Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

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Length composition data in the IATTC EPO bigeye stock assessment, and the sensitivity of assessment results to the estimated L infinity value

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Outline

- Introduction to current IATTC bigeye stock assessment
- Length composition data in the IATTC EPO bigeye stock assessment
- Specification of growth in the current stock assessment
- The sensitivity of assessment results to the estimated L infinity value

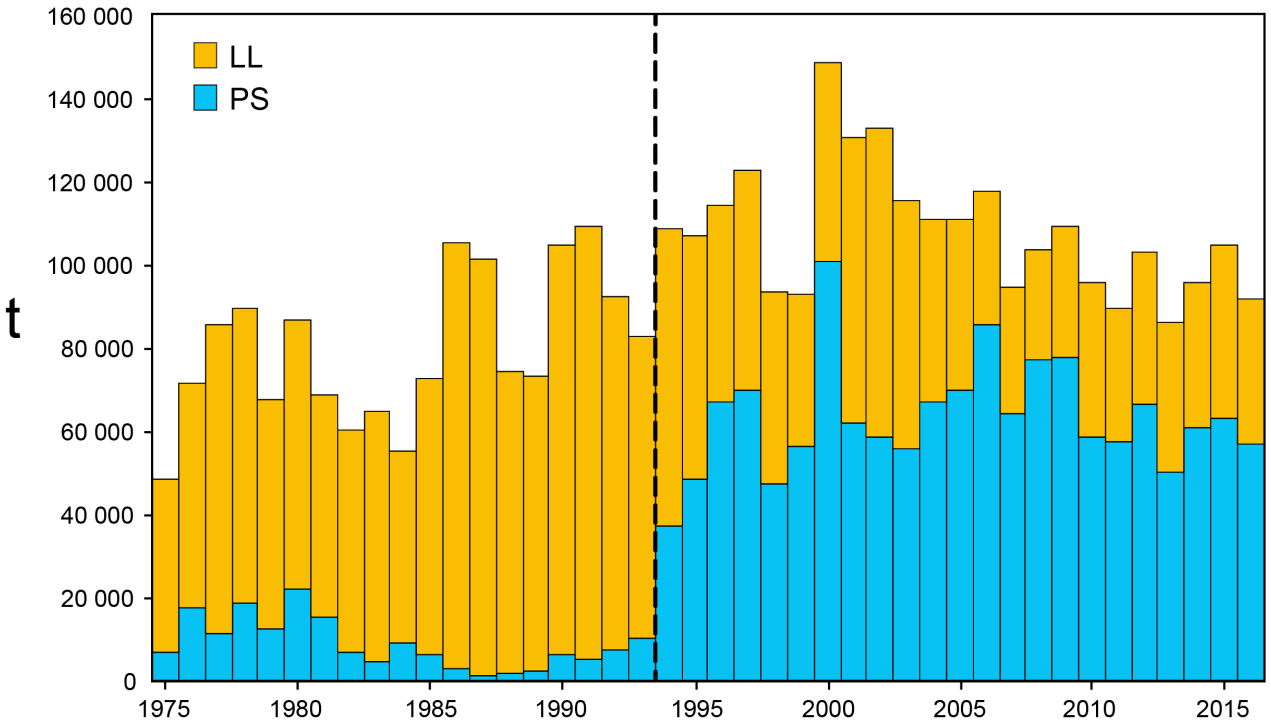
IATTC bigeye stock assessment (base case)

- Integrated stock assessment model: Stock Synthesis v3.23
- Quarter-as-year: 1975-2017 with a model time step of one quarter (172 model years)
- Area-as-fleet: 11 PS fleets and 8 LL fleets
- Fitted to a variety of data including catch, discard, CPUE, and length comp
- Length comps are down-weighted by a factor of 20 (lambda = 0.05) to reduce the pronounced recruitment shift
- Growth curve is estimated outside the stock assessment model

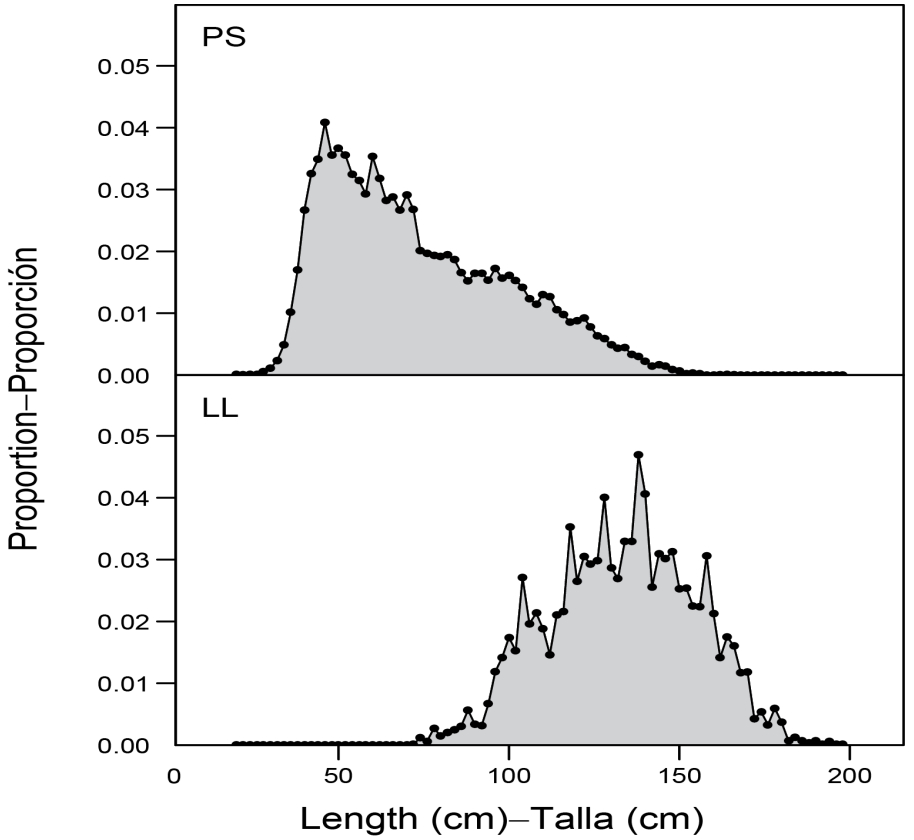
Length composition data in the IATTC EPO bigeye stock assessment

- Sources: purse-seine (PS) fishery and longline (LL) fishery

Expansion of the PS fishery after 1993



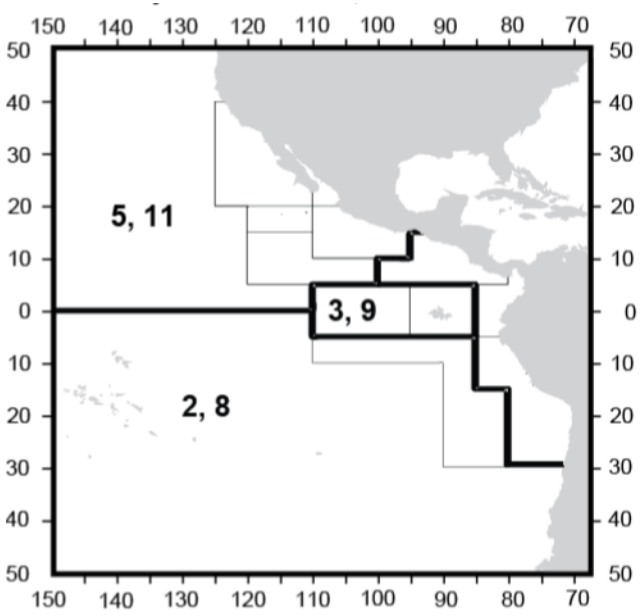
PS fishery catches small-medium bigeye
LL fishery catches medium-large bigeye



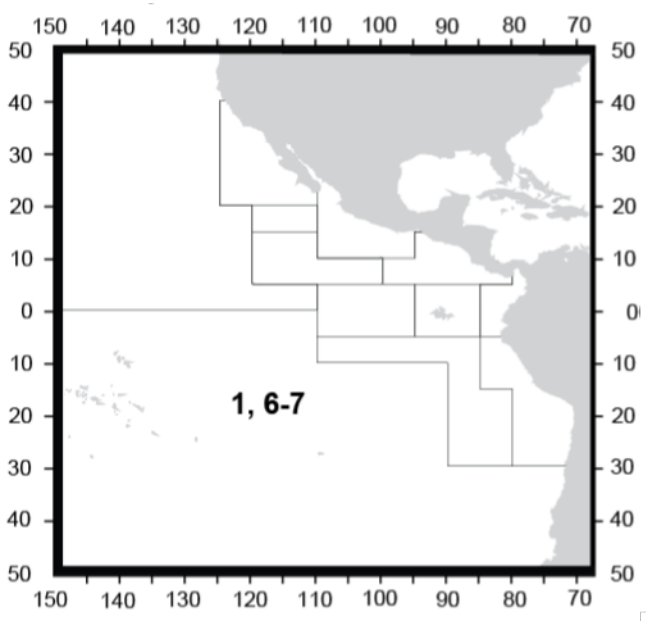
Length composition data in the IATTC EPO bigeye stock assessment

- Area-as-fleet approach: 11 PS fleets and 8 LL fleets

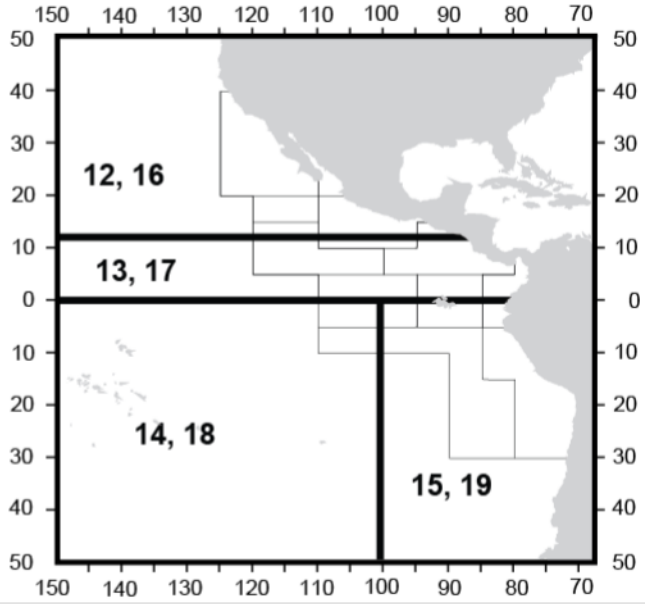
Floating object fishery
dome-shaped selex



Unassociated fishery
dome-shaped selex



Longline fishery
dome-shaped & asymptotic selex



Length composition data in the IATTC EPO bigeye stock assessment

- Spatial resolution of length-comp data: 5° by 10° for LL and 5° by 5° for PS (since 2000)
- Input sample size of PS length-comp = number of wells sampled
- Input sample size of LL length-comp = number of fish sampled * scaler (rescaled to have the same mean (~16) as PS length comp)

  Assumption: PS and LL length-comps have same data quality
- 90 length bins with a bin size of 2cm (20, 22, …, 198 cm)

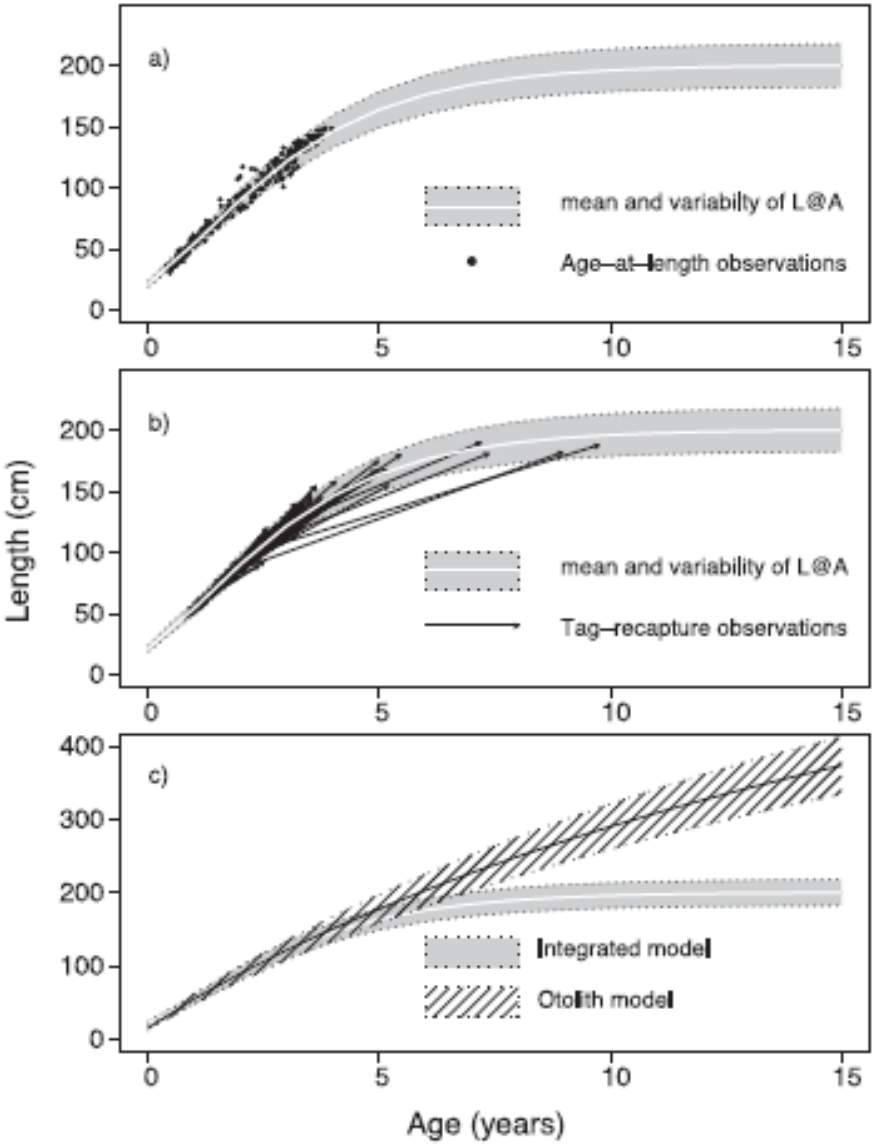
Specification of growth in current stock assessment

Based on Aires-da-Silva et al. (2015)

- The Richards growth curve is used (more flexible than the von Bertalanffy curve)

$$L_a = L_\infty \left(1 + \frac{1}{p} e^{-K(a-t_0)}\right)^{-p}$$

- Parameters are estimated externally by fitting the growth curve to otolith and tagging data simultaneously



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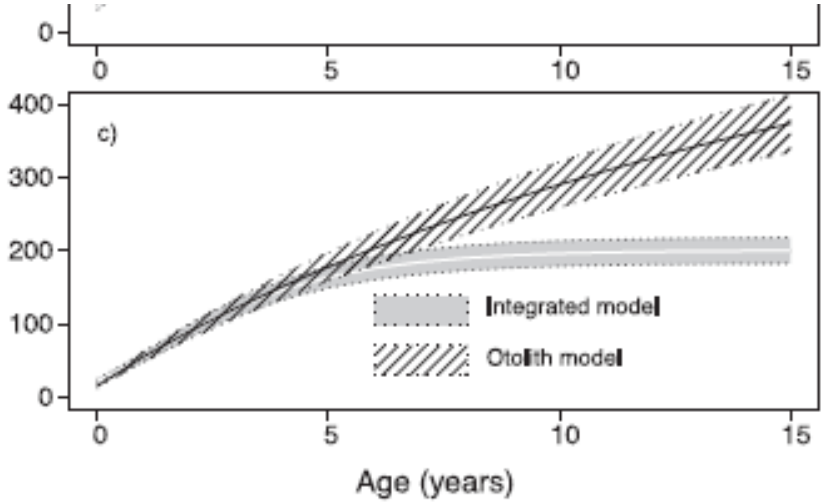
Parameter	Fit to otolith data (age-at-length)	Integrated analysis (age-at-length and tagging)
Growth curve		
L_∞	647.7 (1142.8)	200.8 (5.7)
K	0.051 (0.13)	0.44 (0.037)
t_0	−2.47 (10.73)	1.26 (0.10)
p	−0.90 (0.24)	−4.27 (1.92)
Variability of length-at-age		
a^*	0.68 (0.46)	0.60 (0.27)
b	0.052 (0.0065)	0.042 (0.0035)
Age at release random effects		
$\mu_{\log A}$	–	0.46 (0.015)
$\sigma_{\log A}$	–	0.29 (0.010)

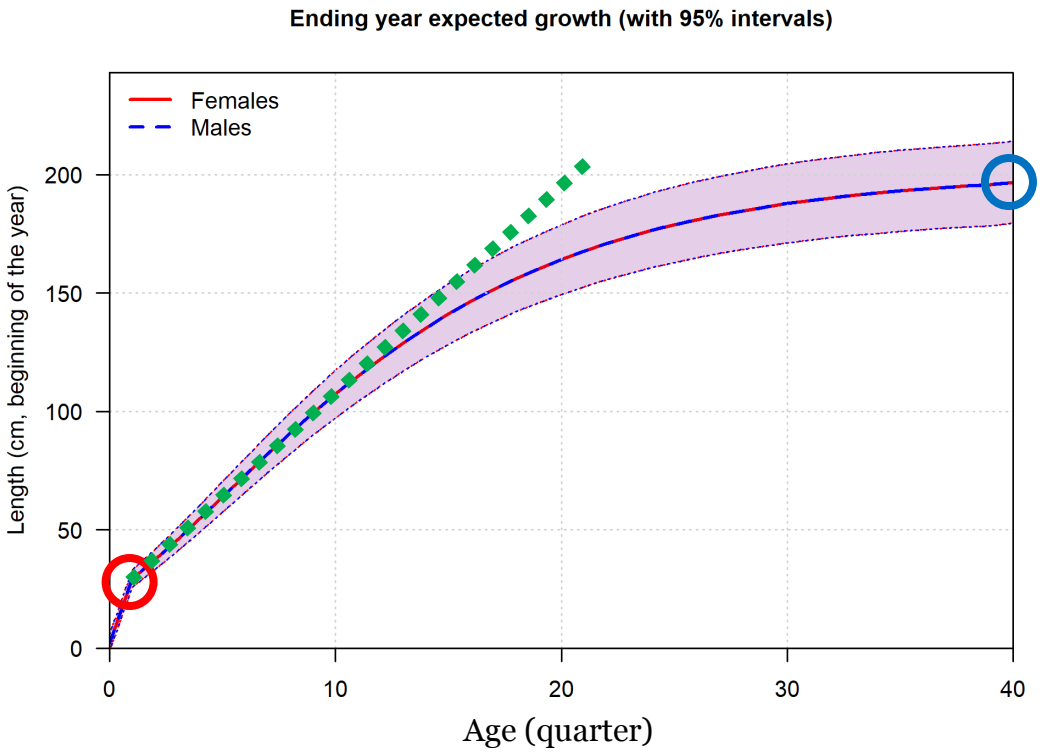


Specification of growth in current stock assessment

- Stock Synthesis parameterizes the Richards growth curve as

$$(15)\quad Y(t) = \left[y_1^{\,b} + (y_2^{\,b} - y_1^{\,b}) \frac{1 - e^{-a(t-\tau_1)}}{1 - e^{-a(\tau_2-\tau_1)}} \right]^{1/b}$$

Equation 15 in Schnute 1981



$y_1 = 29$ cm: expected length at age 1 quarter

$y_2 = 196$ cm: expected length at age 40 quarters ($L_{inf} = 201$cm)

$a = 0.108$ quarter^{-1}: growth rate parameter

$b = 0.23$: shape parameter

The sensitivity of assessment results to y_2 ($\approx L_{inf}$)

- Run the base case model with various y_2 (expected length at age 40 quarters) from 175 cm to 205 cm

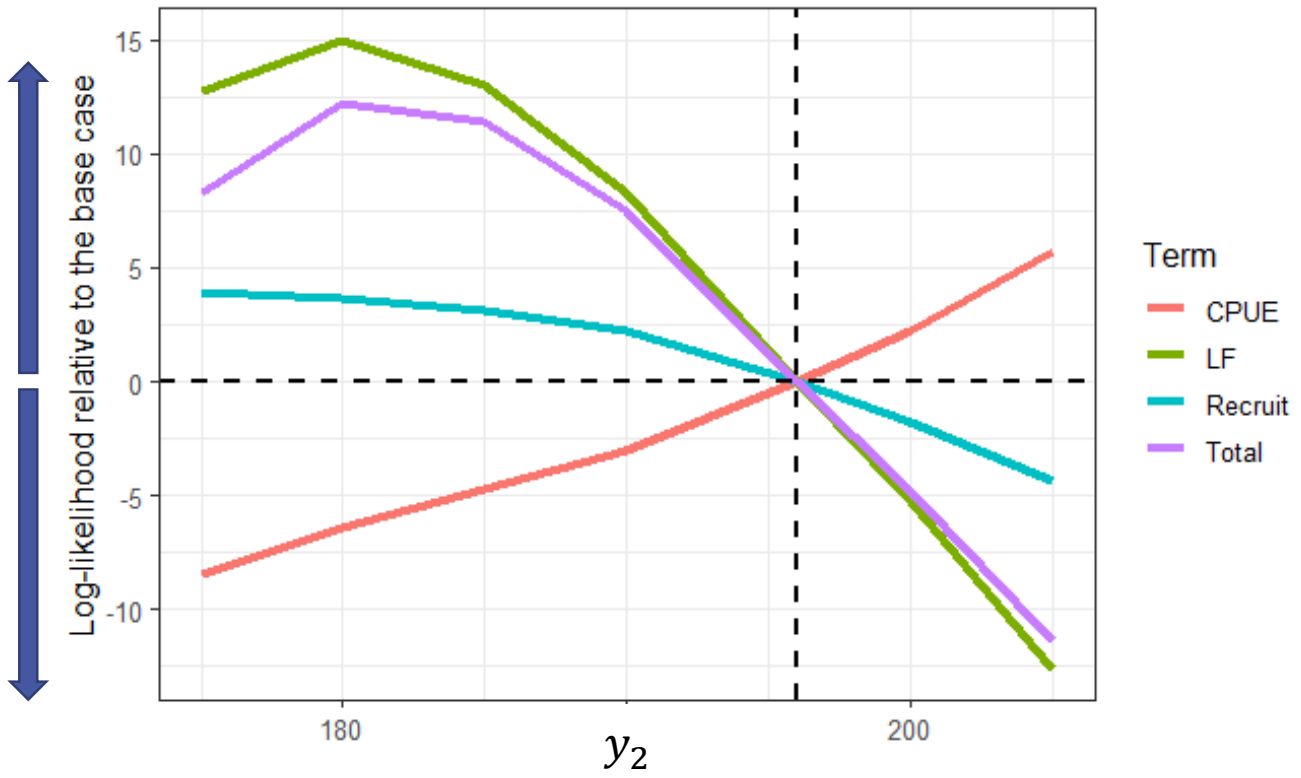
  175, 180, 185, 190, 196 (base case), 200, 205
- Evaluate the sensitivity of model fit (log-likelihood) to y_2
- Evaluate the sensitivity of population attributes (R, SB) and management quantities (SB/SB_0 and F multiplier) to y_2

The sensitivity of model fit (log-likelihood) to y_2

- Fits to data best when $y_2 \approx 180$cm (196cm in the base case)
- Length comp and recruit (penalty) support a lower y_2 and CPUE supports a higher y_2

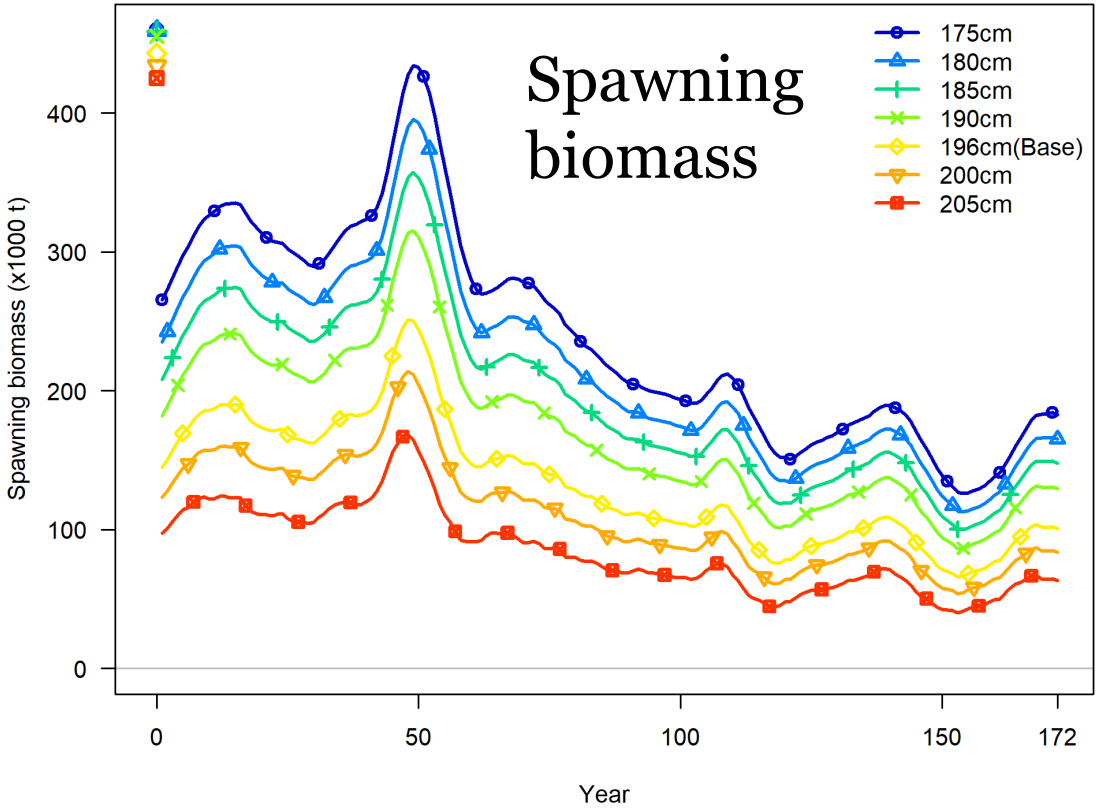
Fits **better** than the base case

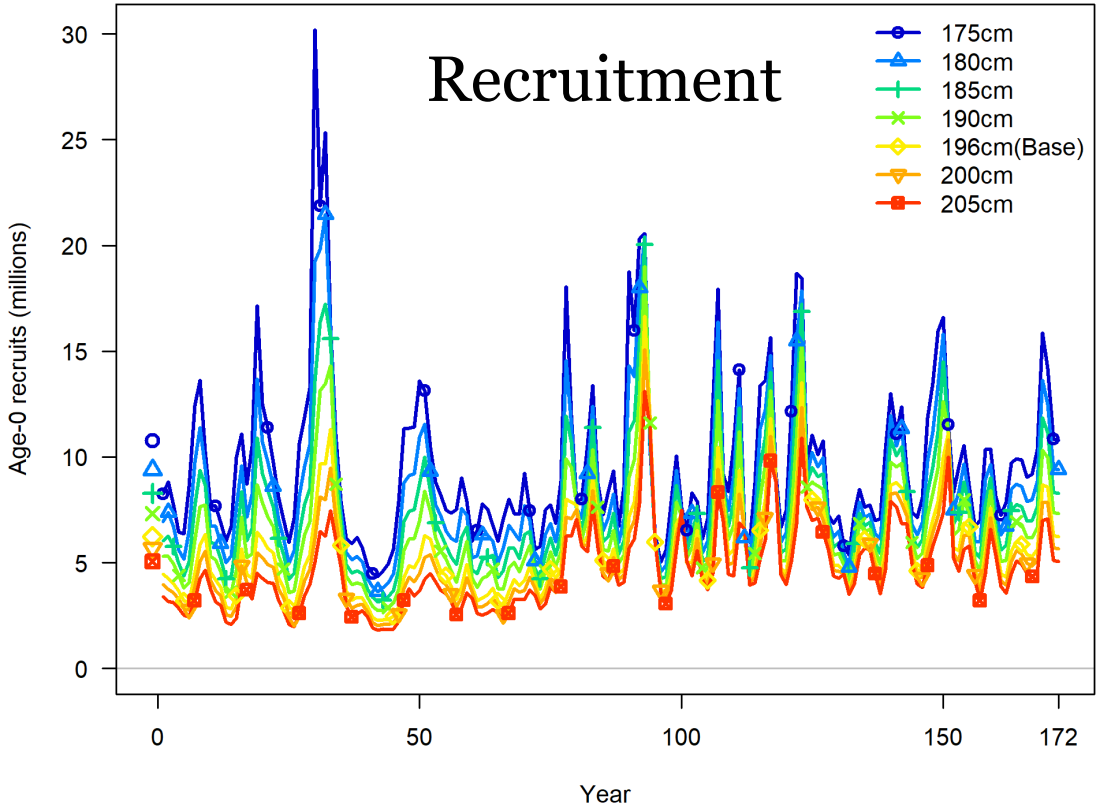
Fits **worse** than the base case



The sensitivity of population attributes to y_2

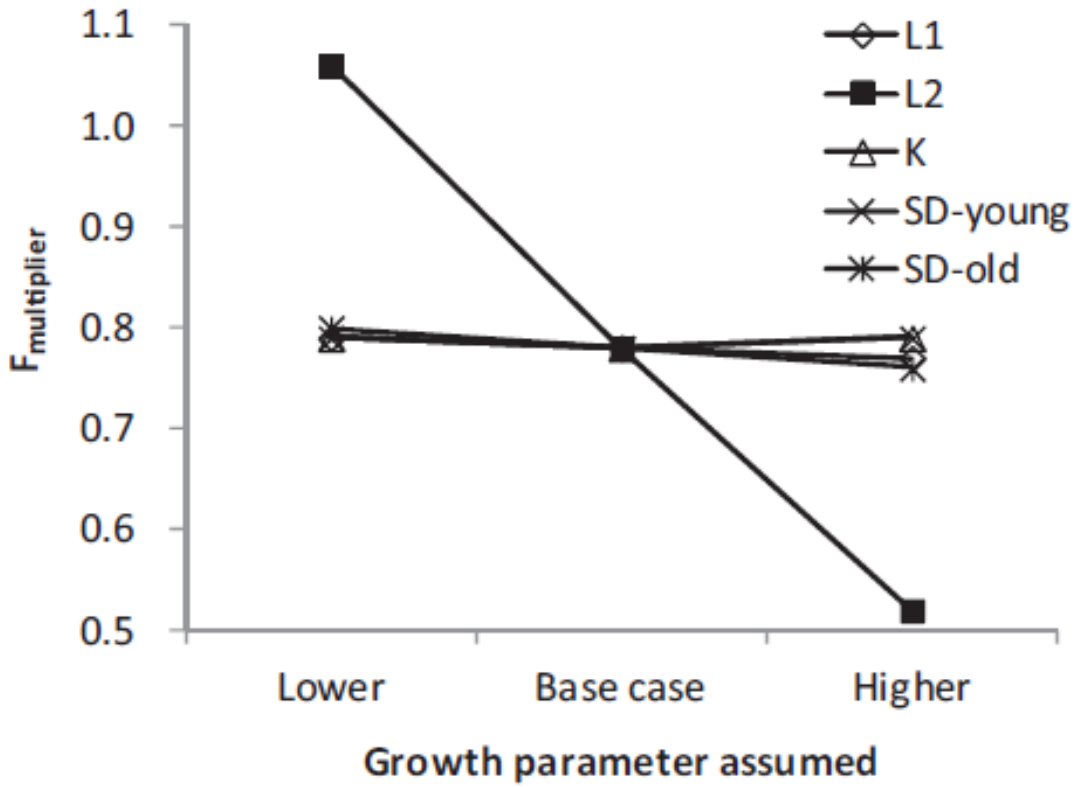
- y_2 increases -> estimates of both spawning biomass and recruitment decrease





The sensitivity of management quantities to y_2

- Zhu et al. (2016): F multiplier (F_{MSY}/F_{recent}) is **most** sensitive to y_2 (L_2 in the figure) in the growth curve

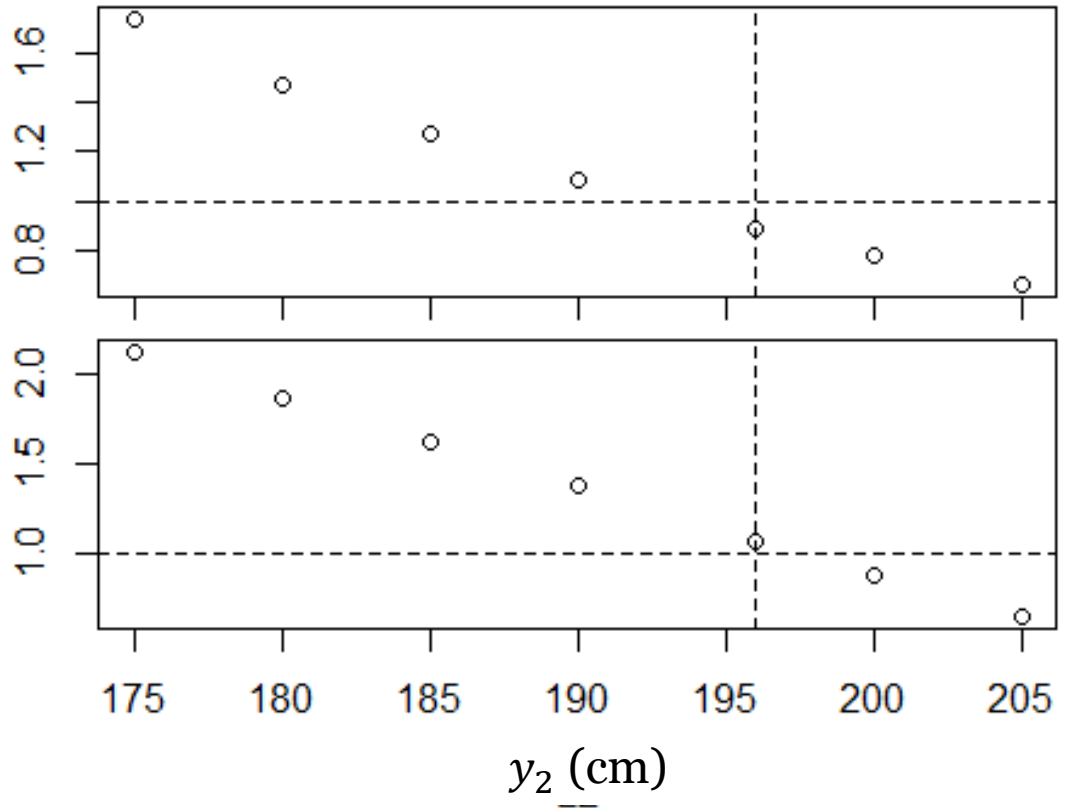


The sensitivity of management quantities to y_2

- y_2 increases -> higher fishing morality and lower spawning biomass depletion in recent years

F multiplier (F_{MSY}/F_{recent})

SB_{recent}/SB_{MSY}



$F_{recent} < F_{MSY}$

$F_{recent} > F_{MSY}$

$SB_{recent} > SB_{MSY}$

$SB_{recent} < SB_{MSY}$

Summary

- Length-comp data are greatly down-weighted in the assessment
- The Richards growth curve is estimated outside the assessment model based on both length-at-age and tagging data
- Both population attributes and management quantities are very sensitive to L_∞: $\uparrow L_\infty$ corresponds to $\downarrow SB_{recent}$ and $\uparrow F_{recent}$
- The assessment model reach maximum likelihood when $L_2 \approx 180$cm

Thank you!