Dealing with time-varying composition data in fisheries stock assessment through selectivity: adding process of simplifying?

SAC-06-04b

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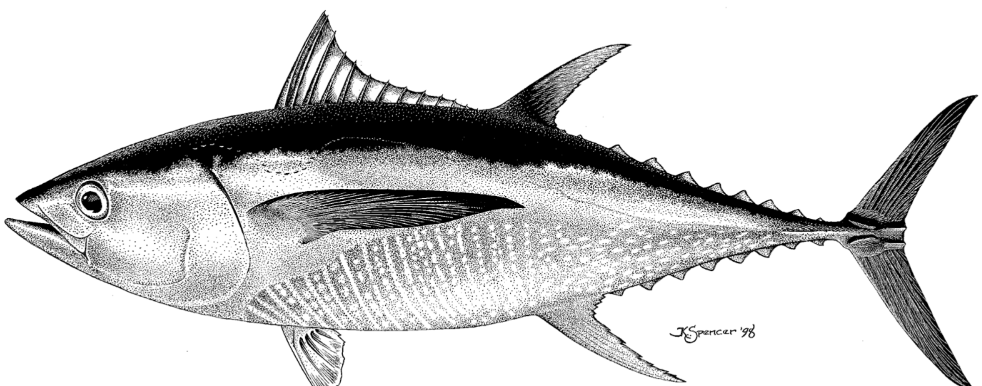

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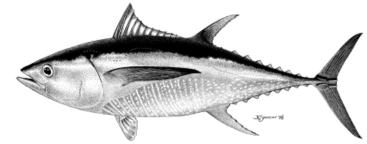

Background

- Selectivity is on of the main processes in statistical catch-at-age assessments (SCAAs)
  - Its influence on management advice has been under-appreciated
- Selectivity as used in SAMs is relative vulnerability of fish to the gear (by size or age), and a combination of:
  - Availability: being in the area where the gear is deployed
  - Contact selectivity: being retained if contacted by gear
- It is important to get selectivity right
  - Likely to change over time due to spatial variation (population or fishery)
  - Selectivity curves can taken on much less regular shapes than those assumed by functional forms as in SCAAs

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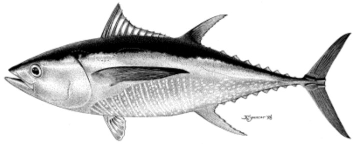
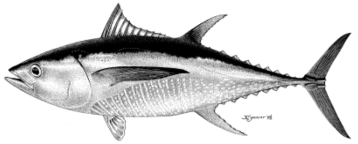


Objectives

- Use YFT assessment as case study:
  - YFT SAC3 model (2012)
  - Illustrate potential biases associated with highly variable composition data
  - Apply and compare several approaches to modeling selectivity to mitigate these biases

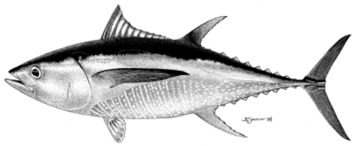


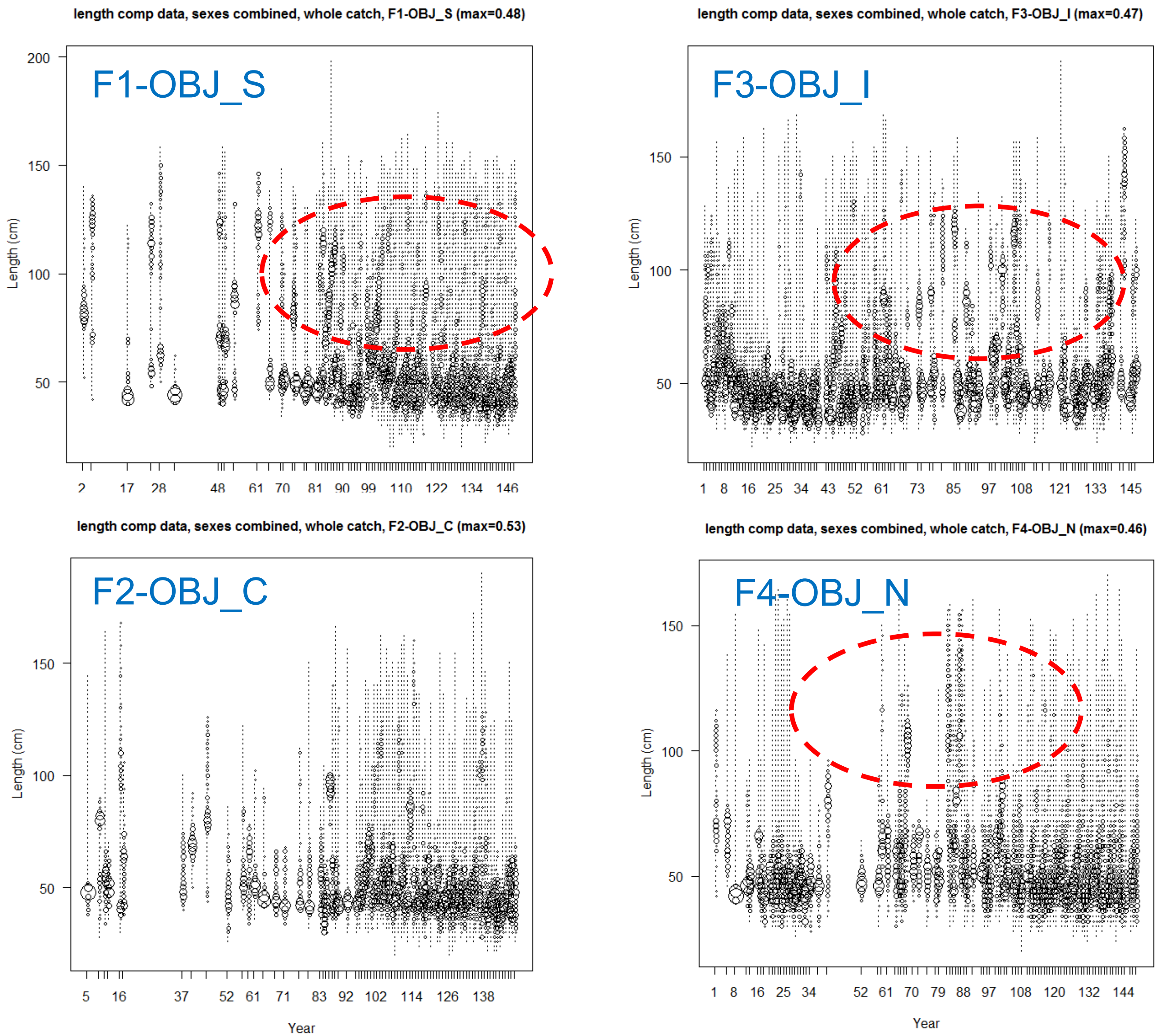
Outline

- Selectivity issues in the YFT assessment
  - Highly variable (time-varying) composition data
- Explore SS3 selectivity approaches to deal with variable composition data
  - Process approach: full time-varying selectivity
  - Simplified approach: ignore time-varying selectivity, assume selectivity is constant over time (fit or not to composition data)
  - Hybrid approach: Time-varying selectivity for recent years only

Issues

OBJ time-varying selectivity?

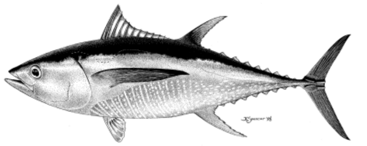




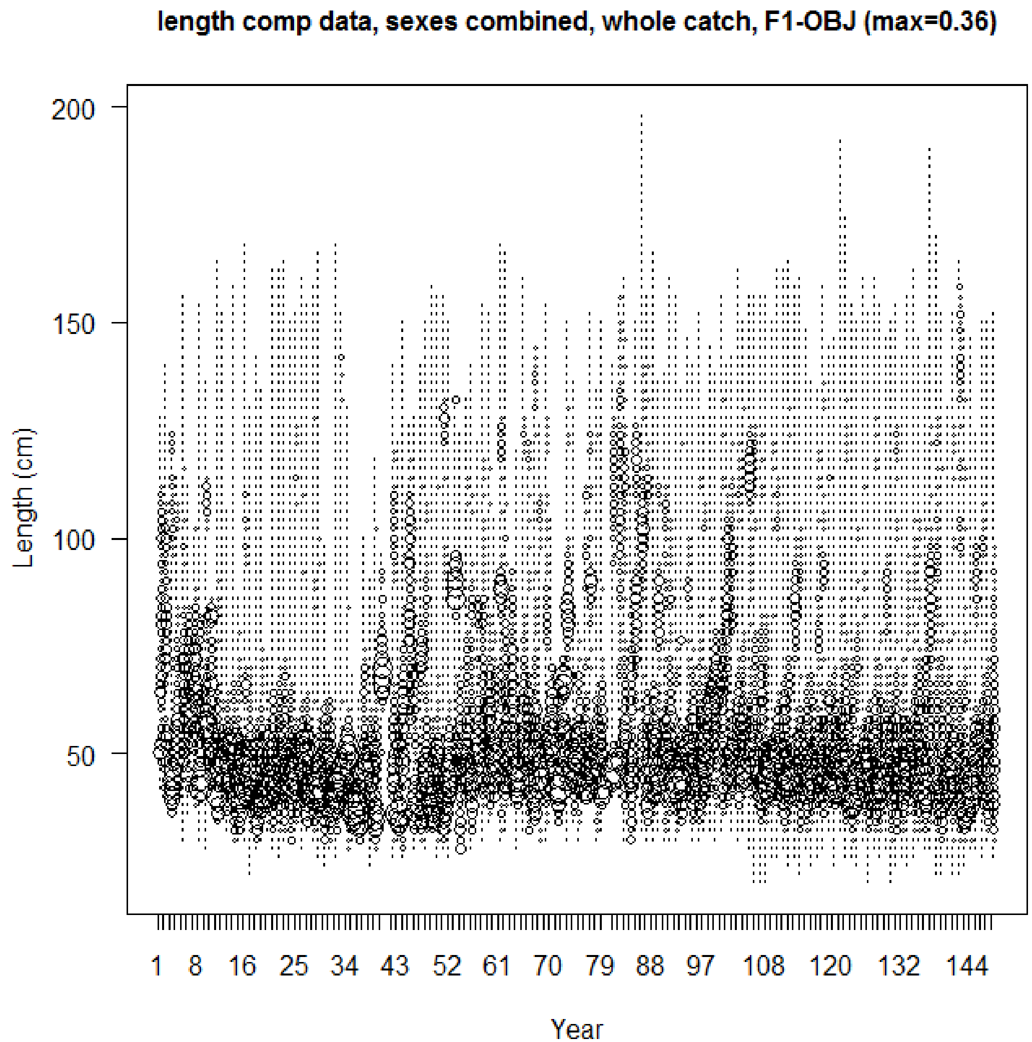
Numerical and convergence issues

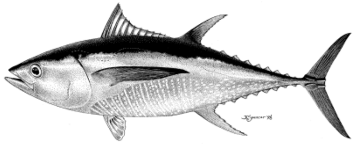
- Unstable selectivites (OBJ)
  - Sensitive to initial parameter values and phases
  - Long run times (> 4 hours)
  - Issues inverting hessian matrix (steepness run)

Data



A single “lumped” OBJ fishery





Method 1: the process approach

- Full time-varying selectivity process
- Estimate quarterly deviates on base selectivity curve
- Fit to historic OBJ length-frequency (LF) data
- SDs need to be defined for quarterly deviates
  - Objective criteria: use Thompson-Lauth's method

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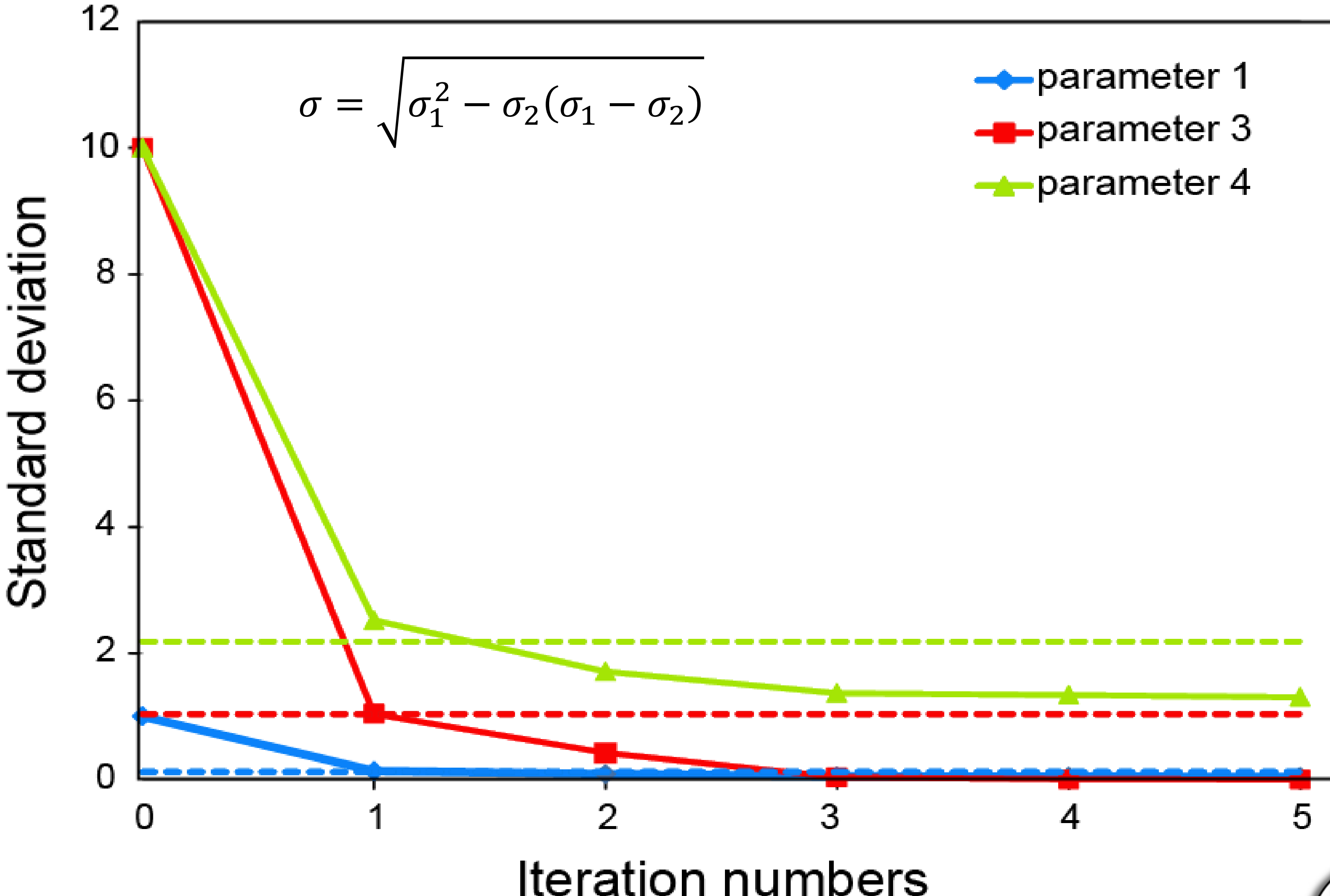
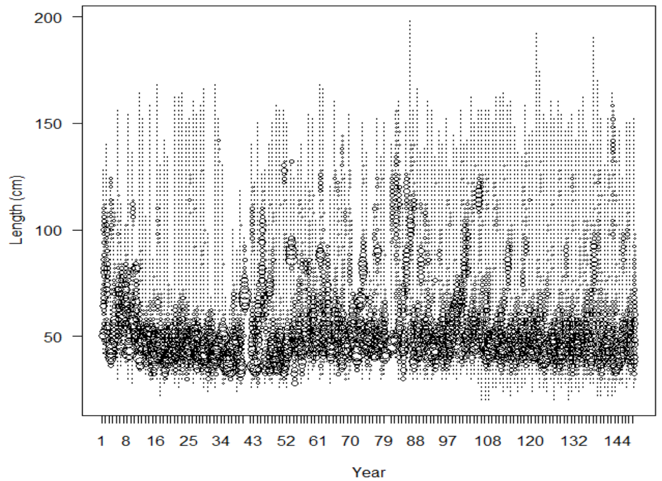
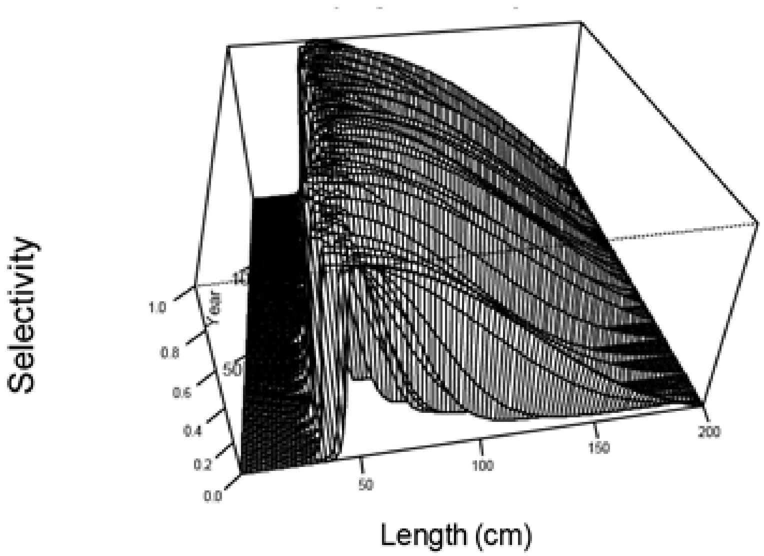
Method 1: Thompson-Lauth's method

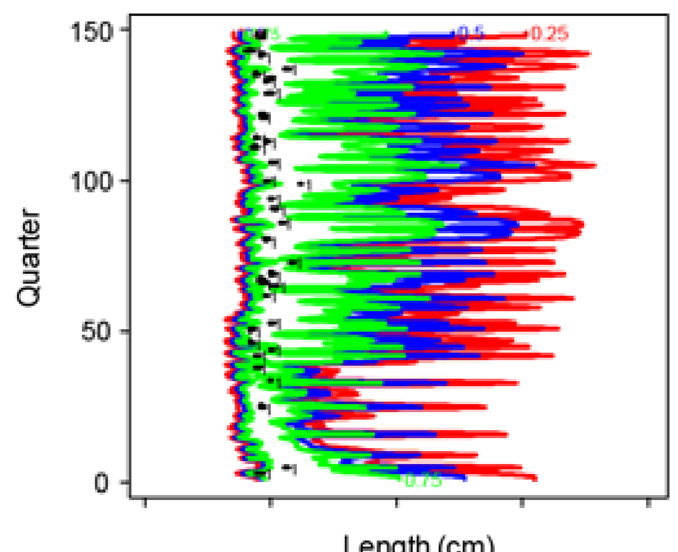


Results

Method 1: the process approach

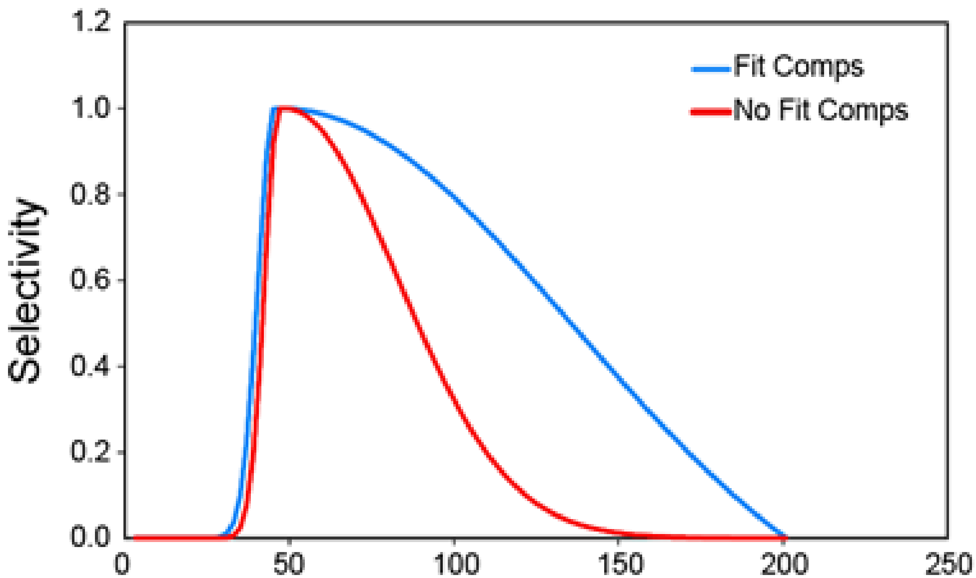




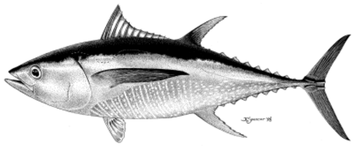


Method 2: the simplified approach

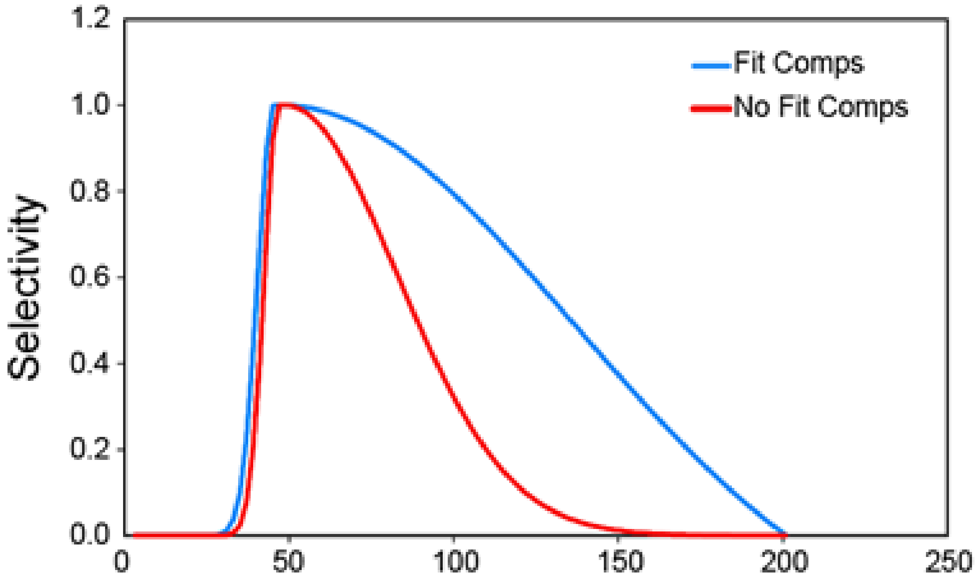
- Assume that selectivity is constant (time-invariant)
- Two ways to treat the length-frequency (LF) data
  - Method 2a: Estimate constant selectivity, fit to LF data (Base case)
  - Method 2b: Assume (fix in model) constant selectivity , ignore (not fit) the historic LF data

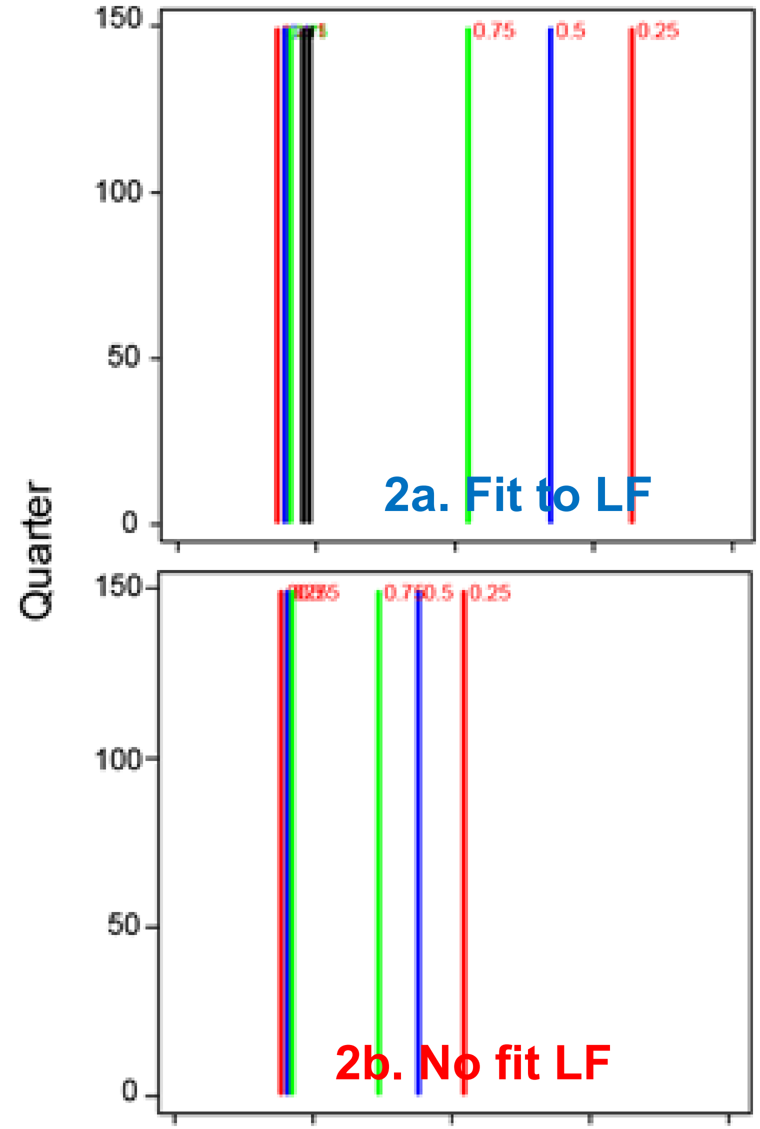


Results



Method 2: the simplified approach





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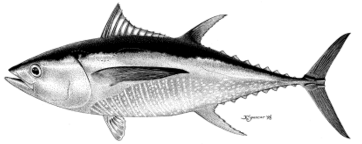
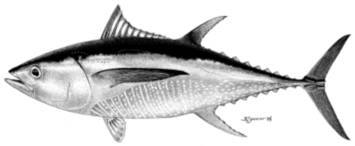
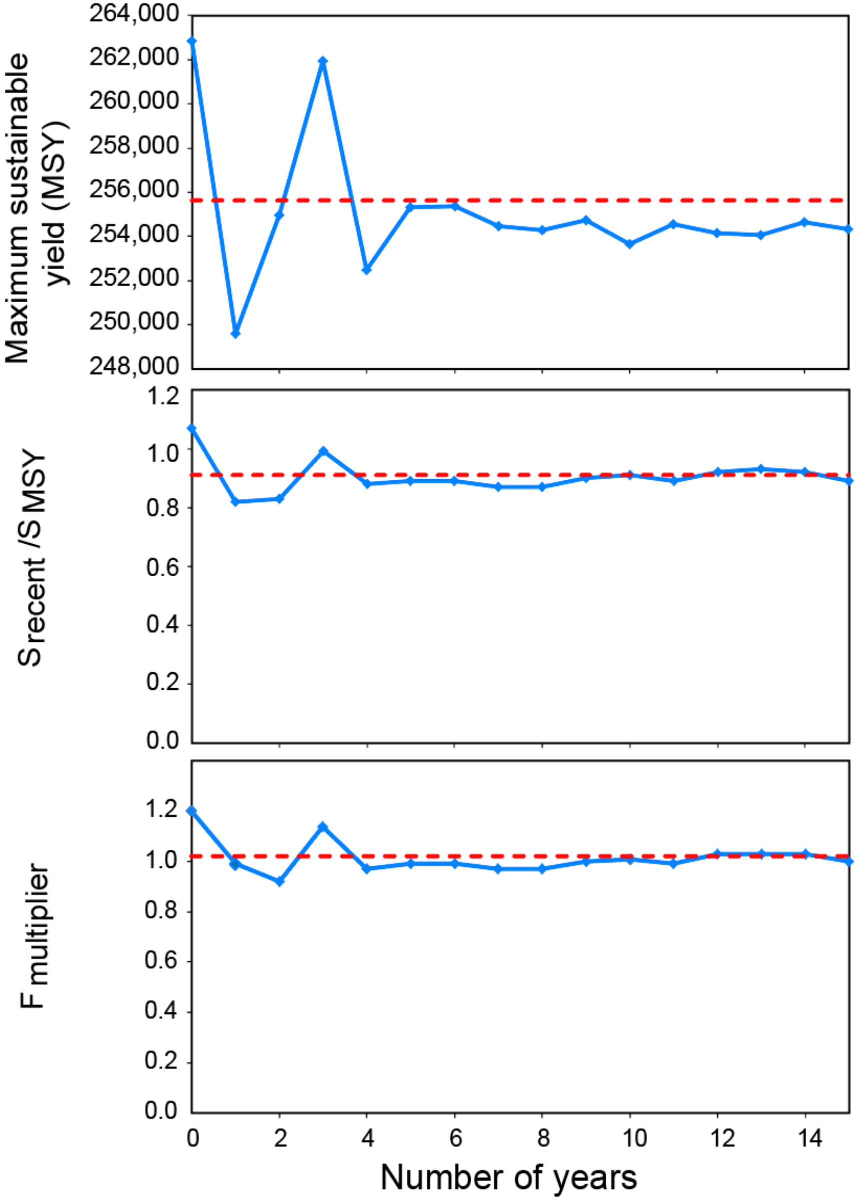
Method 3: the hybrid approach



- Recent period is the most influential on management quantities (recent recruitments, *F*s)
- Lets be sure we take catch out of right ages in this period
- Time-varying selectivity process in recent years only
  - Fit to LF data for recent period only (how many yeas?)
  - As for early period, fix to “average” constant selectivity from recent years

Method 3: the hybrid approach





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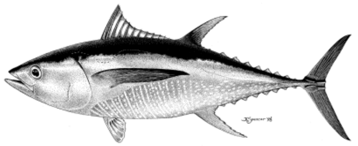
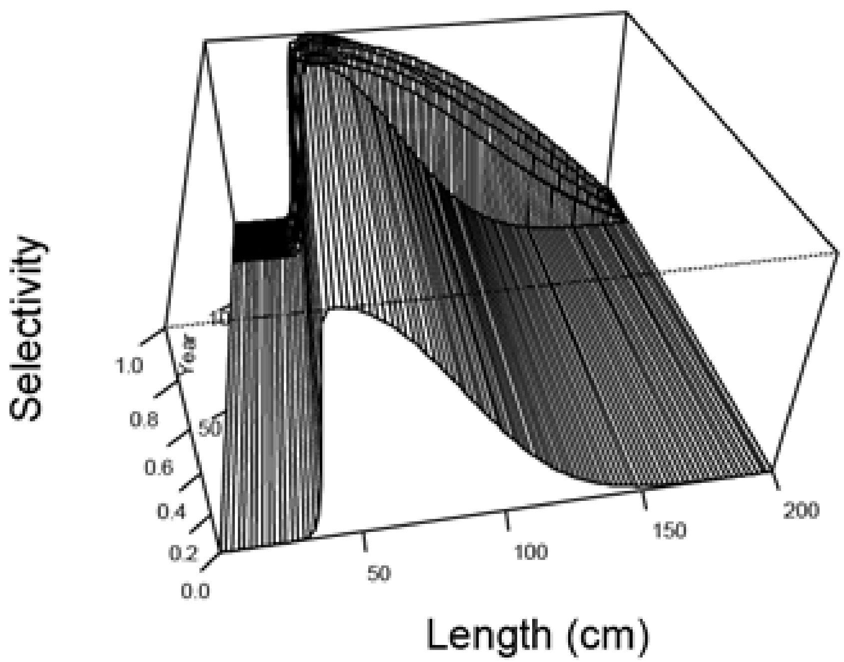
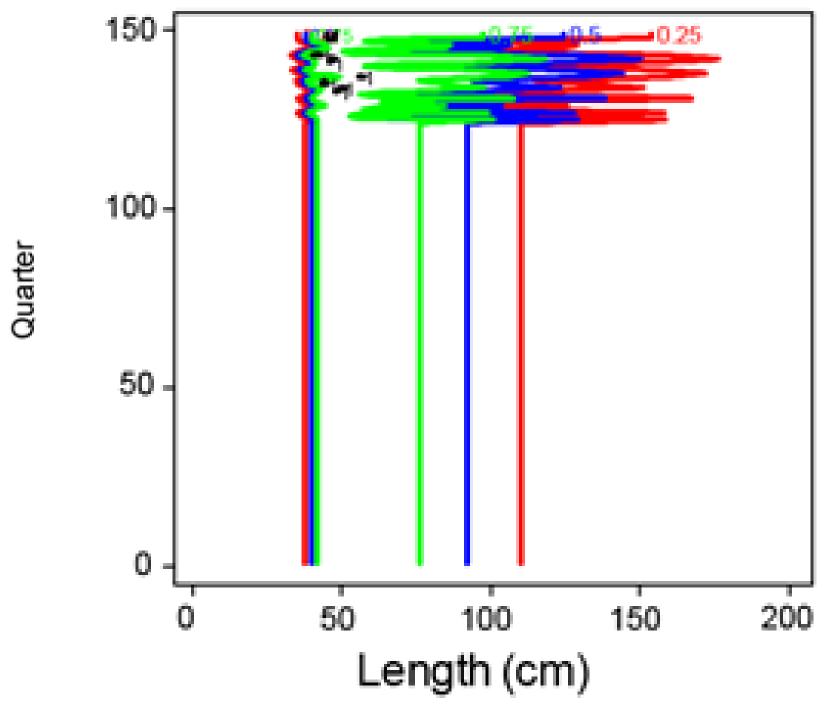
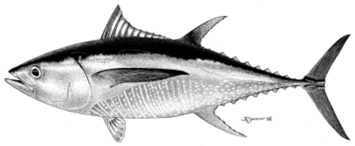




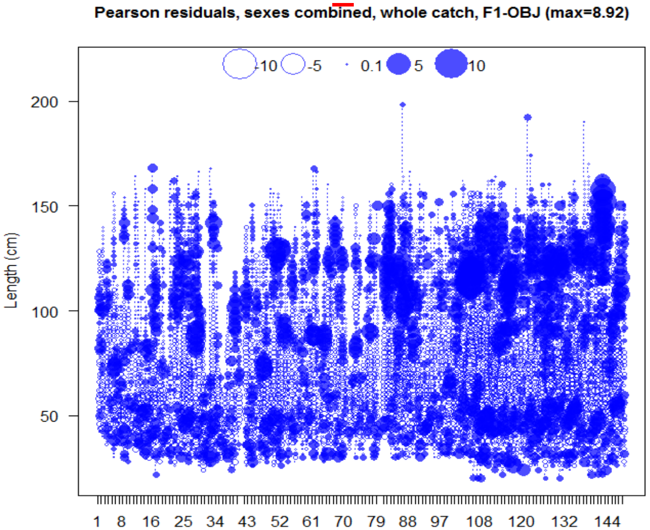


Comparisons among methods: residual pattern

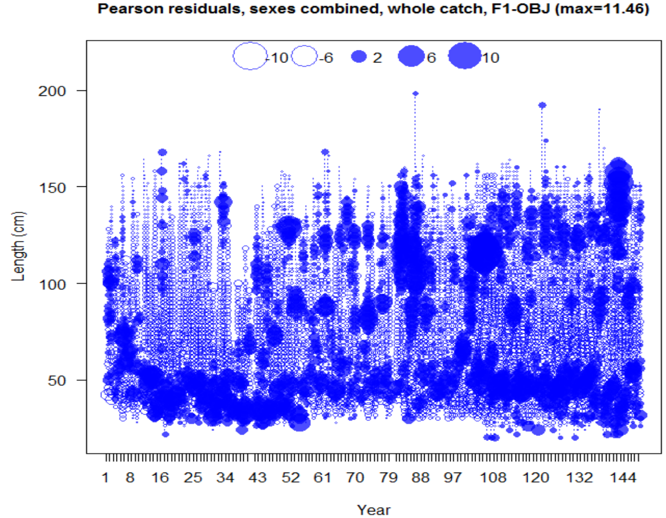
Results

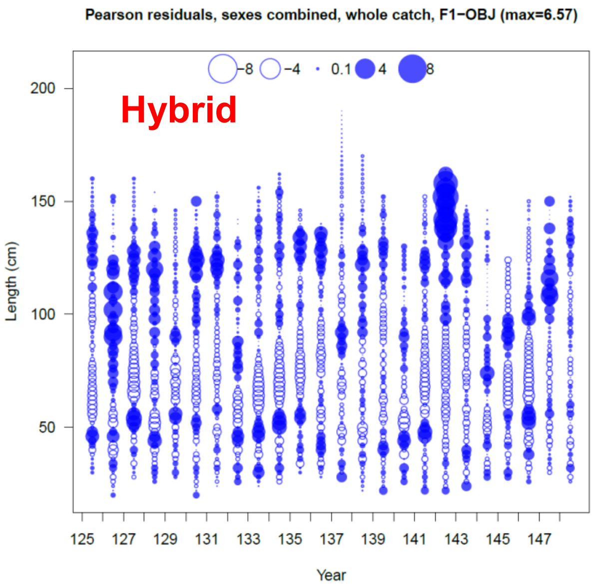


TvarSelex_Full

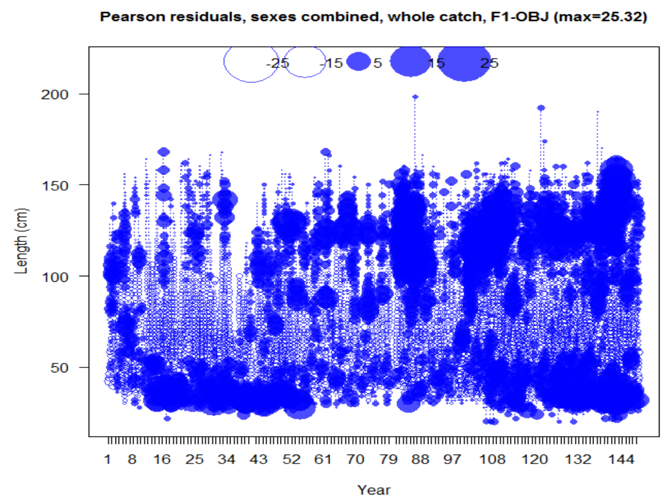


ConstSelex_FitLF





ConstSelex_NoFitLF



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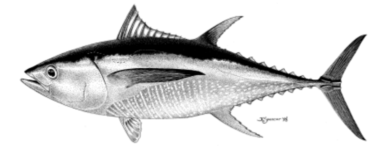
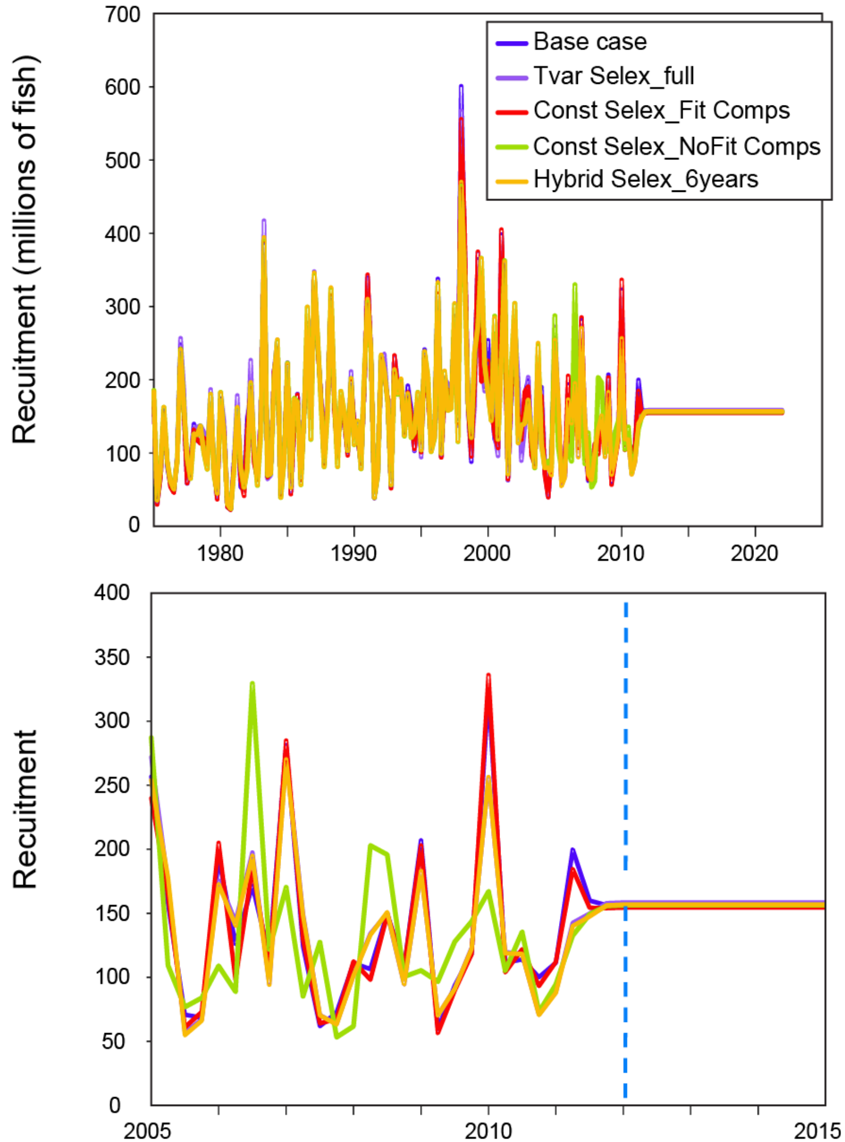
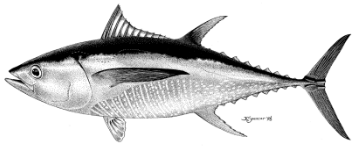
Comparisons among methods: recruitment

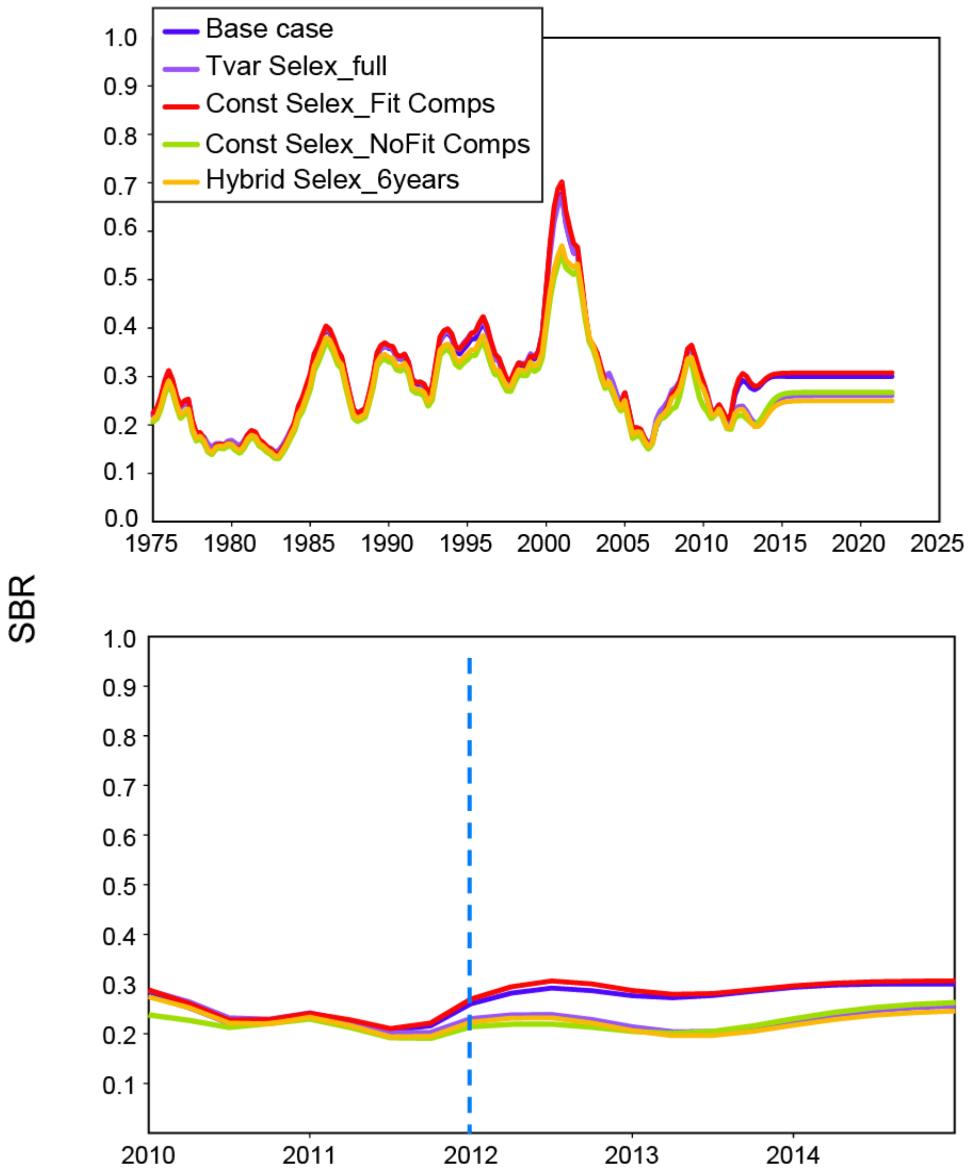
Results

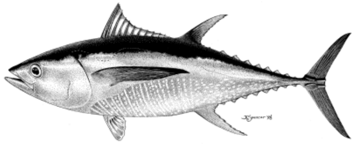




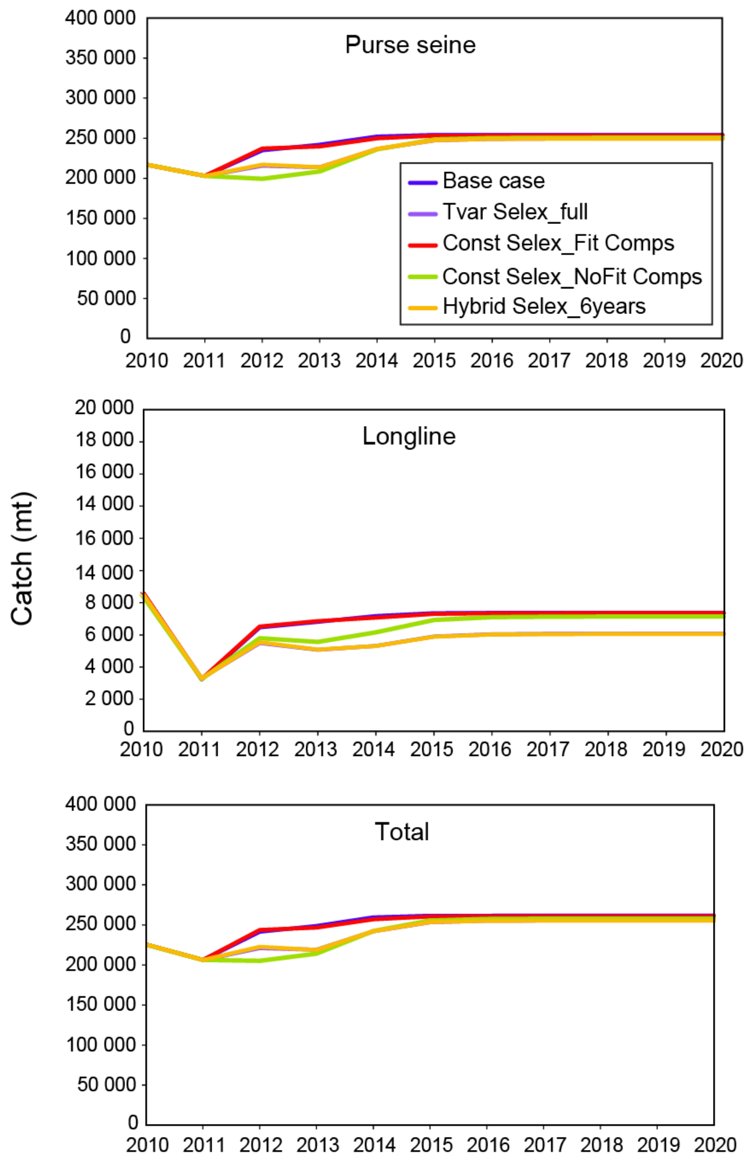


Comparisons among methods:
Spawning Biomass Ratio (SBR)





Comparisons among methods:
Projected catches



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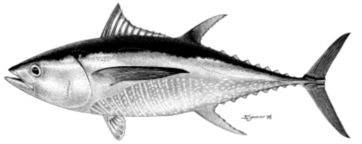
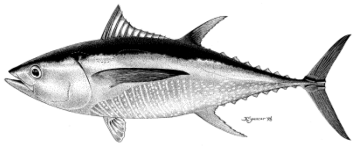
Comparisons among methods:
Management quantities

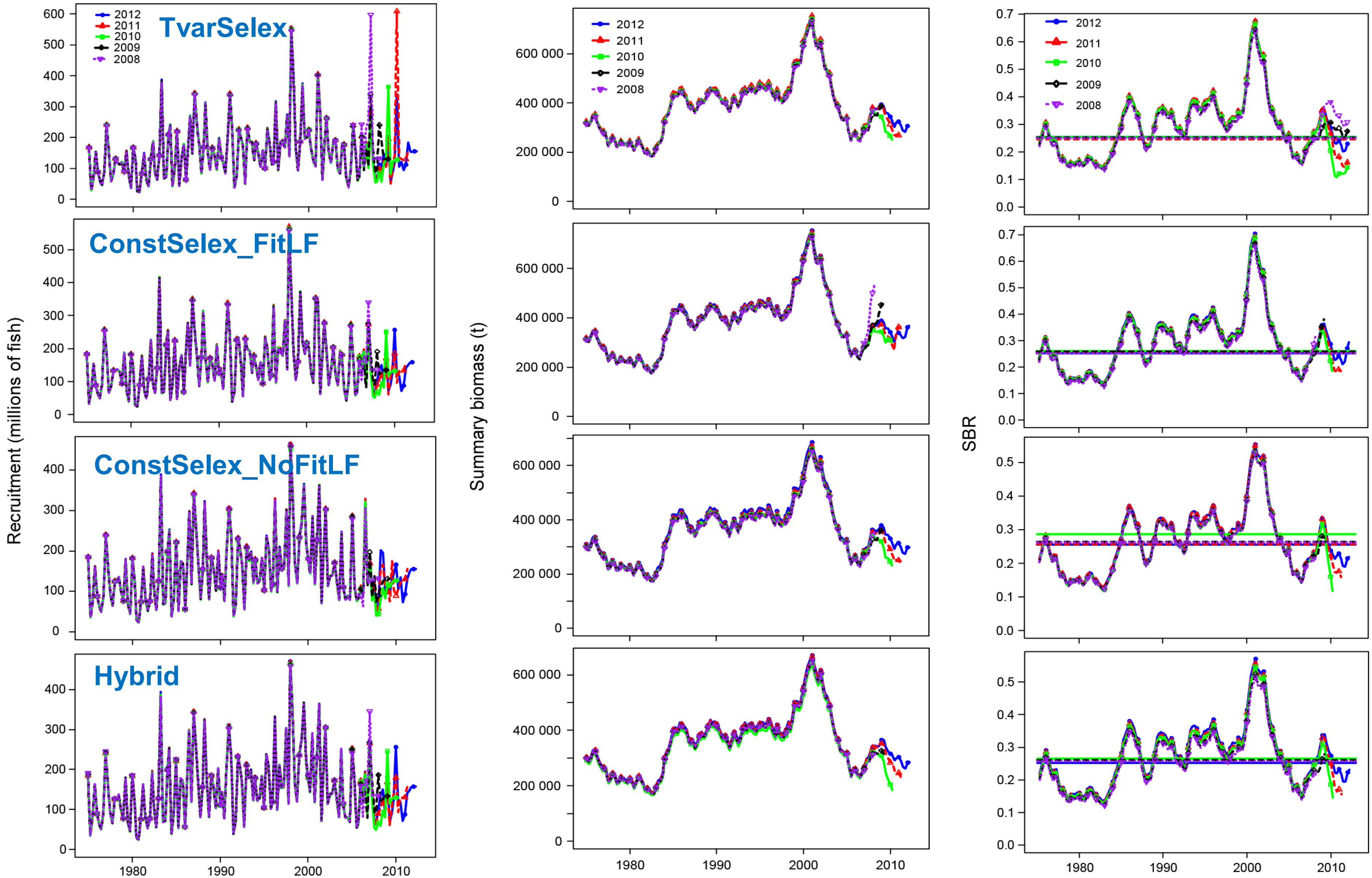


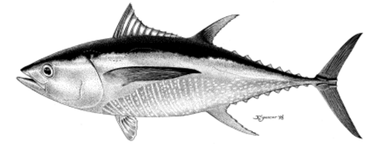
Quantities	Base case	TvarSelex_ full	ConstSelex_ FitComps	ConstSelex_ NoFitComps	Hybrid Selex_6years
MSY	262,642	255,654	262,852	257,868	255,383
B_{MSY}	356,682	352,561	348,836	351,797	348,430
S_{MSY}	3,334	3,292	3,208	3,283	3,239
B_{MSY}/B_0	0.31	0.31	0.31	0.31	0.31
S_{MSY}/S_0	0.26	0.25	0.25	0.26	0.25
C_{recent}/MSY	0.79	0.81	0.78	0.80	0.81
B_{recent}/B_{MSY}	1.00	0.87	1.04	0.81	0.86
S_{recent}/S_{MSY}	1.00	0.91	1.07	0.84	0.89
F multiplier	1.15	1.02	1.20	1.04	0.99

Results



Retrospective bias





Conclusions

- Correct specification of selectivity is critical in fisheries stock assessment models that fit to composition data
- Unmodelled temporal variation in selectivity can cause bias in abundance, current status, and short-term projections
- For YFT:
  - Use time-varying selectivity for some fisheries (OBJ) to avoid biases
  - The hybrid approach seems to offer a compromise between modelling time-varying selectivity and computational demands, particularly of MSE is to be conducted
- The performance of the methods need to be simulation tested