range of ages 3-20)

Kobe plot 3



Comparability of MSY based metrics between the two platforms.

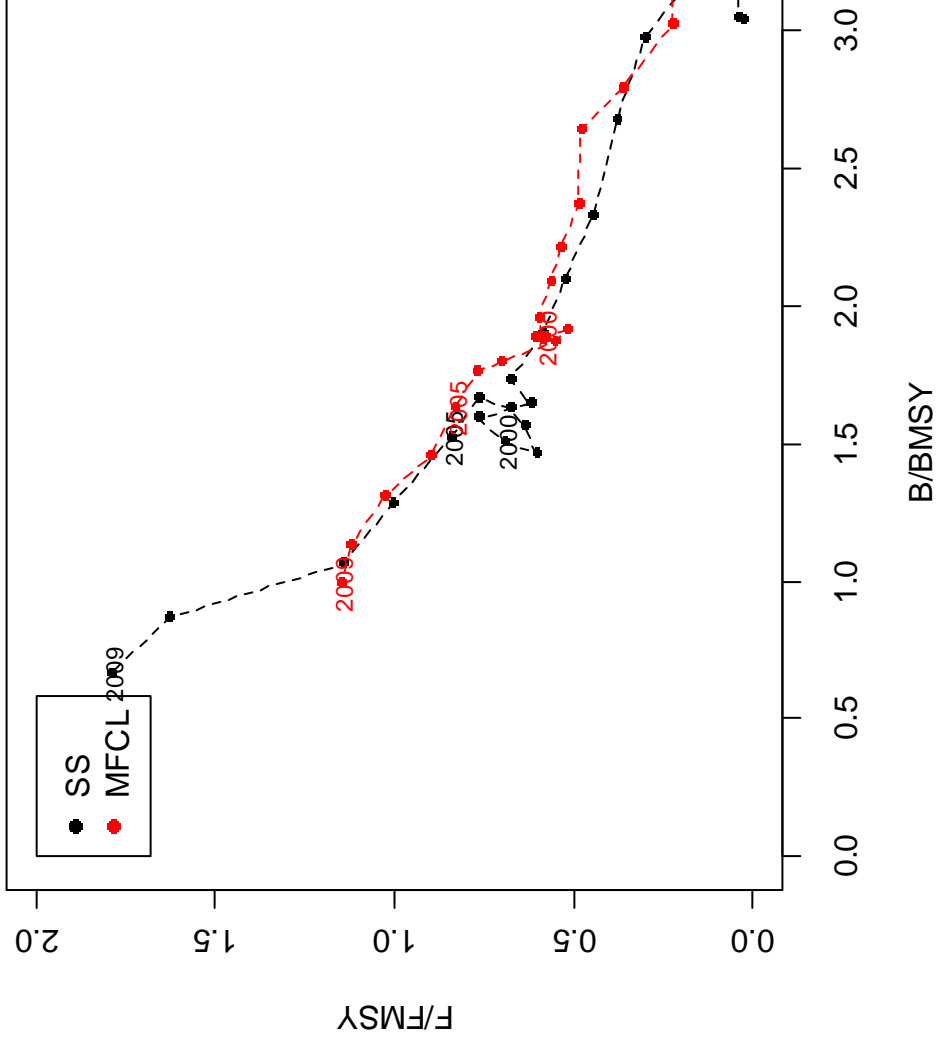
MFCL MSY computed based on annual F-at-age matrix.

SS approach assumes constant selectivity over entire model period (benchmark was 2005-09).

SS F determined by "True F" approach.

F_report_units = 4 (true F for range of ages 5-15)

Kobe plot 4



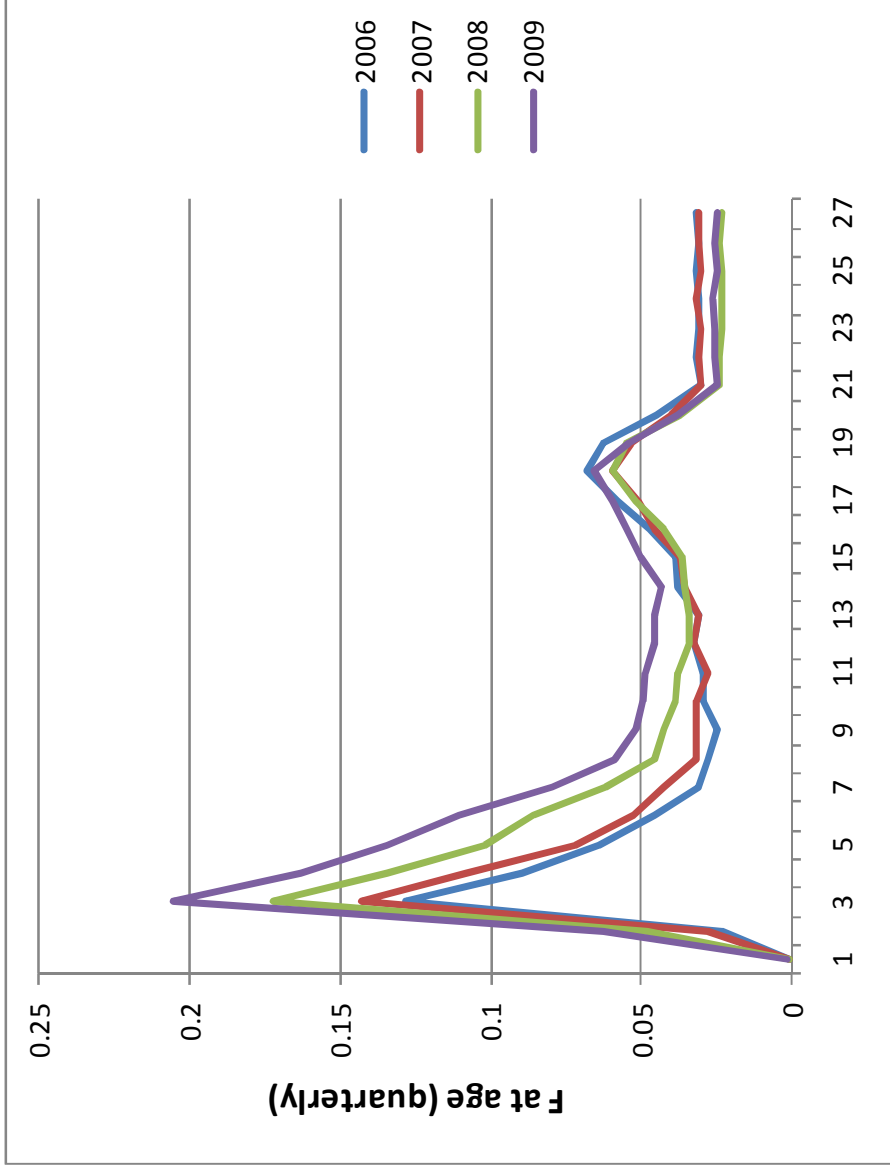
Comparability of MSY based metrics between the two platforms.

MFCL MSY computed based on annual F-at-age matrix.

SS F determined by "True F" approach.

F_report_units = 4 (true F for range of ages 1-28)

Recent F at Age (SS)



Largest relative increase in F is in the 5-15 range of age classes.
Recent (2007-2009) regional recruit deviates = 0.

SS3 performance

- Seven phases. 772 parameters (rec_dev * region = 600 parameters).
- 4GB RAM machine. 3-4 hours w/o hessian.
- Convergence (grad = 0.00065).
- Hessian, covariance matrix computed.
- Key parameters fixed (e.g. Growth) as per MFCL.
- Obj fnt 19972.1 (cf MFCL 290504.6). Obj fnts not comparable – e.g. MFCL effort deviates.

To do/issues

- Initial F (in 1972).
- Selectivity – cubic splines for fisheries with bimodal structure.
- Seasonal LL catchability for CPUE indices.
- Recruitment deviation period – constrain last year.
- Tag recoveries – aggregation of PS recoveries (associated and unassociated).
- Assignment of tags to age class at release (refinement).
- Growth patterns (region specific).
- Definition of reference points.

Conclusions

- Some differences in dynamics.
- Assumptions regarding growth influential.
- But, overall (very) similar results from the two platforms. Derivation of MSY based reference points differ btwn MFCL and SS.
- Pros and cons of both platforms. SS time varying parameterization; less flexible wrt growth.
- Useful exercise to routinely compare and contrast results – more rigor when considering structural assumptions.