Blueline Tilefish: North of Cape Hatteras Data Limited Methods (DLM)

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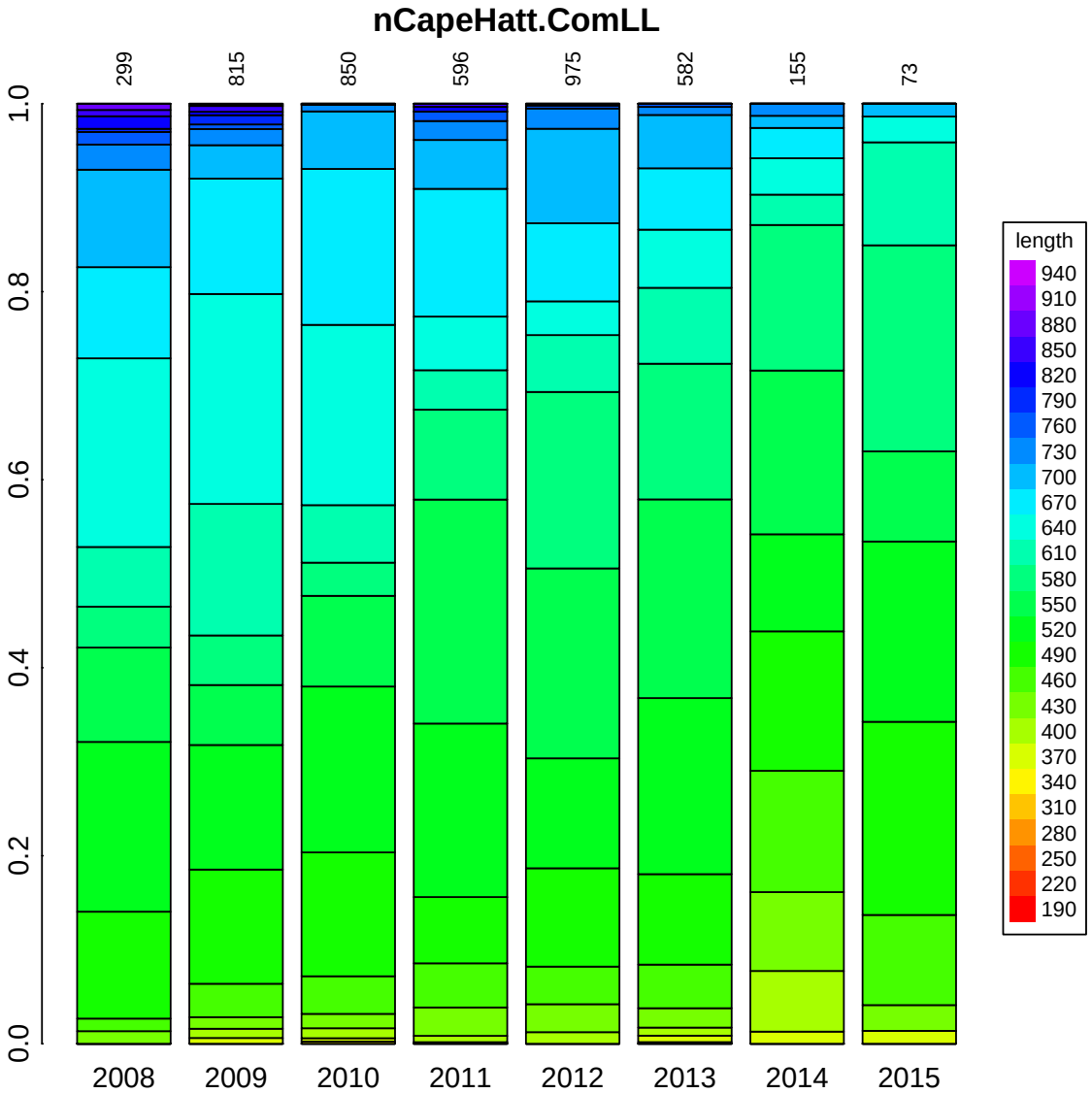
Input Data

- Input data for DLMtool functions are listed below and plotted thereafter where appropriate
- Data supplied to DLMtool are presented here by type:
  - Matrices
  - Vectors
  - Points

Methods

Input Data: Matrices

- Catch-at-length (`CAL`): a single matrix of numbers-at-length by year
- Data used for `CAL` were limited to longline length compositions, over period of years (2008-2015) during a period when landings had recently exhibited a large increase



Methods

Input Data: Vectors

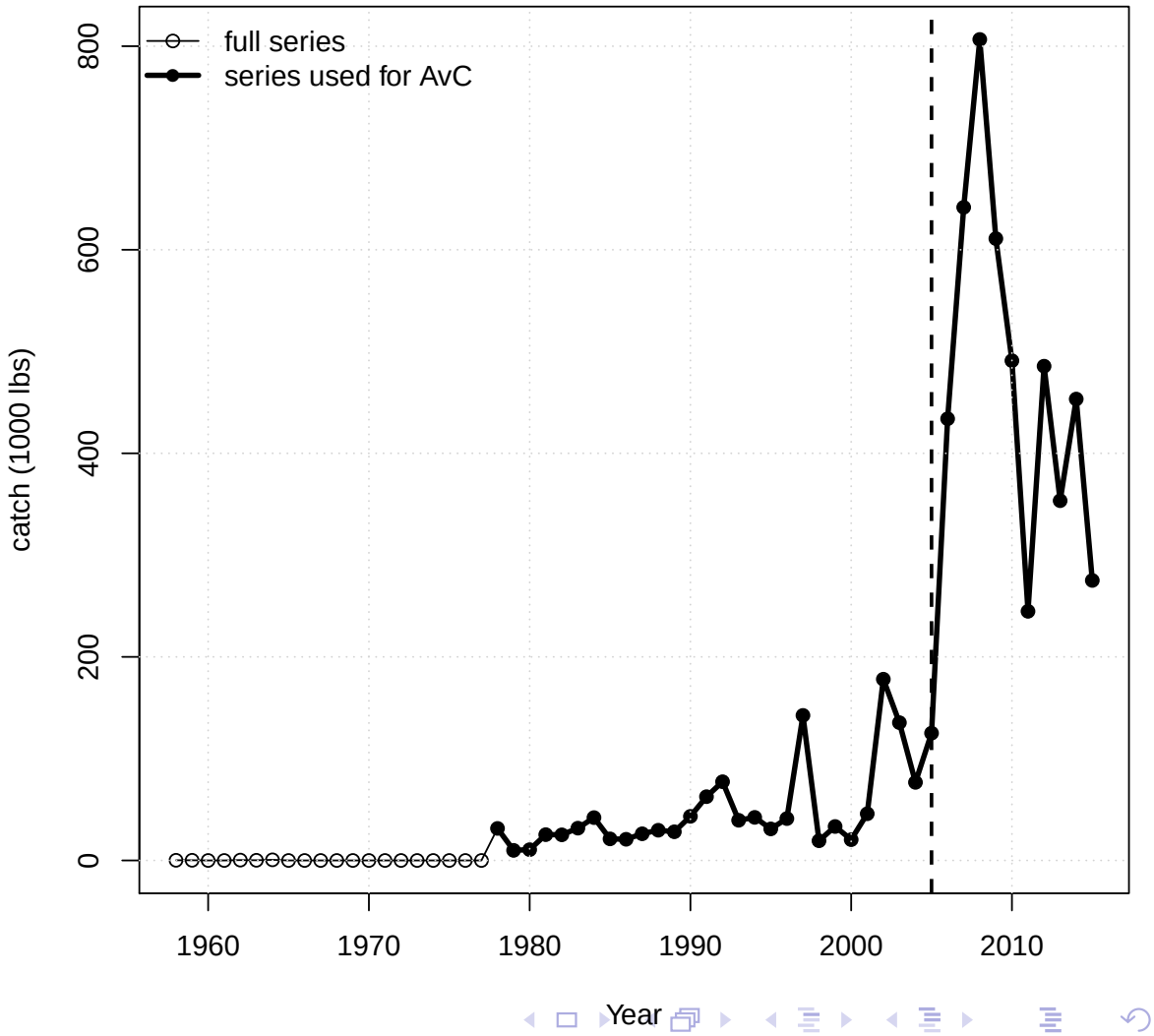
1. catch (`Cat`): time series of removals in pounds. Also used to calculate a CV of catches (`CV_Cat` = 1.3)
2. years (`Year`): years associated with catch data 1978 to 2015
3. mean length (`ML`): mean length by year calculated from `CAL` matrix

Methods

Input Data: Vectors

Catch data used in north of Cape Hatteras DLM analysis

- Full series (thin solid line) includes all removals for all years available
- Truncated series (thick solid line) limited to years where with substantial landings (1978-2015) was used for `Cat`

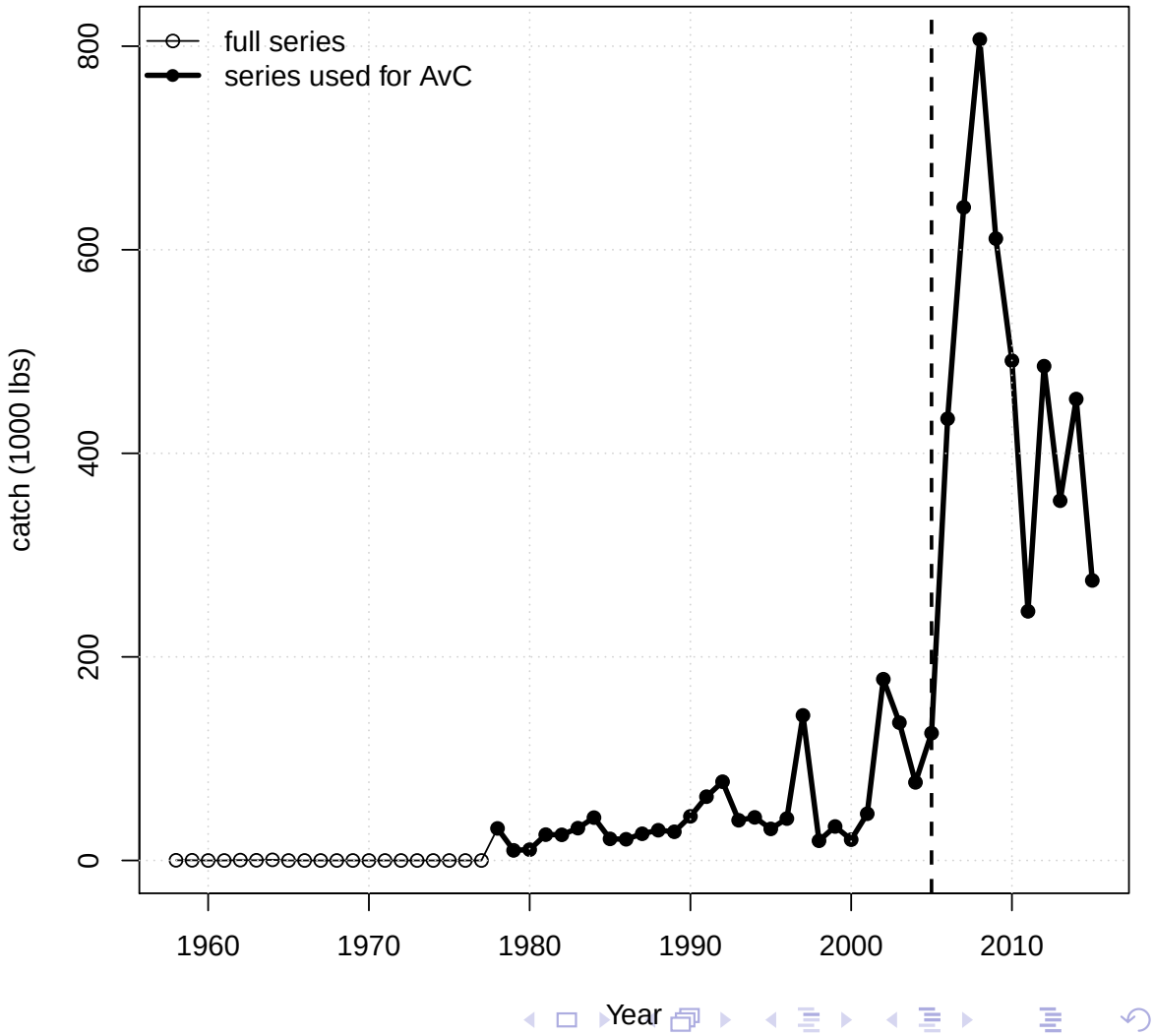


Methods

Input Data: Vectors

Catch data used in north of Cape Hatteras DLM analysis

- This series was further divided into an early period (1978-2005) of lower landings and a late period (2006-2015) of higher landings
- Dashed vertical line at 2005 divides early and late periods



Methods

Input Data: Points

1. natural mortality (M; `Mort`): Estimate of M based on $t_{\max} = 40$ and the Then et al equation. An upper estimate of $M = 0.25$, based on $t_{\max} = 26$ and the Then et al equation, was used to estimate a CV. A normal distribution was assumed around M, for which 0.25 represented the 97.5th percentile. The CV of this distribution was used then determined: `Mort` $= 0.17$, `CV_Mort` $= 0.24$
2. L_{50}: length at 50% maturity $= 305$ mm. Very few immature fish. (`CV_L50` $= 0.45$)
3. length at first capture: Minimum size among all lengths in `CAL` (`LFC` $= 340$ mm.). These data were bootstrapped 1000 times to calculate `CV_LFC` $= 0.01$
4. length at full selection: Set to the mean of the distribution of all lengths `CAL` (`LFS` $= 577$ mm.). The CV was also calculated directly from this distribution (`CV_LFS` $= 0.14$)

Methods

Input Data: Points

6. Von Bert. K: Value from meta-analysis. See SEDAR 50 DW Report (`vbK` $= 0.16$, `CV_vbK` $= 0.23$).
7. Von Bert. L_∞: Value from meta-analysis. See SEDAR 50 DW Report (`vbLinf` $= 690$, `CV_vbLinf` $= 0.024$).
8. Von Bert. t_0 (`vbt0`): Value from meta-analysis. See SEDAR 50 DW Report (`vbt0` $= -1.33$, `CV_vbt0` $= -0.18$).
9. weight length equation parameter a: SEDAR 50 blueline tilefish $W = aL^b$ fit (`wla` $= 1.78e-05$, `CV_wla` $= 0.08$; units: mm and g)
10. weight length equation parameter b: SEDAR 50 blueline tilefish $W = aL^b$ fit (`wlb` $= 2.94$, `CV_wlb` $= 0.004$; units: mm and g)

Methods

Input Data: Points

11. Beverton-Holt steepness parameter: Estimate from SEDAR 32 meta-analysis (`steep` = 0.836). The CV was taken from a meta-analysis by Shertzer and Conn (2012; `CV_steep` = 0.24)
12. average catch: The arithmetic mean of `Cat` and corresponding CV (`AvC` = 163517 lbs, `CV_AvC` = 0.21)
13. maximum age: Estimate based on Golden Tilefish `MaxAge` = 40 years.
14. assumed observaton error of the length composition data: Default guess `sigmaL` = 0.2
15. number of years corresponding to `AvC` and `Dt` (`t` = 38 years)

Methods

Available Methods for Calculating TACs with **DLMtool**

1. `AvC`: Average catch over entire `Cat` time series (1978-2015)
   1.1 `AvC.early`: Average catch over early `Cat` time series (1978-2005)
   1.2 `AvC.late`: Average catch over late `Cat` time series (2006-2015)
2. `CC1`: Average catch over most recent 5 years of `Cat` time series
3. `CC4`: 70% of average catch over most recent 5 years of `Cat` time series

Methods

Available Methods for Calculating TACs with DLMtool

4. `SPMSY`: Catch trend Surplus Production MSY MP
   - Uses Von Bert. parameters and L_{50} to calculate a_{50}
   - Uses a set of rules based on the Von Bert. K_{vb} parameter, t_{max}, and a_{50}, to set the range of r values to sample from, then generates a random uniform sample of r (i.e. r_{sample})
   - Generates carrying capacity K values by sampling a random uniform distribution
     from $mean(\texttt{Cat})/(r_{\text{sample}})$ to $10 * mean(\texttt{Cat})/(r_{\text{sample}})$
   - Initial biomass (B_1) is then set based on whether the first year of `Cat` is greater or less than $0.5max(\texttt{Cat})$
   - Time series of B are then generated with a Schaefer model
   - $dep = B_{\text{current}}/K$
   - $(r/2) * K * dep = F_{\text{MSY}} B_{\text{current}} = \text{TAC}$

Methods

Available Methods for Calculating TACs with DLMtool

5. `Fdem_ML`: Demographic F_{MSY} method that uses mean length data to estimate recent Z.
   - Uses Gedamke and Hoenig non-equilibrium mean length method to estimate recent Z then subtracts M to estimate F_{recent}
   - Calculates B_{current} as the most recent year of catch divided by $1 - \exp(-F_{\text{recent}})$
   - Using life history data, solves the Euler-Lotka equation for r
   - Calculates $r/2 = F_{\text{MSY}}$
   - $F_{\text{MSY}} B_{\text{current}} = \text{TAC}$

Methods

Available Methods for Calculating TACs with DLMtool

6. `YPR_ML`: Yield Per Recruit analysis to get F_{MSY} proxy ($F_{0.1}$) paired with a mean-length estimate of current stock size
   - Uses Gedamke and Hoenig non-equilibrium mean length method to estimate recent Z then subtracts M to estimate F_{recent}
   - Calculates B_{current} as the most recent year of catch divided by $1 - \exp(-F_{\text{recent}})$
   - Conducts a yield-per-recruit analysis to determine the value of F at which the slope of the $YPR = f(F)$ curve is 10% of the slope of this curve at the origin (i.e. $F_{0.1}$)
   - $F_{0.1}$ serves as a proxy for F_{MSY}
   - $F_{\text{MSY}} B_{\text{current}} = \text{TAC}$

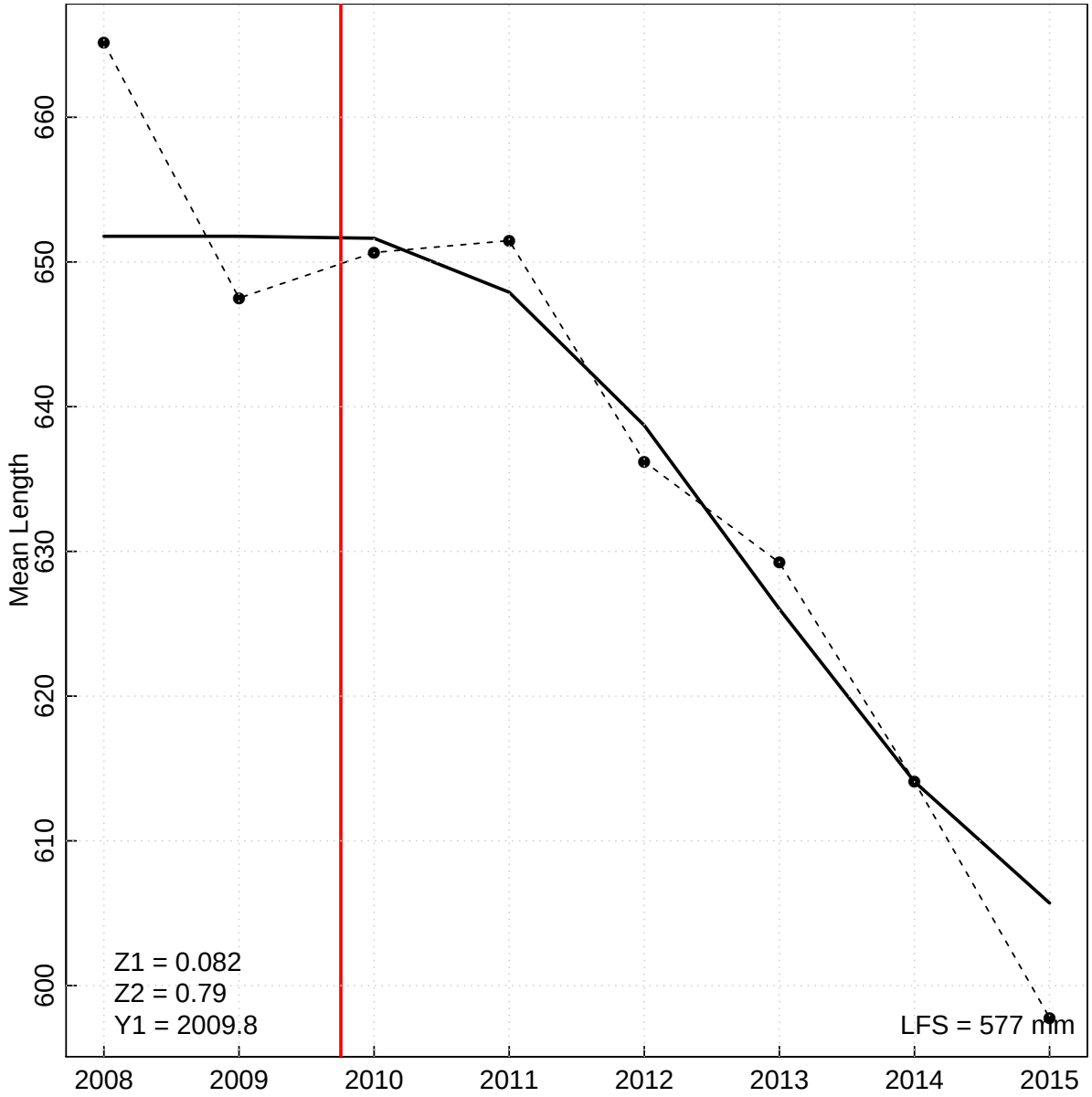
Methods

Table: Data required by each data limited method. These methods were applied to all regions.

Data.type	AvC	CC1	CC4	Fdem.ML	SPMSY	YPR.ML
Bev. Holt. steepness				X		
Bev. Holt. steepness (CV)				X		
Catch at length matrix				X		X
Catch time series	X	X	X	X	X	X
Catch time series (CV)		X	X	X		X
Length at 50% maturity					X	
Length at full selection						X
Length at full selection (CV)						X
Maximum age				X	X	X
Natural mortality				X		X
Natural mortality (CV)				X		X
Von. Bert. K				X	X	X
Von. Bert. K (CV)				X		X
Von. Bert. L_∞				X	X	X
Von. Bert. L_∞ (CV)				X		X
Von. Bert. t_0				X	X	X
Von. Bert. t_0 (CV)				X		X
weight-length parameter a				X		X
weight-length parameter b				X		X
Years of catch time series		X	X			

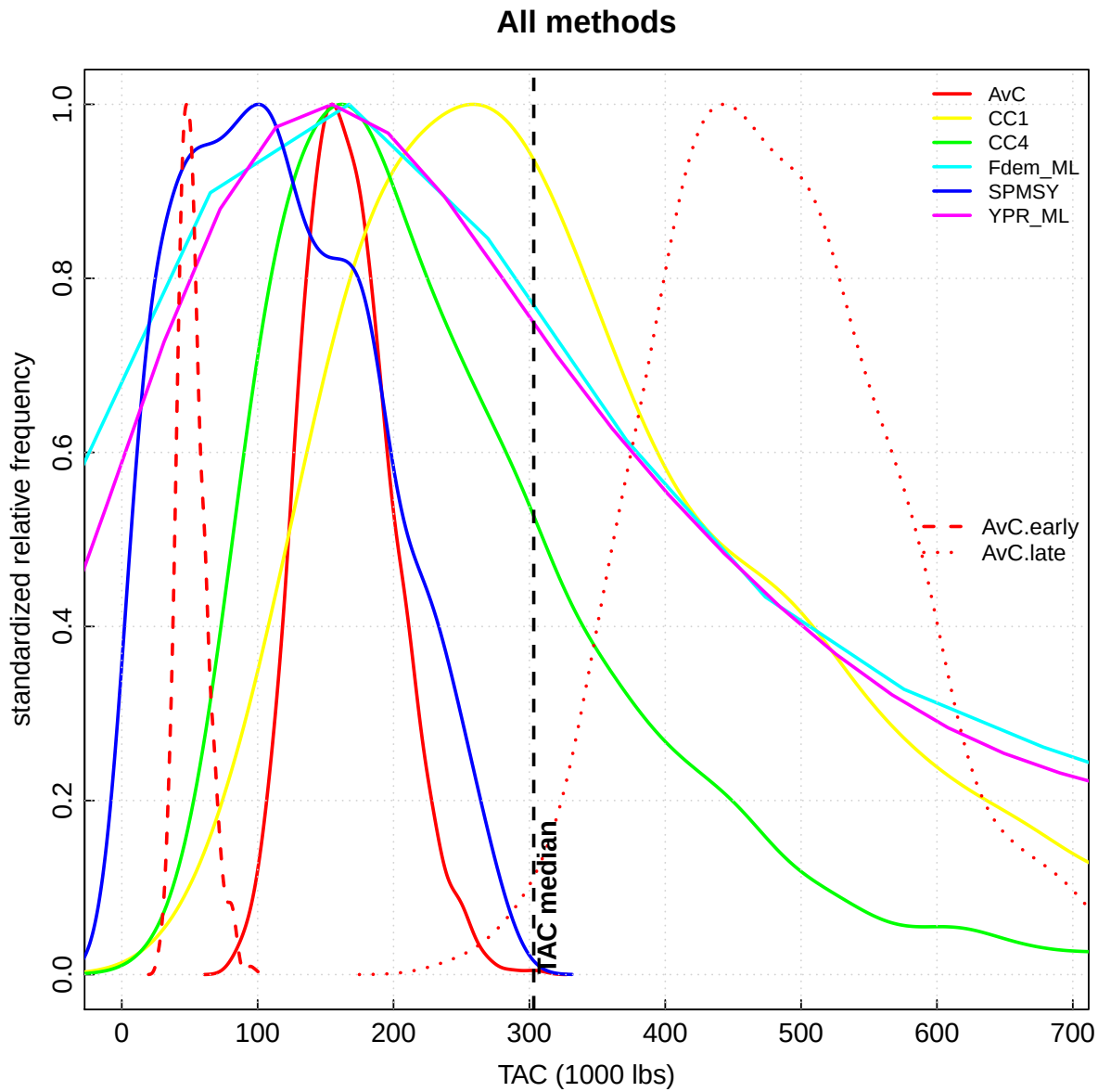
Results

Observed and estimated mean length series for north of Cape Hatteras DLM analysis



Results

Distributions of TACs from north of Cape Hatteras DLM analysis



Results

Table: TAC quantiles for all DLM methods North of Cape Hatteras

Quantile	AvC	CC1	CC4	Fdem.ML	SPMSY	YPR.ML	AvC.early	AvC.late	TOTAL
2.5%	109	104	78	23	9	26	35	326	30
5%	116	129	93	31	15	41	37	350	40
10%	126	157	106	52	25	59	40	371	49
25%	142	215	147	117	60	135	45	416	103
50%	164	309	214	290	110	310	51	474	193
75%	188	456	311	805	170	743	58	540	413
90%	211	620	437	2085	217	1628	67	597	619
95%	226	748	526	3798	240	2911	72	647	998
97.5%	239	857	628	5847	254	5353	78	690	1854

Discussion

- For the areas north of Cape Hatteras DLMtool analyses are presented as the main analysis
- Estimated MSY proxies ranged widely (medians 51,000 ??? 474,000 lbs)
- Minimum estimate from `AvC.early` (1978-2005; 51,000 lbs)
  - Sustainable for nearly three decades
- Maximum estimate from `AvC.late` (2006-2015; 474,000 lbs)
  - More than double MSY for area south of Cape Hatteras (ASPIC MSY = 212,000 lbs) or for the Gulf of Mexico (ASPIC Gulf of Mexico Run 10 MSY = 177,000 lbs).
- Recent removals north of Cape Hatteras also appear to be causing decreases in mean length, at approximately 1cm per year since 2010