

SEDAR 46 Review Workshop: Estimating mortality rates and deriving overfishing limits using length observations

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Outline

- Application of mean length mortality estimator for point estimates of mortality
- Application of DLMtool
 - Management Strategy Evaluations (MSEs) of mean length-based management procedures (MPs)
 - Distribution of overfishing limits (OFLs) from MPs
- Stock-specific results
- Conclusions

Application of mean length mortality estimator

- Non-equilibrium Beverton-Holt mean length-based mortality estimator by Gedamke and Hoenig (2006)
- Method assumes observed length distribution above critical length L_c reflects that of the population
- Lengths from most sampled gear usually used
- Determine L_c and calculate annual mean lengths $> L_c$
- Total mortality Z estimated in periods of time from a time series of mean lengths
 - User specifies number of changes in Z
- Use statistical diagnostics (AIC, trends in residuals) to find best fit model
- Other assumptions: Continuous & constant recruitment, deterministic growth, step-wise changes in Z

Application of mean length mortality estimator

- Derive point estimates of OFL
 - From results of mean length estimator and external natural mortality M :

$$F_{recent} = Z_{recent} - M$$

- Prescribe OFL:

$$OFL = F_{MSY} \cdot Abun = F_{MSY} Catch_{recent} / F_{recent}$$

- Possible F_{MSY} proxies:
 - $F_{0.1}$ (YPR_ML)
 - $F_{SPR=30\%}$ (SPR30_ML)
 - $F_{SPR=40\%}$ (SPR40_ML)

Application of DLMtool

- Management strategy evaluation of mean length MPs for the 6 stocks
- DLMtool MSE components:
 - Stock - 15% variability in life history
 - Fleet
 - Logistic selectivity - PR yellowtail snapper, PR hogfish, STX stoplight parrotfish
 - Highly-Domed selectivity - STT queen triggerfish, STT spiny lobster, STX spiny lobster
 - Observation – Precise, unbiased
- 500 simulations, 250 reps, 75 historical years, 40 projections years, interval of 3 years (all converged at 1% threshold)
- Alternative MSEs
 - Observation is imprecise, biased (all 6 stocks)
 - Moderate Dome for STT queen triggerfish, STT spiny lobster, STX spiny lobster

Application of DLMtool

- Performance metrics
 - PNOF P(not overfishing)
 - B50 P($B > 0.5 B_{msy}$)
 - LTY Long-term yield
 - AAVY Average annual variability in yield

- For MPs which met management criteria:
 - Stochastic OFLs
 - Sensitivity analysis of OFL to input parameters
 - Von Bertalanffy K and L_{inf}
 - Catch and M
 - Von Bertalanffy t_0 , Length-weight a, b

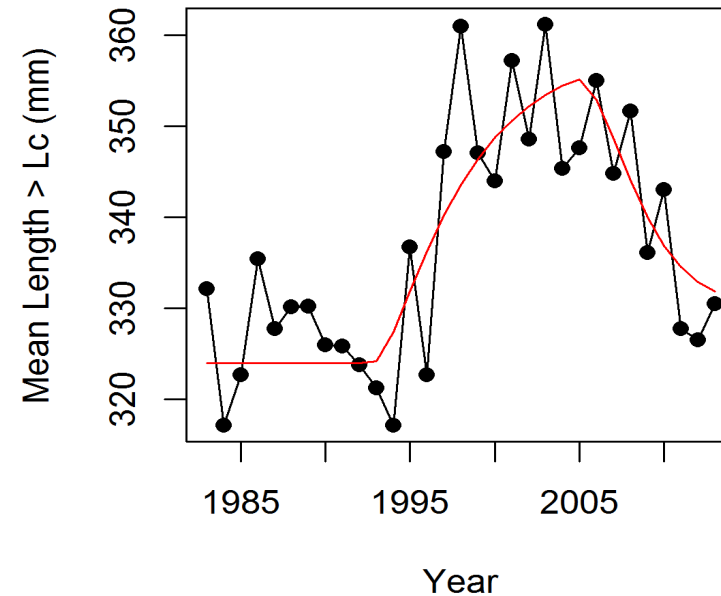
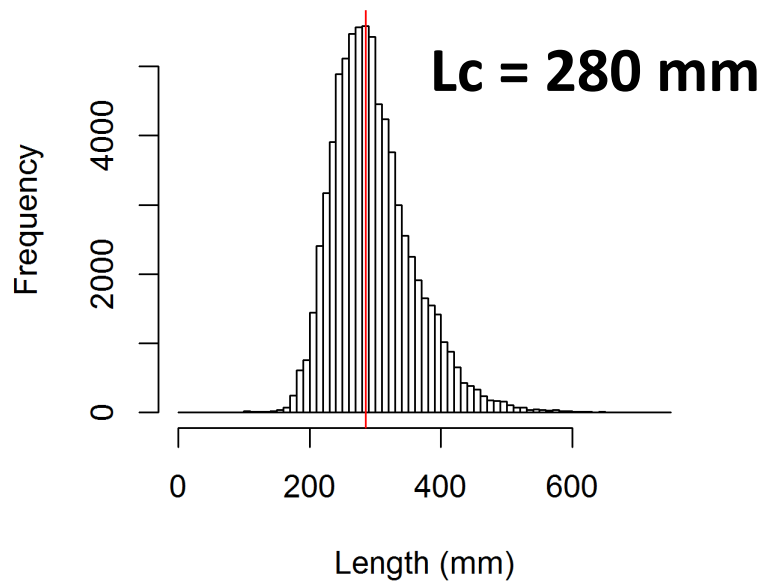
Stock-specific results

- Application of mean length estimator
- MSEs of mean length MPs for the 6 stocks
 - If management criteria met: quantiles and point estimates of OFLs
- Sensitivity analyses of OFLs to input values

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Puerto Rico yellowtail snapper: mean length estimator



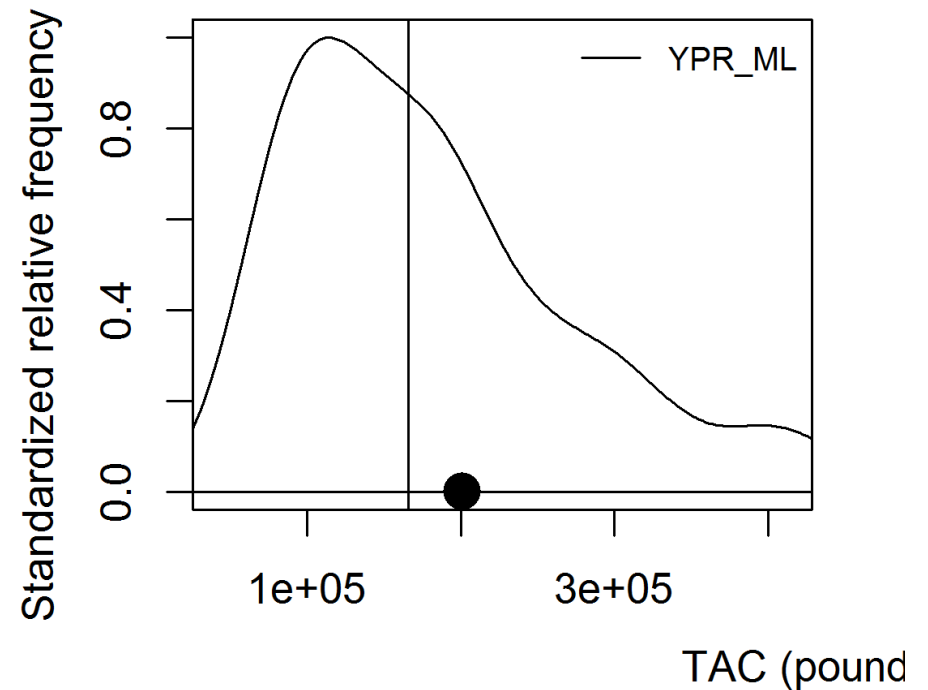
<http://www.photolib.noaa.gov/>

<u>Z</u>	<u>Time</u>
0.56	1983.0 – 1992.8
0.26	1992.8 – 2004.5
0.48	2004.5 – 2013.0

Puerto Rico yellowtail snapper: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	91	98	100	100
YPR_ML**	54	73	69	95
SPR30_ML	15	41	60	96
SPR40_ML	40	62	68	94

** MP meets management criteria



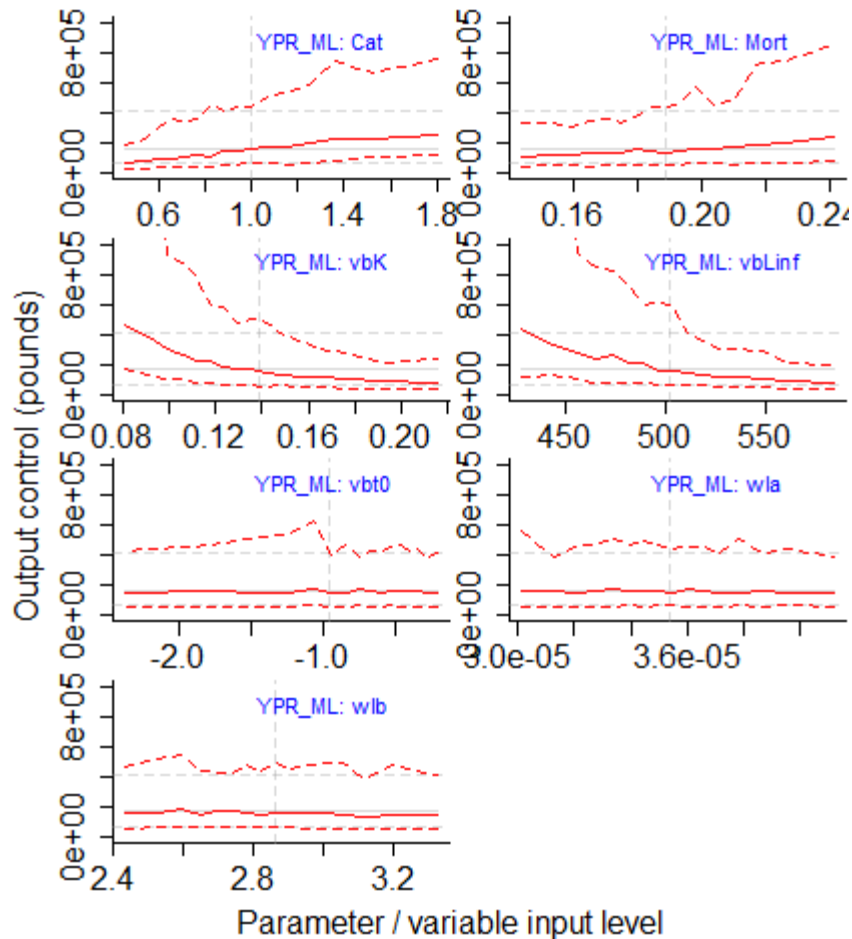
Dot: point estimate

Vertical line: median of distribution

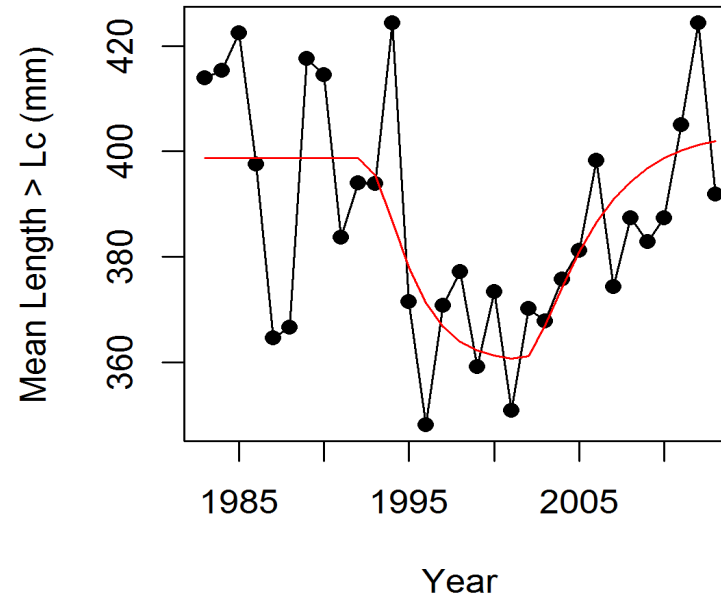
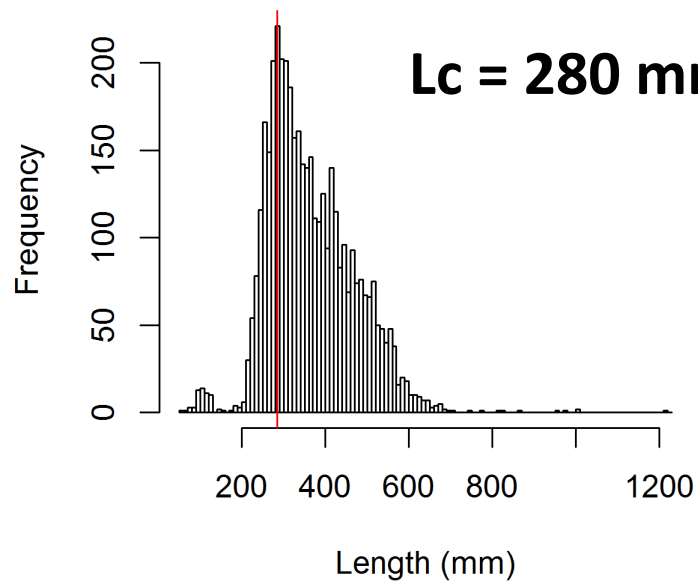
OFL quantiles (x 1000 pounds)

MP	Min	25%	Median	75%	Max	Point Estimate
YPR_ML**	31.9	109.1	166.0	241.2	734.1	201.3

Puerto Rico yellowtail snapper: DLMtool – Sensitivity of OFL



Puerto Rico hogfish: mean length estimator



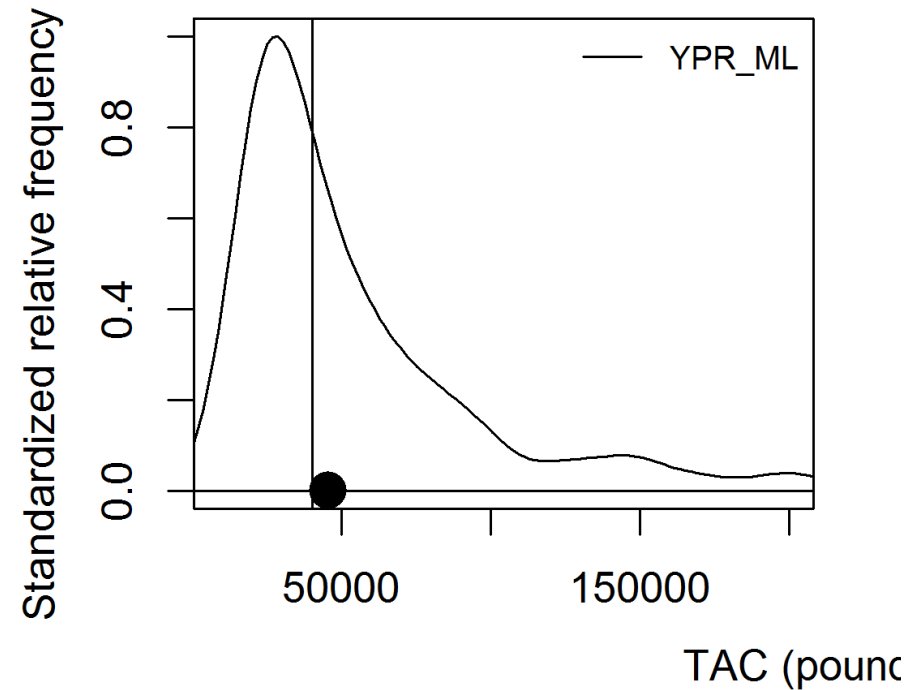
<http://www.photolib.noaa.gov/>

<u>Z</u>	<u>Time</u>
0.36	1983.0 – 1992.8
0.56	1992.8 – 2000.7
0.34	2000.7 – 2013.0

Puerto Rico hogfish: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	96	96	100	100
YPR_ML**	70	84	77	78
SPR30_ML	24	48	55	82
SPR40_ML	49	70	73	77

** MP meets management criteria



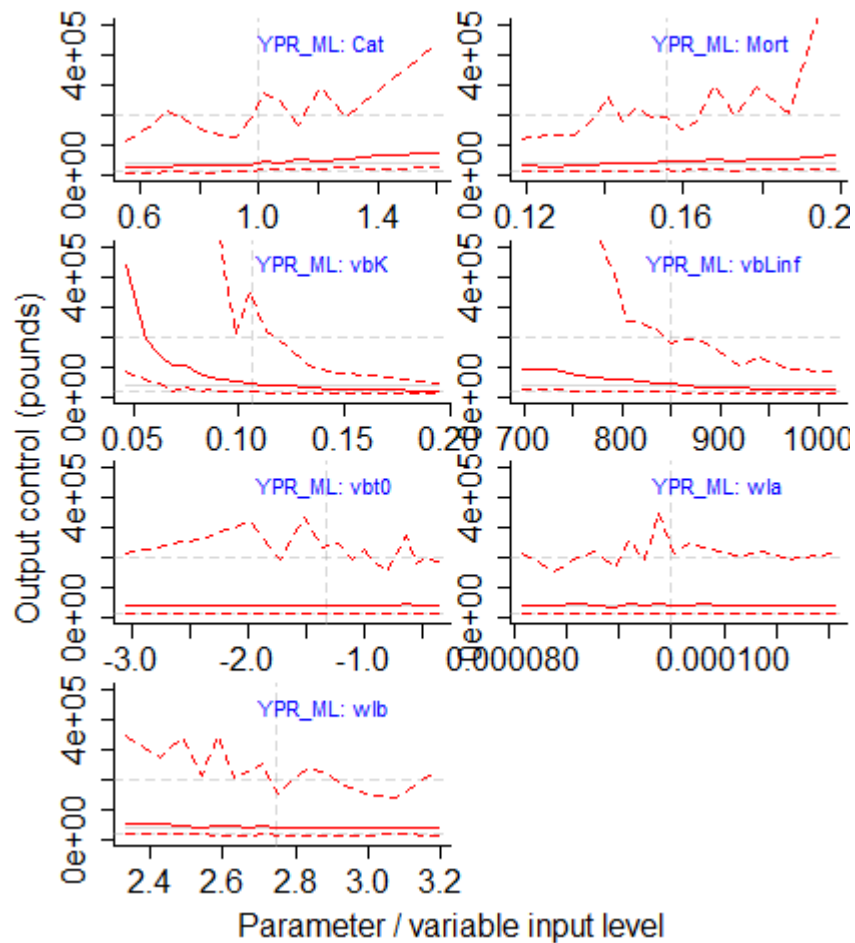
Dot: point estimates

Vertical line: median of distribution

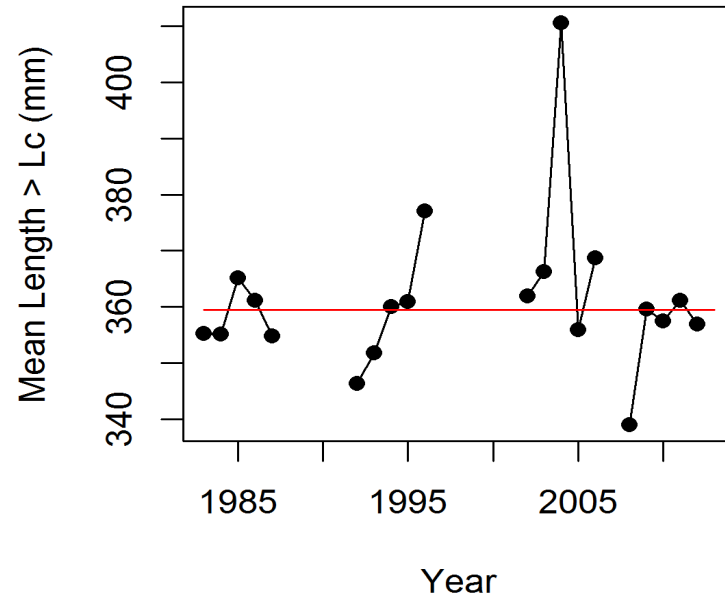
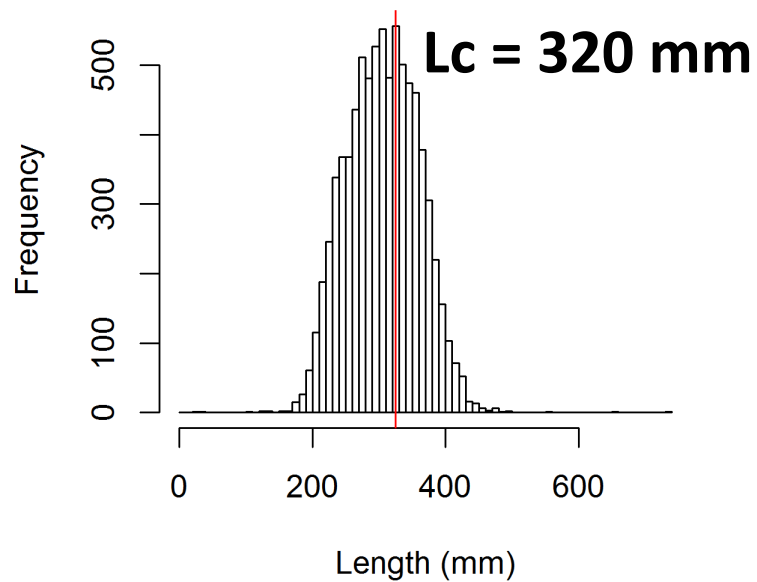
OFL quantiles (x 1000 pounds)

MP	Min	25%	Median	75%	Max	Point Estimate
YPR_ML**	4.2	26.1	40.2	72.8	890.7	45.8

Puerto Rico hogfish: DLMtool – Sensitivity of OFL



STT queen triggerfish: mean length estimator



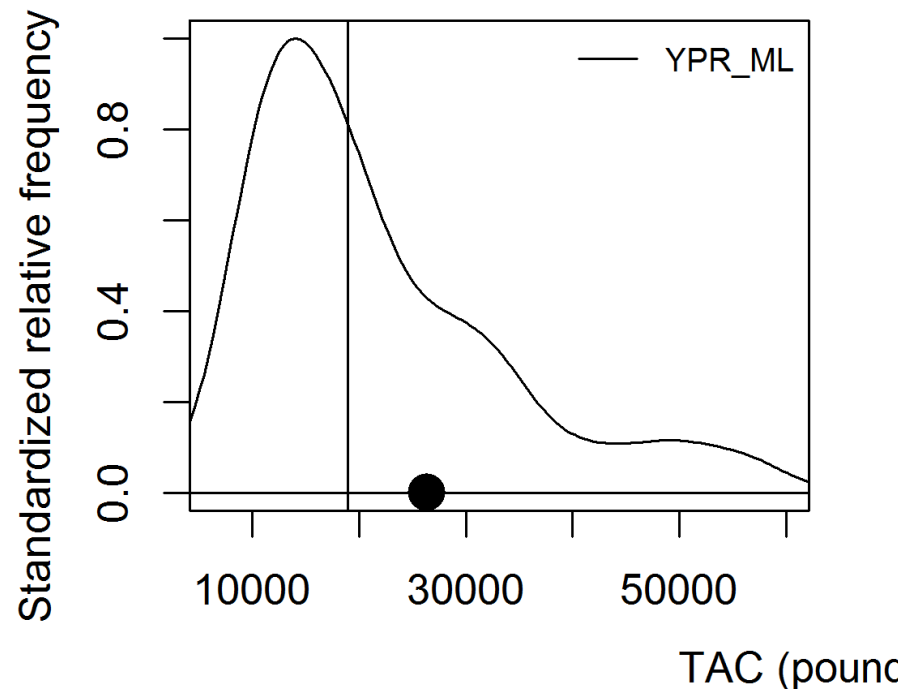
<http://www.photolib.noaa.gov/>

<u>Z</u>	<u>Time</u>
1.34	1983.0 – 2013.0

STT queen triggerfish: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	93	97	97	100
YPR_ML**	65	78	63	93
SPR30_ML	23	40	54	91
SPR40_ML	45	61	64	91

** MP meets management criteria



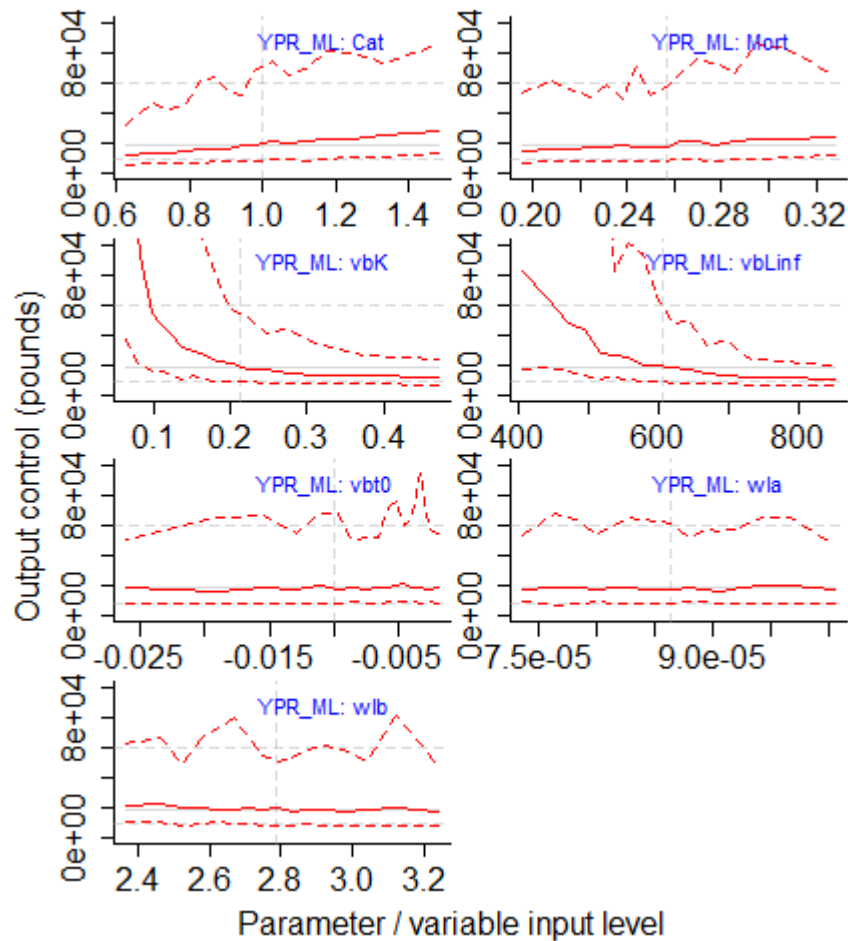
Dot: point estimates

Vertical line: median of distribution

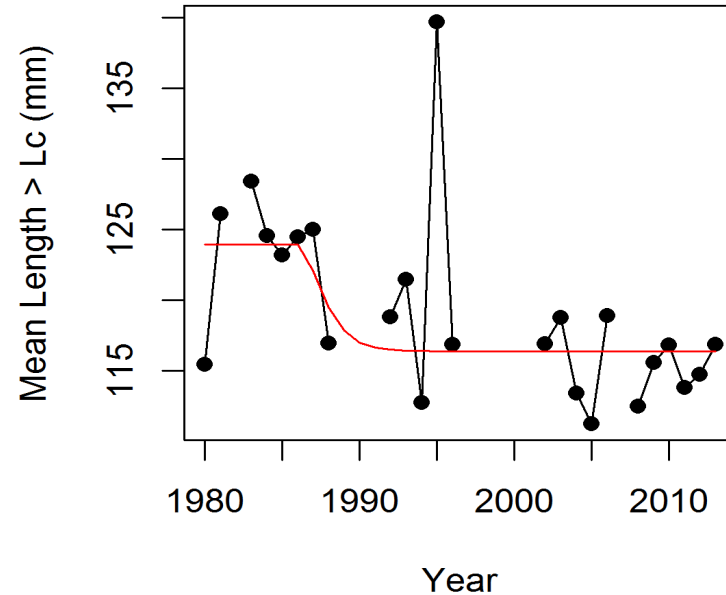
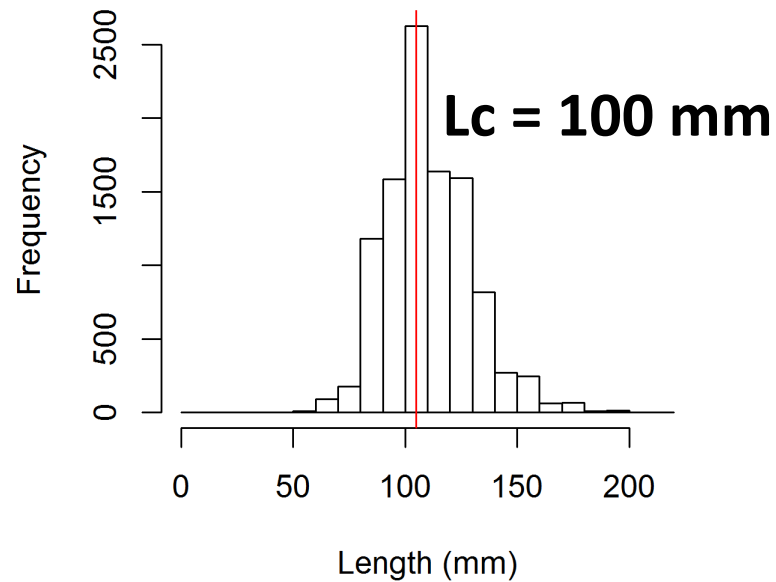
OFL quantiles (x 1000 pounds)

MP	Min	25%	Median	75%	Max	Point Estimate
YPR_ML**	4.7	13.0	18.9	30.2	189.3	26.4

STT queen triggerfish: DLMtool – Sensitivity of OFL



STT spiny lobster: mean length estimator



<http://www.photolib.noaa.gov/>

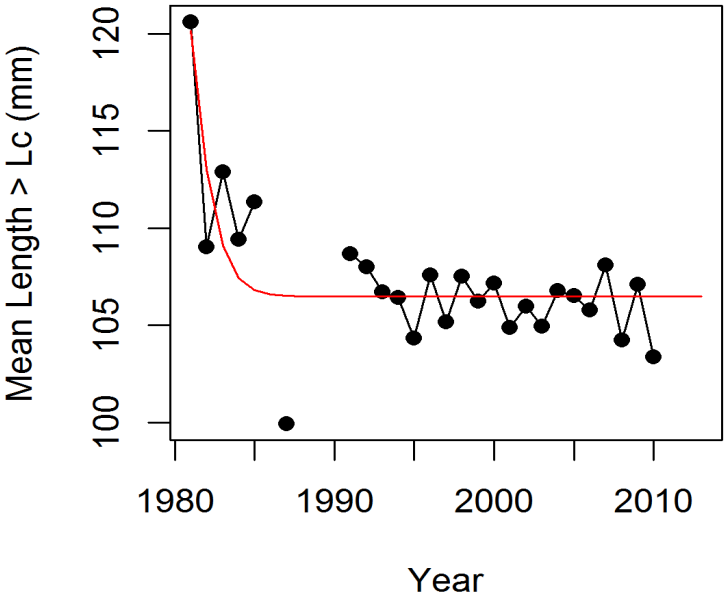
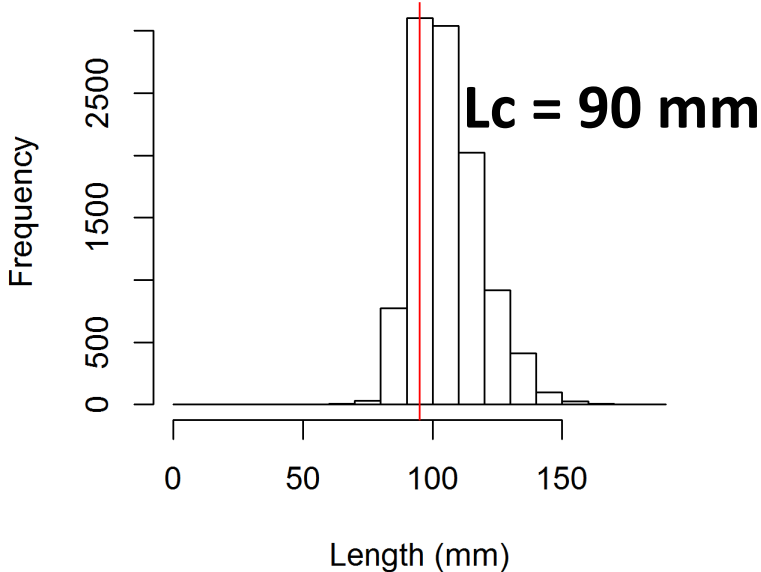
<u>Z</u>	<u>Time</u>
0.59	1980.0 – 1986.0
0.98	1986.0 – 2013.0

STT spiny lobster: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	56	90	78	100
YPR_ML	21	39	16	95
SPR30_ML	3	13	4	87
SPR40_ML	10	23	9	89

None of the mean length MPs meet
management criteria

STX spiny lobster: mean length estimator



<http://www.photolib.noaa.gov/>

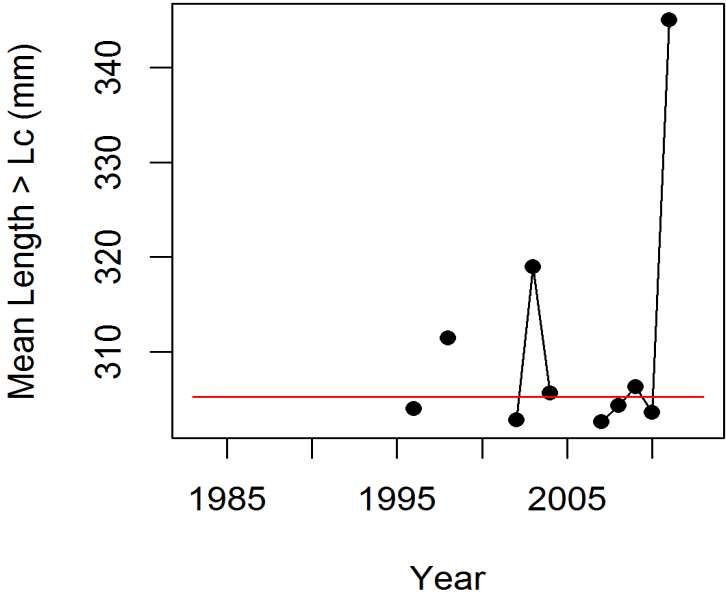
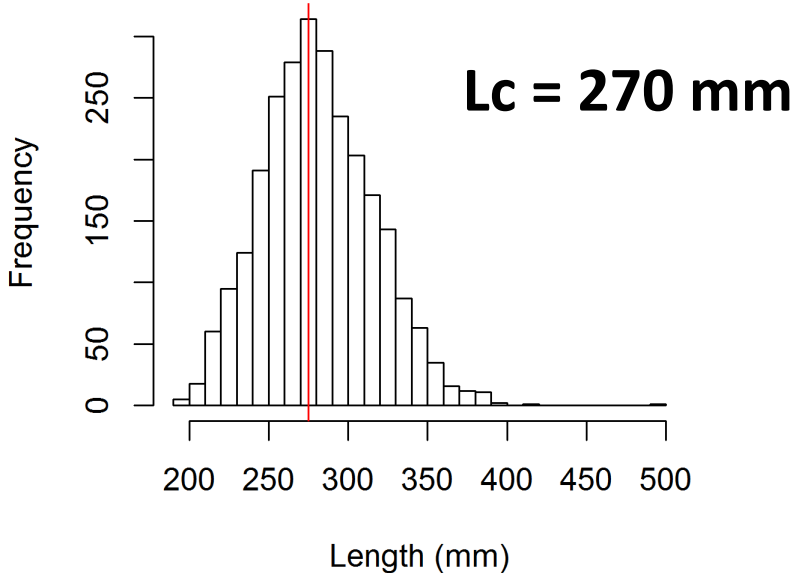
<u>Z</u>	<u>Time</u>
0.35*	– 1979.6
0.98	1979.6 – 2013.0

STX spiny lobster: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	72	91	85	100
YPR_ML	35	63	46	99
SPR30_ML	3	35	26	96
SPR40_ML	9	43	32	97

None of the mean length MPs meet
management criteria

STX stoplight parrotfish: mean length estimator



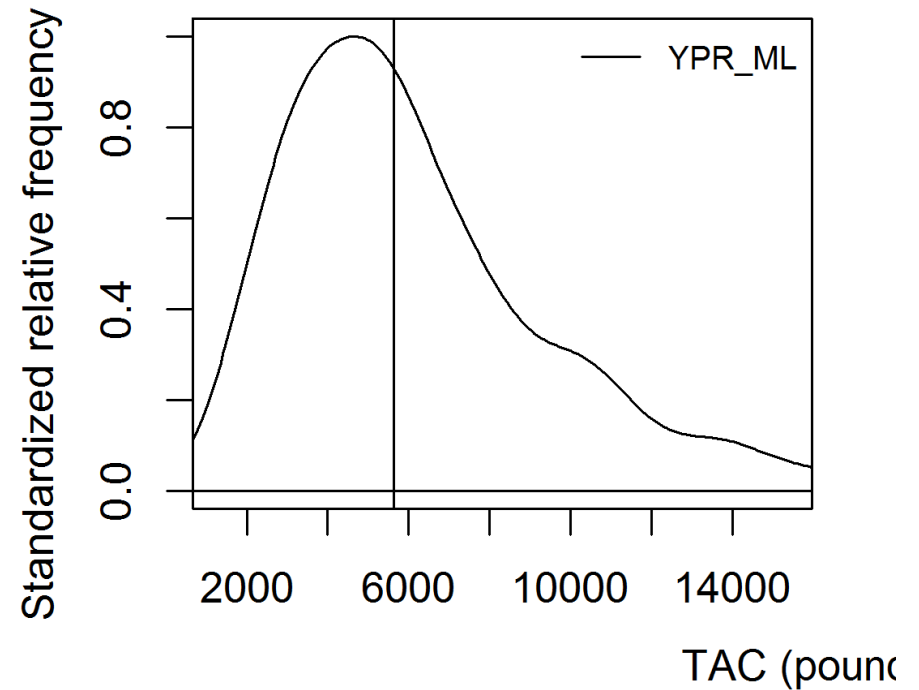
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<u>Z</u>	<u>Time</u>
2.70	1995.0 – 2013.0

STX stoplight parrotfish: DLMtool – MSE/OFL

MP	PNOF	B50	LTY	AAVY
FMSYref	86	97	99	100
YPR_ML**	52	72	75	96
SPR30_ML	14	40	81	98
SPR40_ML	31	56	82	97

** MP meets management criteria



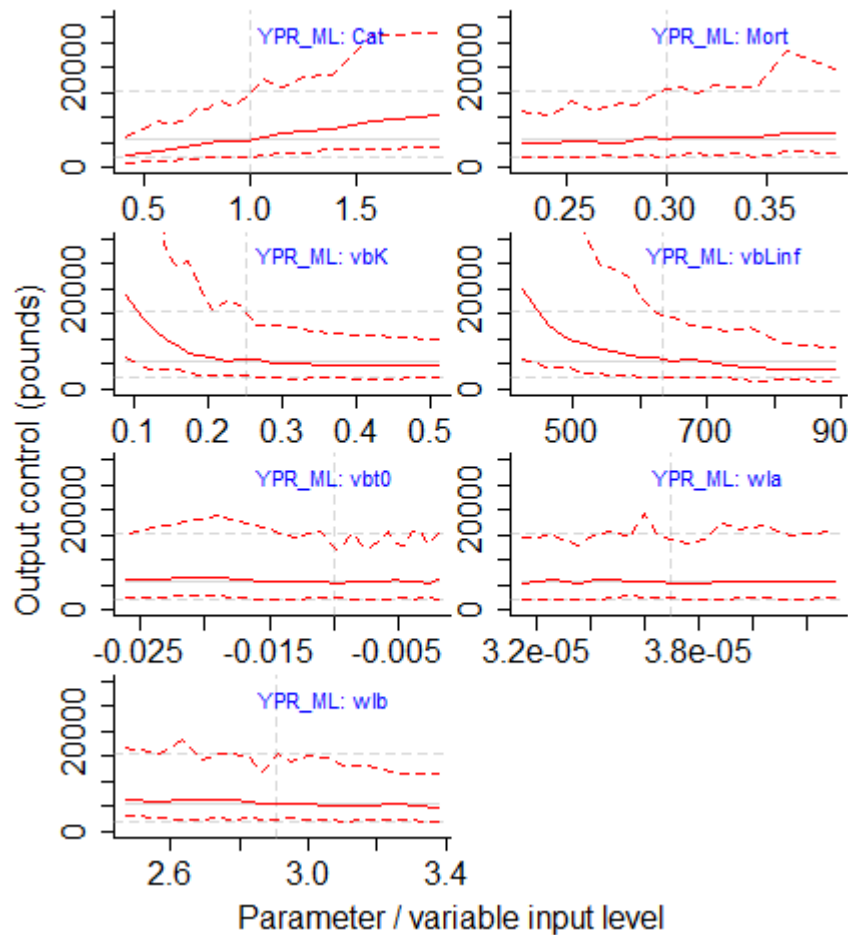
Dot: point estimates

Vertical line: median of distribution

OFL quantiles (x 1000 pounds)

MP	Min	25%	Median	75%	Max	Point Estimate
YPR_ML**	1.0	3.8	5.6	8.2	27.7	21.3

STT stoplight parrotfish: DLMtool – Sensitivity of OFL



Conclusions

Mean length estimator

- Data provided contrast in mortality rates for 4/6 stocks
 - PR yellowtail snapper and PR hogfish - Visible contrast in mean lengths in time series over time
 - STT queen triggerfish – no change in Z detected
 - STT / STX spiny lobster – evidence for change in Z in 1970s/1980s
 - STX stoplight parrotfish - no change in Z detected, short time series, small sample sizes

Conclusions

Application of DLMtool to mean length MPs

(Base simulations)

- From MSEs, YPR_ML (using F-0.1) was the best performing MP, followed by SPR40_ML and SPR30_ML
 - Met management criteria for 4/6 stocks, excluding STT and STX spiny lobster
 - From those 4 stocks, point estimates of OFLs were within interquartile range for 3/4 stocks, excluding STX stoplight parrotfish
- MPs with SPR-based proxies did not perform well
 - None met management criteria
 - Higher SPR thresholds required to meet management criteria

Conclusions

Application of DLMtool to mean length MPs (Alternative simulations)

- Values of management metrics were higher (better) with imprecise observations
 - YPR_ML met management criteria for all 6 stocks
 - SPR40_ML met criteria for PR yellowtail snapper, PR hogfish, and STT queen triggerfish
- Values of management metrics not affected by severity of assumed dome-shaped selectivity pattern

Conclusions

Application of DLMtool to mean length MPs

- Sensitivity analysis of OFL to input values
 - K and $Linf$ are most sensitive – not surprising. Used to estimate Z in mean length estimator
 - $Catch$ and M are somewhat sensitive. Used to OFL and F , respectively.
 - OFL did not vary to different values of t_0 , length-weight a and b