

**INTER-AMERICAN TROPICAL TUNA COMMISSION  
SCIENTIFIC ADVISORY COMMITTEE**

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**ADDITIONAL SENSITIVITY ANALYSES IN THE STOCK  
ASSESSMENT OF BIGEYE TUNA IN THE EASTERN PACIFIC  
OCEAN, MAY 2010**

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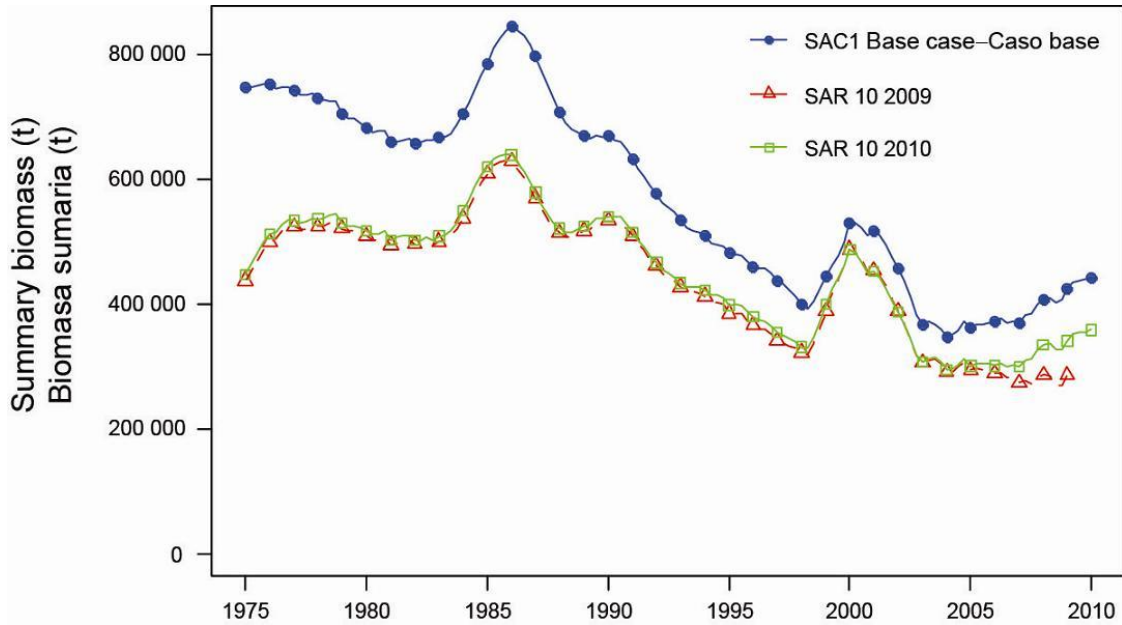
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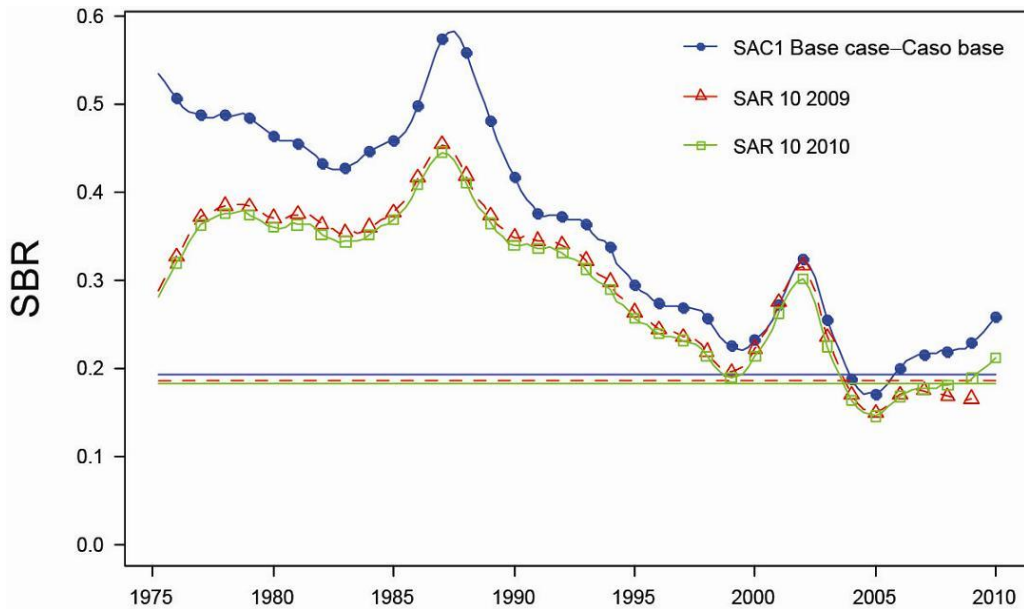
**TABLE 1.** Summary description of models presented in the sensitivity analyses.

Appendix	Model	Growth				
		LL-S CPUE CV	Curve	Lsd	LL areas	Time Blocks (2)
1	SAC1 BC	0.15	Richards	est	4	N, C, S, I
	SARM10-2009	est	VB	fixed	2	no
	SARM10-2010	est	VB	fixed	2	no
1	SAC1 BC	0.15	Rich	est	4	N, C, S, I
	SARM10-2010	est	VB	fixed	2	no
	SAR10-2010, LL-CPUEcv=0.15	0.15	VB	fixed	2	no
2	SAC1 BC	0.15	Rich	est	4	N, C, S, I
	SARM10-2010	est	VB	fixed	2	no
	SARM10-2010, Rich, Lsd fixed	est	Rich	fixed	2	no
	SARM10-2010, Rich, Lsd est	est	Rich	est	2	no
	SARM10-2010, Rich, Lsd est, LL-S CVfix)	0.15	Rich	est	2	no
4	SAC1 BC	0.15	Rich	est	4	N, C, S, I
	SARM10-2010	est	VB	fixed	2	no
	SAC1-no time blocks	0.15	Rich	est	4	no
	SAC1-time blocks S	0.15	Rich	est	4	S
	SAC1-time blocks S&C	0.15	Rich	est	4	C, S
5	SAC1 BC	0.15	Rich	est	4	N, C, S, I
	Early Catch	0.15	Rich	est	4	N, C, S, I
6	SAC1 BC	0.15	Rich	est	4	N, C, S, I
	LL-LF_lambda10_L2fix	0.15	Rich	est	4	N, C, S, I
	LL-LF_lambda10_L2fix	0.15	Rich	est	4	N, C, S, I

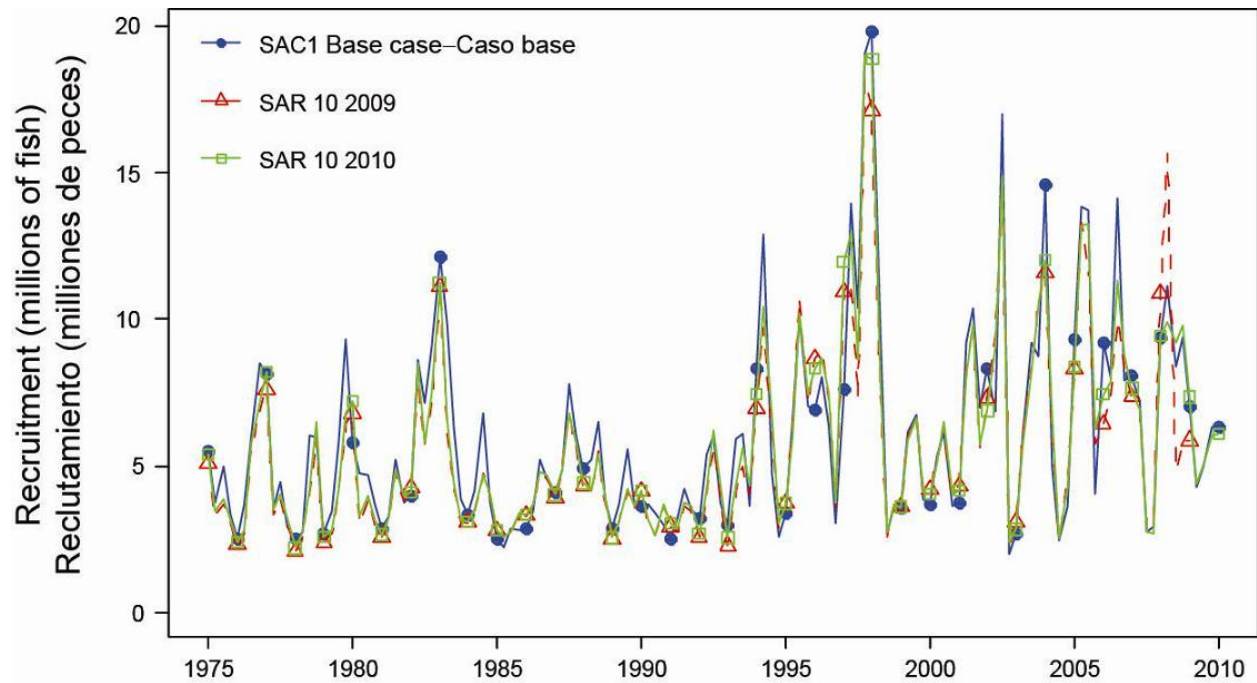
**APPENDIX 1: SENSITIVITY TO USING A SAR10 (LATEST ASSESSMENT) BASE CASE MODEL CONFIGURATION**



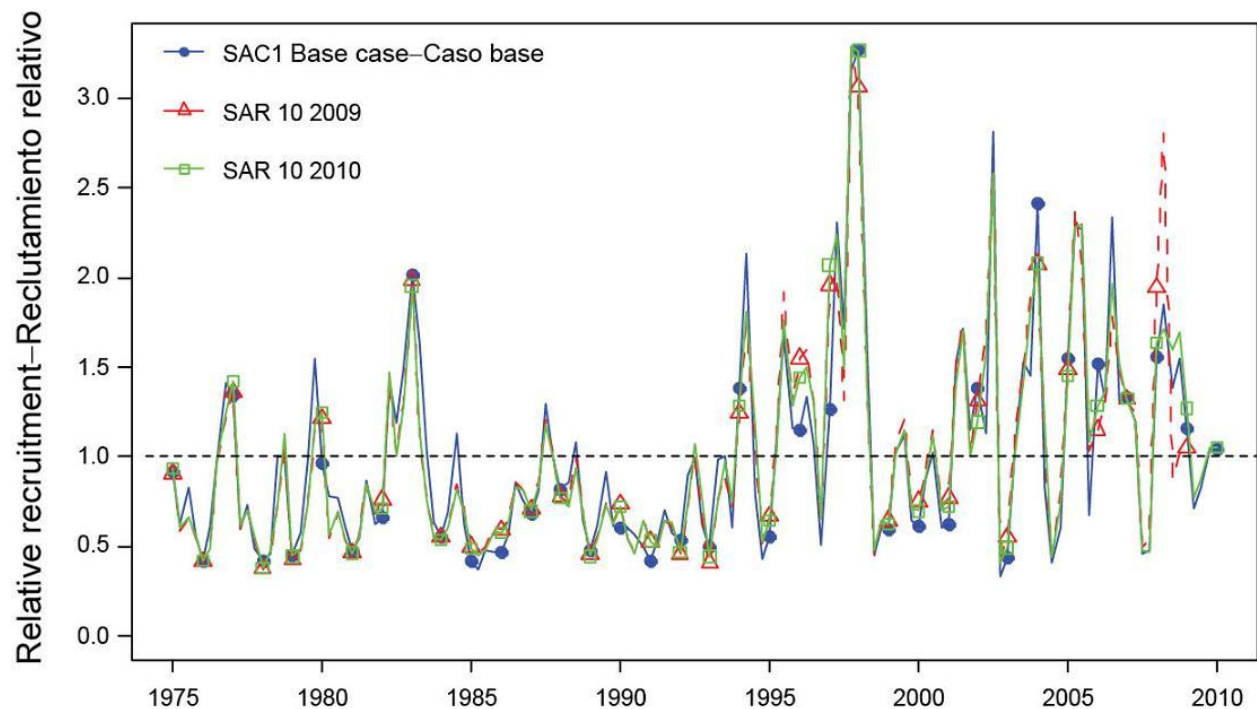
**FIGURE 1.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model of the current assessment (SAC1), the latest assessment (SAR10–2009; Aires-da-Silva and Maunder, 2010), and an updated SAR10 model (SAR10-2010). t = metric tons.



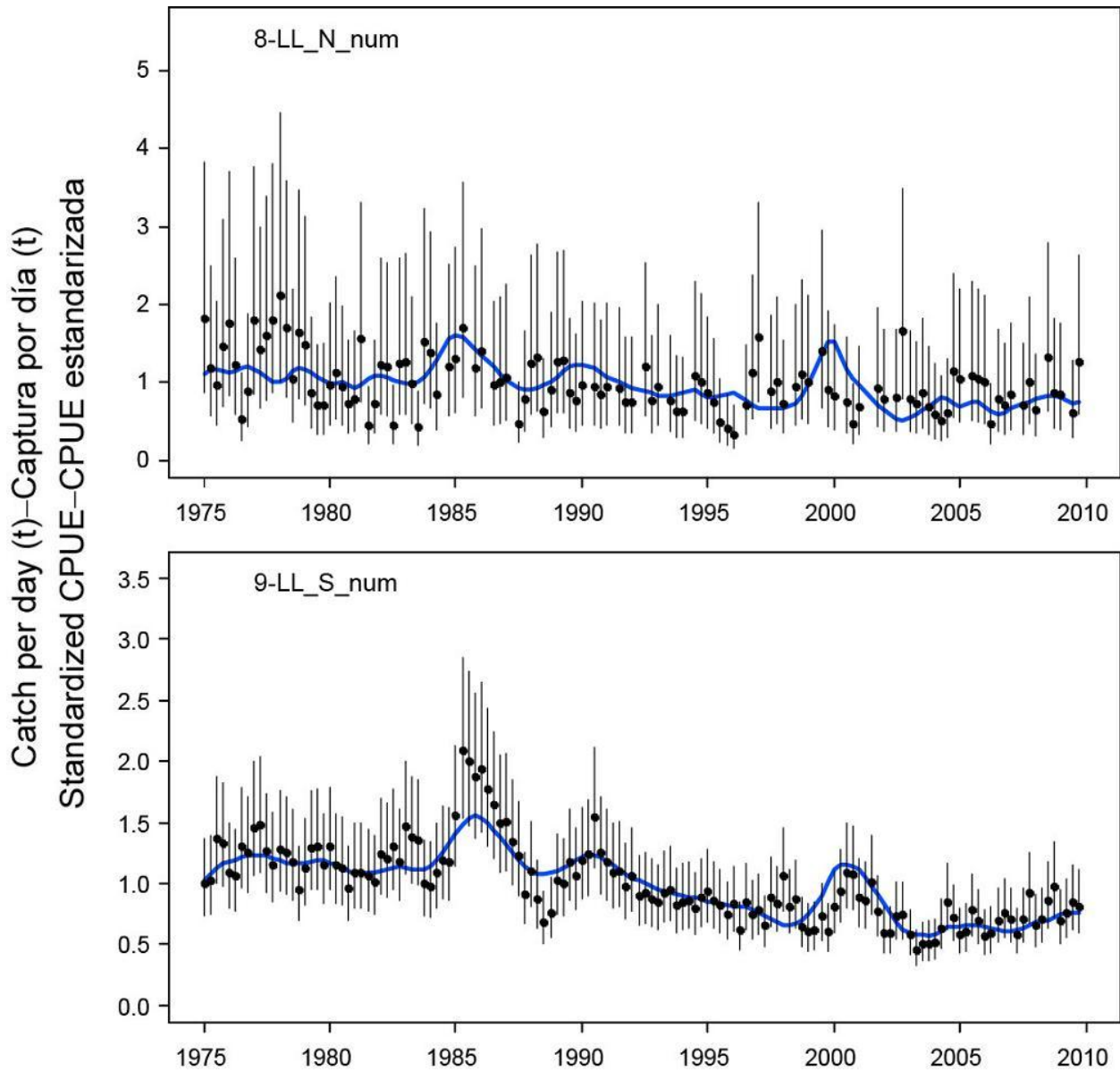
**FIGURE 1.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model of the current assessment (SAC1), the latest assessment (SAR10–2009, Aires-da-Silva and Maunder, 2010), and an updated SAR10 model (SAR10-2010). The horizontal lines indicate the SBR at MSY.



**FIGURE 1.3a.** Comparison of estimated recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), the latest assessment (SAR10–2009, Aires-da-Silva and Maunder, 2010), and an updated SAR10 model (SAR10-2010).



**FIGURE 1.3b.** Comparison of estimated relative recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), the latest assessment (SAR10–2009, Aires-da-Silva and Maunder, 2010), and an updated SAR10 model (SAR10 - 2010). The horizontal lines indicate the SBR at MSY. The estimates are scaled so that the average recruitment is equal to 1.0 (dashed horizontal line).

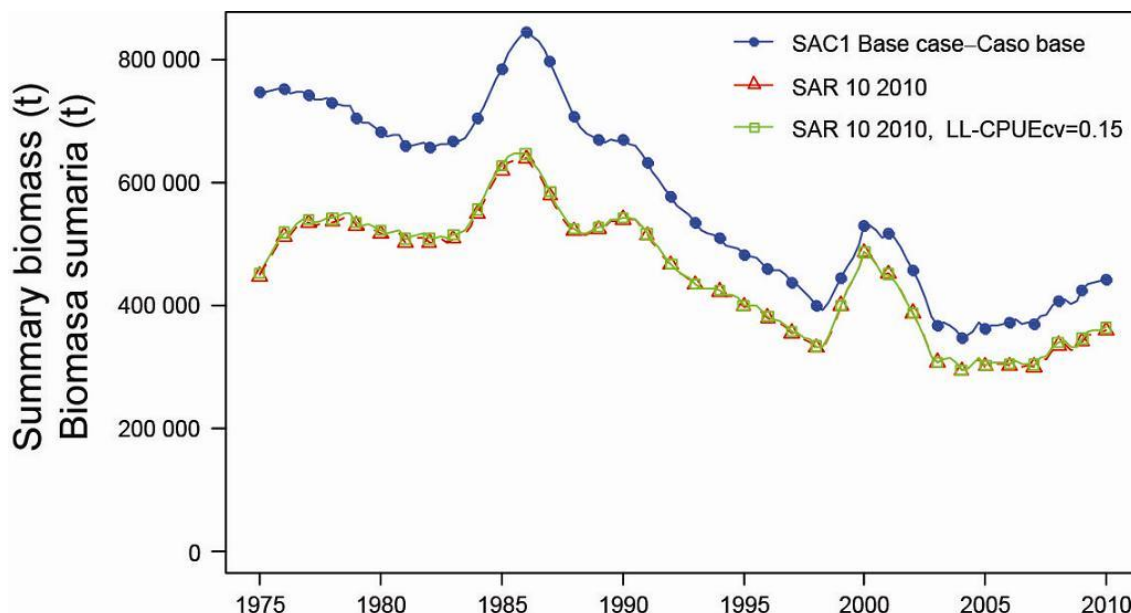


**FIGURE 1.4.** Model fit to the CPUE data from different longline fisheries derived from an updated SAR10 configuration model (SAR10-2010). The CPUEs for longline Fisheries 8-9 are standardized CPUE. The vertical lines represent the estimated confidence intervals ( $\pm 2$  standard deviations) around the CPUE values.

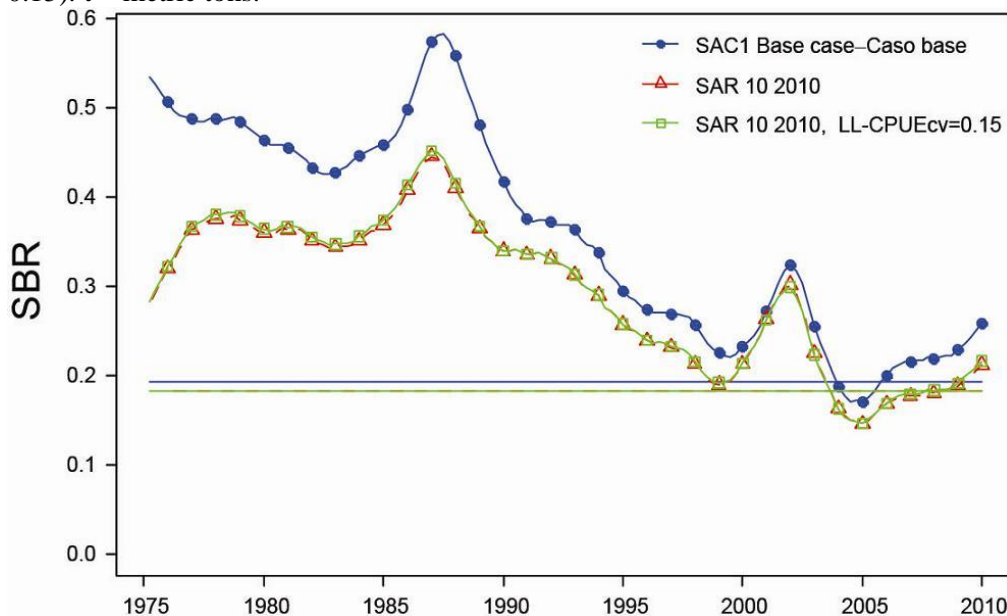
**TABLE 1.1.** Estimates of the MSY and its associated quantities for bigeye tuna for the base case assessment and the sensitivity analyses using an updated SAR10 (Aires-da-Silva and Maunder 2010) configuration model.

	3-year $F$ average				
	SAC1	SAR10-2009	SAR10-2010	SAR10-2010	SAR10-2010
MSY-RMS	90,538	83,615	87,959	89,076	87,010
$B_{\text{MSY}} - B_{\text{RMS}}$	332,331	289,475	298,578	301,717	308,928
$S_{\text{MSY}} - S_{\text{RMS}}$	73,690	60,631	61,947	62,381	64,986
$B_{\text{MSY}}/B_0 - B_{\text{RMS}}/B_0$	0.25	0.25	0.24	0.25	0.25
$S_{\text{MSY}}/S_0 - S_{\text{RMS}}/S_0$	0.19	0.19	0.18	0.18	0.19
$C_{\text{recent}}/\text{MSY} -$ $C_{\text{recent}}/\text{RMS}$	1.17	1.19	1.18	1.17	1.2
$B_{\text{recent}}/B_{\text{MSY}} - B_{\text{recent}}/B_{\text{RMS}}$	1.33	0.99	1.2	1.19	1.16
$S_{\text{recent}}/S_{\text{MSY}} - S_{\text{recent}}/S_{\text{RMS}}$	1.33	0.89	1.16	1.15	1.11
$F$ multiplier- Multiplicador de $F$	1.13	0.81	1.04	0.93	0.86

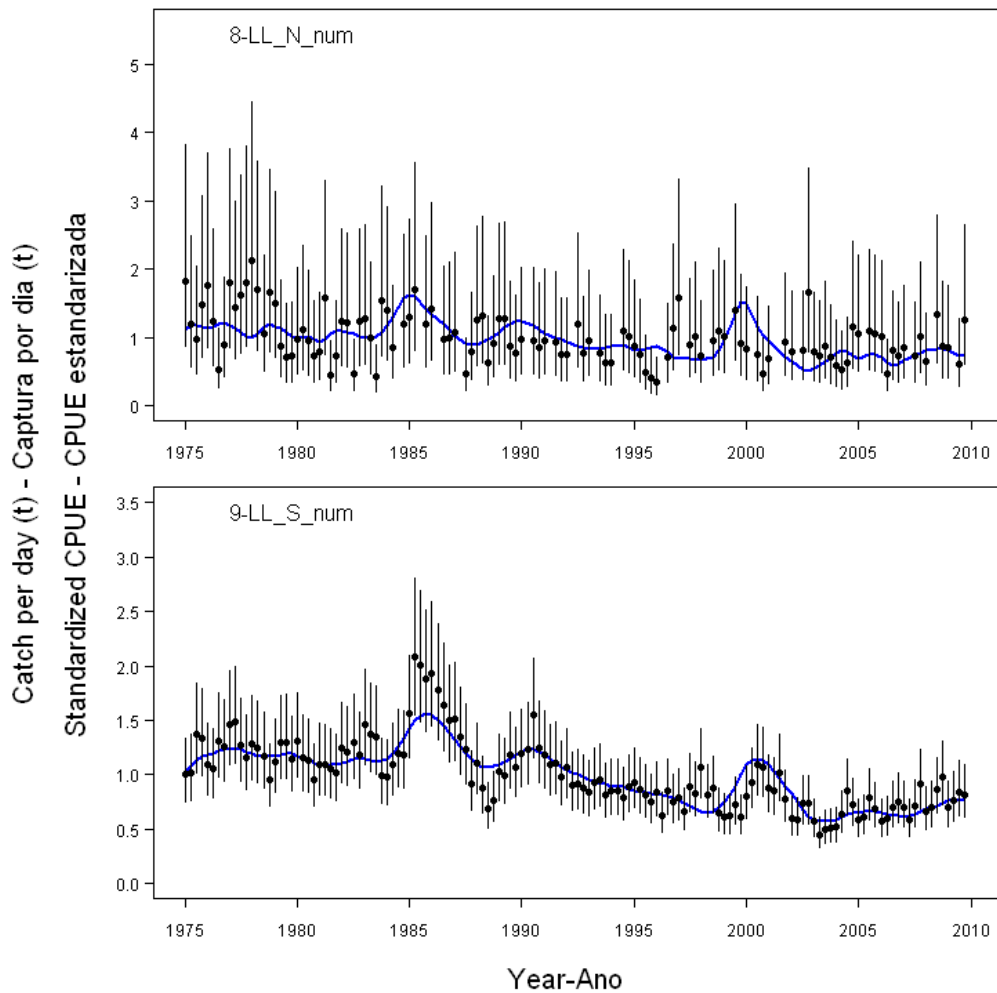
**APPENDIX 2: SENSITIVITY TO THE WEIGHTING OF THE SOUTHERN LONGLINE CPUE**



**FIGURE 2.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model of the current assessment (SAC1), an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), and an updated SAR10 model with the coefficients of variation (CV) for the southern longline fishery fixed at 0.15 (SAR10-2010, LL-CPUEcv=0.15). t = metric tons.



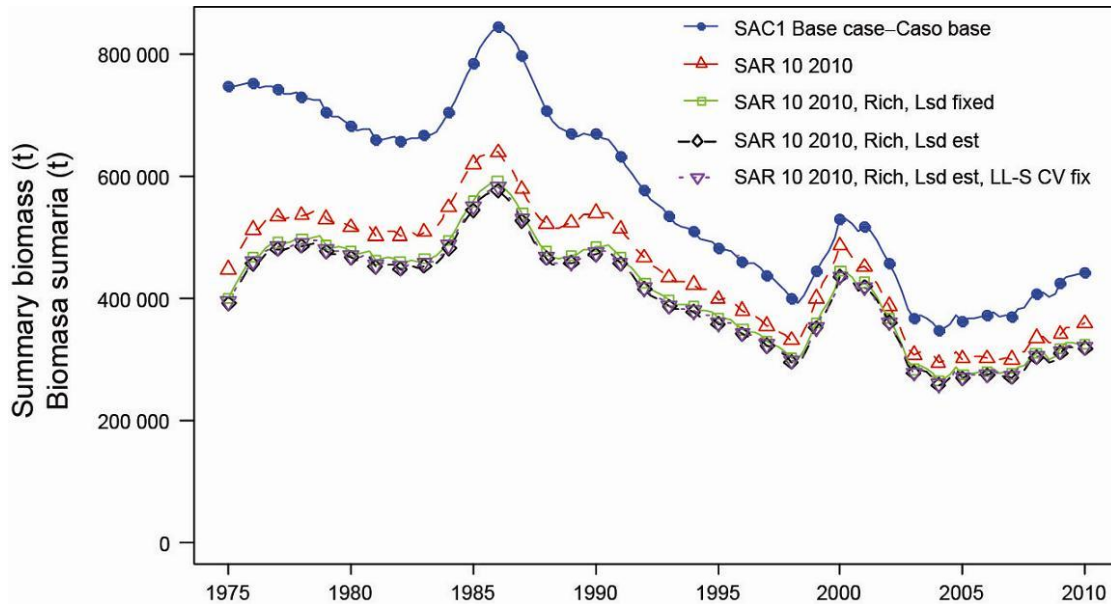
**FIGURE 2.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model of the current assessment (SAC1), an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), and an updated SAR10 model with the coefficients of variation (CV) for the southern longline fishery fixed at 0.15 (SAR10-2010, LL-CPUEcv=0.15). t = metric tons. The horizontal lines indicate the SBR at MSY.



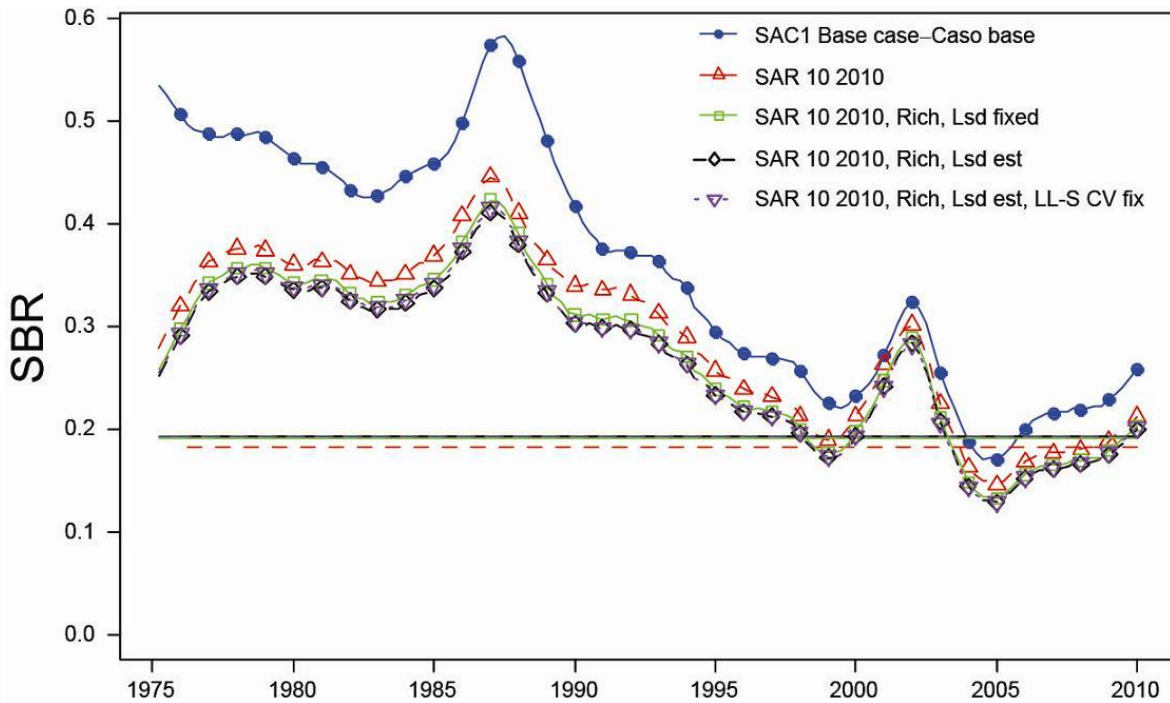
**FIGURE 2.3.** Model fit to the CPUE data from different longline fisheries derived from an updated SAR10 configuration model with the coefficients of variation (CV) of the southern longline fishery fixed at 0.15 (SAR10–2010, LL-CPUE<sub>cv</sub>=0.15). The CPUEs for longline Fisheries 8-9 are standardized CPUE. The vertical lines represent the estimated confidence intervals ( $\pm 2$  standard deviations) around the CPUE values.



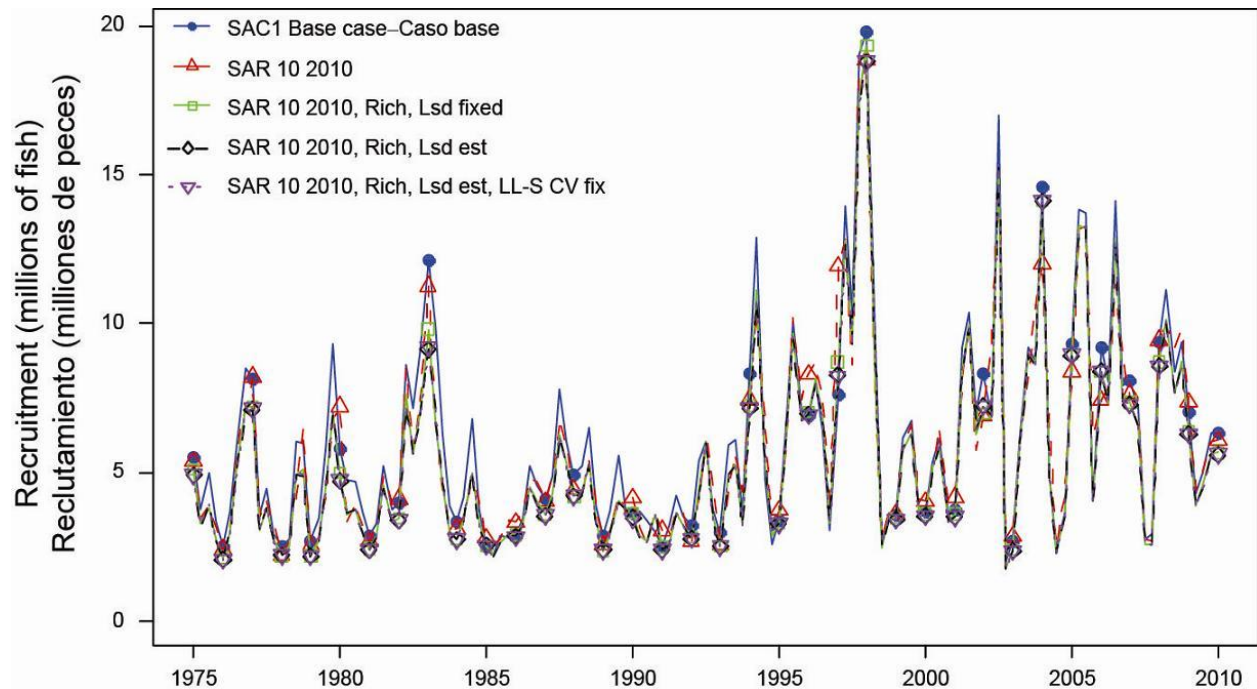
### APPENDIX 3: SENSITIVITY TO USING A RICHARDS GROWTH CURVE



**FIGURE 3.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model of the current assessment (SAC1), an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), and an updated SAR10 model with the following growth specifications: Richards growth curve with the parameters that define the variability of the length at age (Lsd) fixed (SARM10-2010, Rich, Lsd fixed); Richards growth curve with Lsd estimated (SARM10-2010, Rich, Lsd est); and Richards growth curve with Lsd estimated, and the coefficients of variation (CV) of the southern longline fishery fixed at 0.15 (SARM10-2010, Rich, Lsd est, LL-S CVfix). t = metric tons.

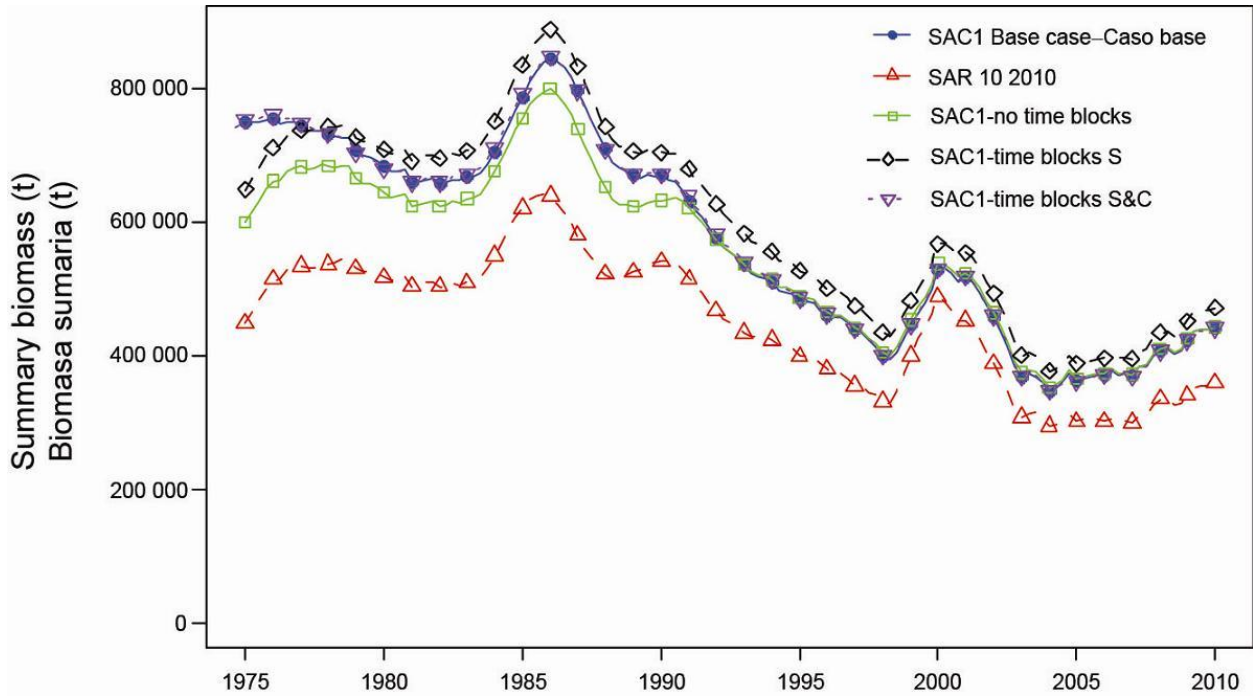


**FIGURE 3.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model of the current assessment (SAC1), an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), and an updated SAR10 model with the following growth specifications: Richards growth curve with the parameters that define the variability of the length at age (Lsd) fixed (SARM10-2010, Rich, Lsd fixed); Richards growth curve with Lsd estimated (SARM10-2010, Rich, Lsd est); and Richards growth curve with Lsd estimated, and the coefficients of variation (CV) of the southern longline fishery fixed at 0.15 (SARM10-2010, Rich, Lsd est, LL-S CVfix). The horizontal lines indicate the SBR at MSY.

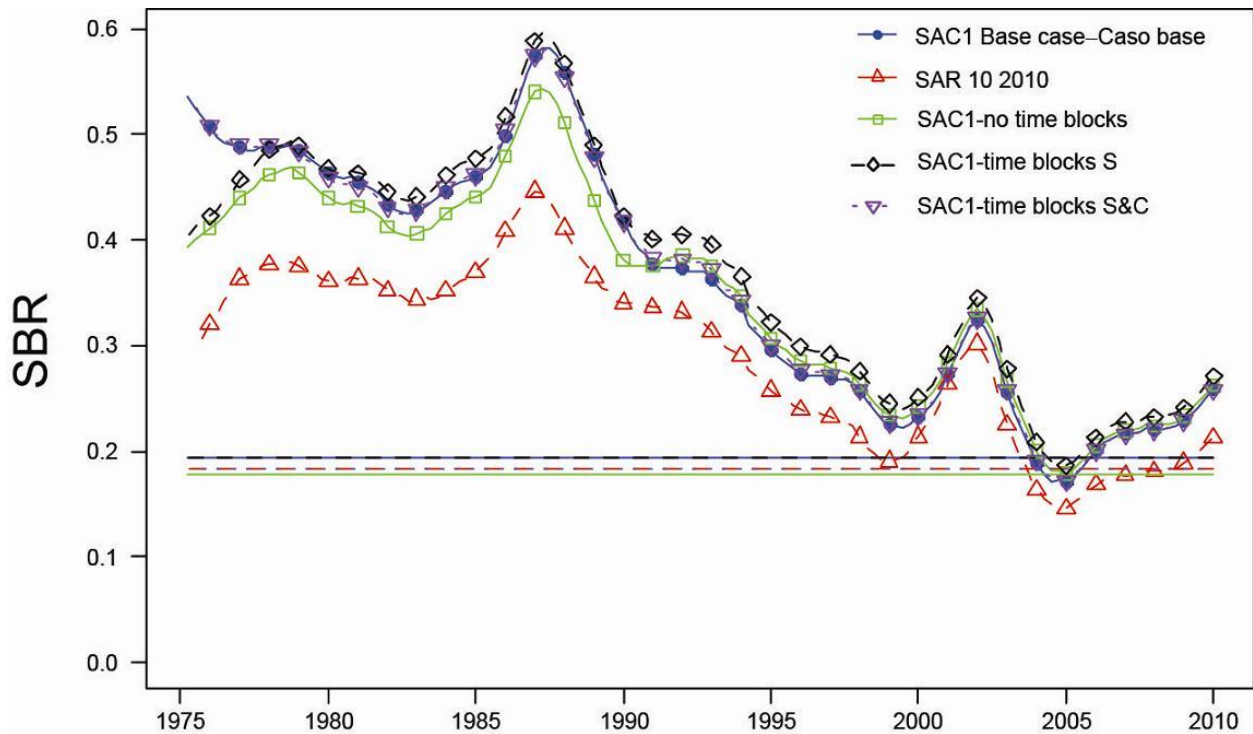


**FIGURE 3.3.** Comparison of estimated recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), and an updated SAR10 model with the following growth specifications: Richards growth curve with the parameters that define the variability of the length at age (Lsd) fixed (SARM10-2010, Rich, Lsd fixed); Richards growth curve with Lsd estimated (SARM10-2010, Rich, Lsd est); and Richards growth curve with Lsd estimated, and the coefficients of variation (CV) of the southern longline fishery fixed at 0.15 (SARM10-2010, Rich, Lsd est, LL-S CVfix).

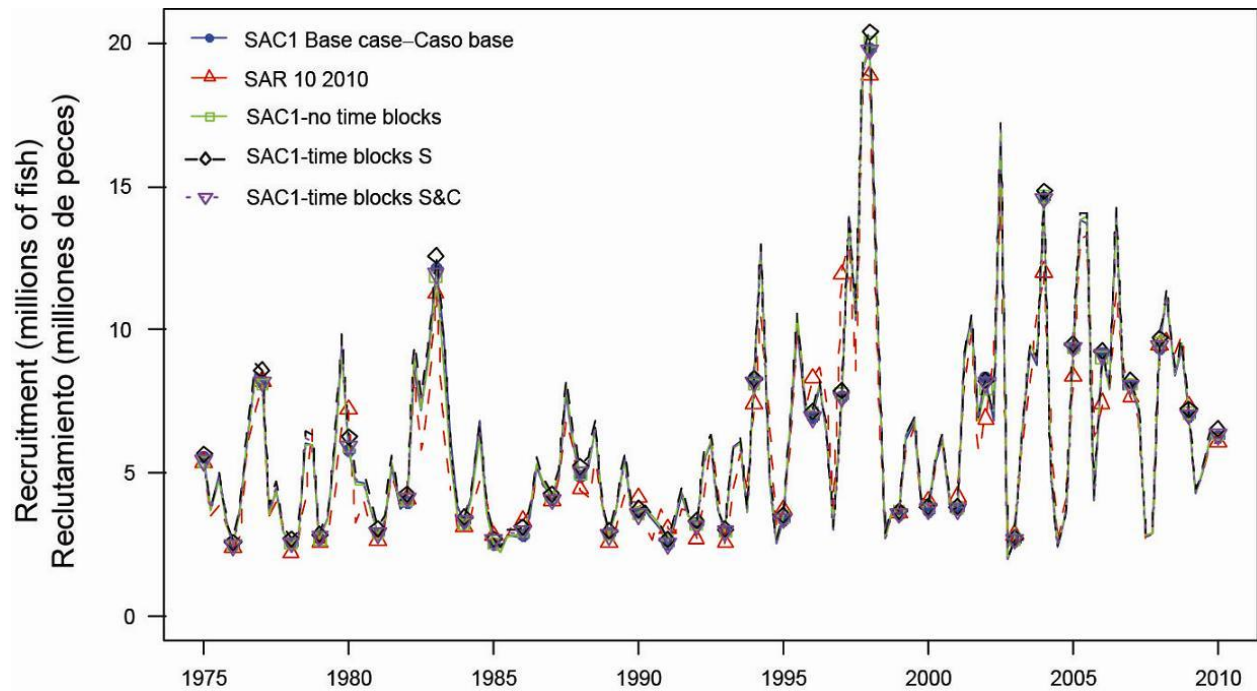
**APPENDIX 4: SENSITIVITY TO NEW FISHERY DEFINITIONS AND TIME BLOCKS OF CATCHABILITY AND SELECTIVITY FOR THE LONGLINE FISHERIES**



**FIGURE 4.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model of the current assessment (SAC1) which considers two time blocks for all longline fisheries, an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), a SAC1 type model with no time blocks for the longline fisheries (SAC1-no time blocks), a SAC1 type model with time blocks for the southern longline fishery only (SAC1-time blocks S), and a SAC1 type model with time blocks for the southern and central longline fisheries only (SAC1-time blocks S&C).

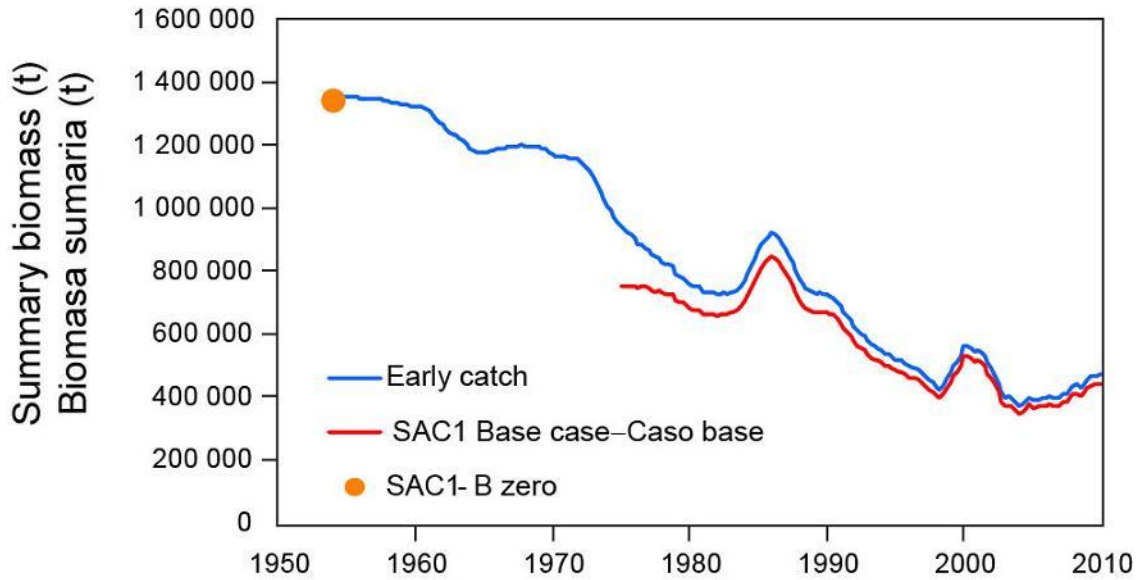


**FIGURE 4.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model of the current assessment (SAC1) which considers two time blocks for all longline fisheries, an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), a SAC1 type model with no time blocks for the longline fisheries (SAC1-no time blocks), a SAC1 type model with time blocks for the southern longline fishery only (SAC1-time blocks S), and a SAC1 type model with time blocks for the southern and central longline fisheries only (SAC1-time blocks S&C). The horizontal lines indicate the SBR at MSY.

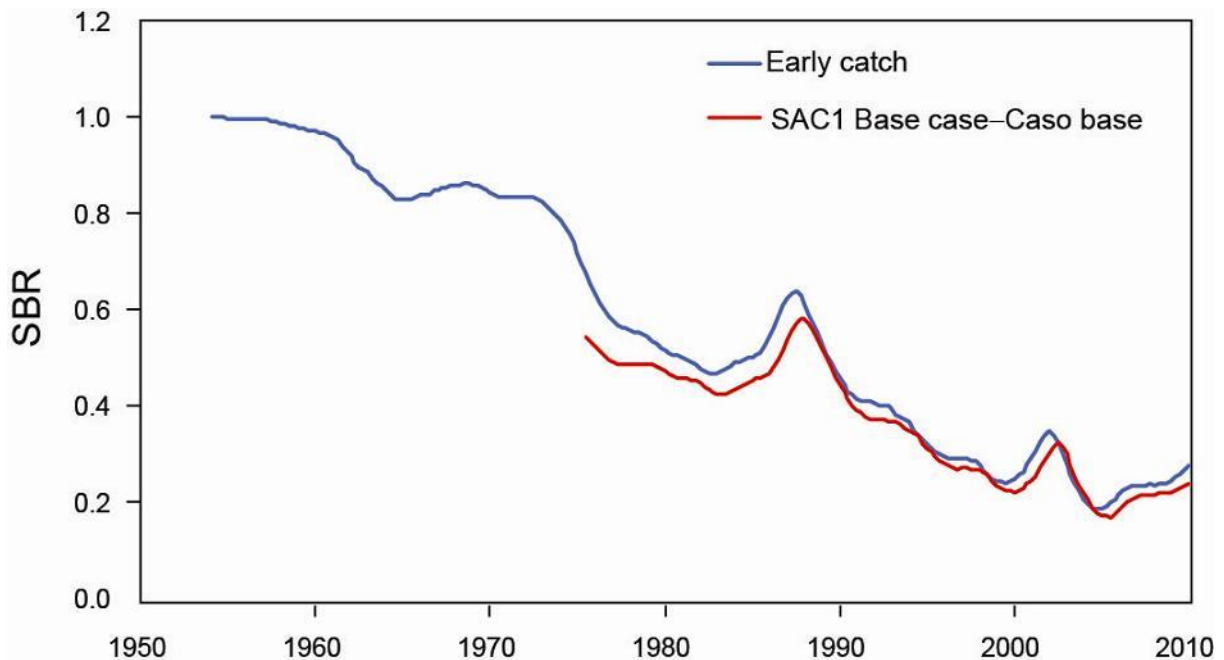


**FIGURE 4.3.** Comparison of estimated recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), which considers two time blocks for all longline fisheries, an updated SAR10 (latest assessment by Aires-da-Silva and Maunder, 2010) configuration model (SAR10-2010), a SAC1 type model with no time blocks for the longline fisheries (SAC1-no time blocks), a SAC1 type model with time blocks for the southern longline fishery only (SAC1-time blocks S), and a SAC1 type model with time blocks for the southern and central longline fisheries only (SAC1-time blocks S&C).

**APPENDIX 5: SENSITIVITY TO INCLUDING EARLY HISTORIC CATCH FOR BIGEYE**

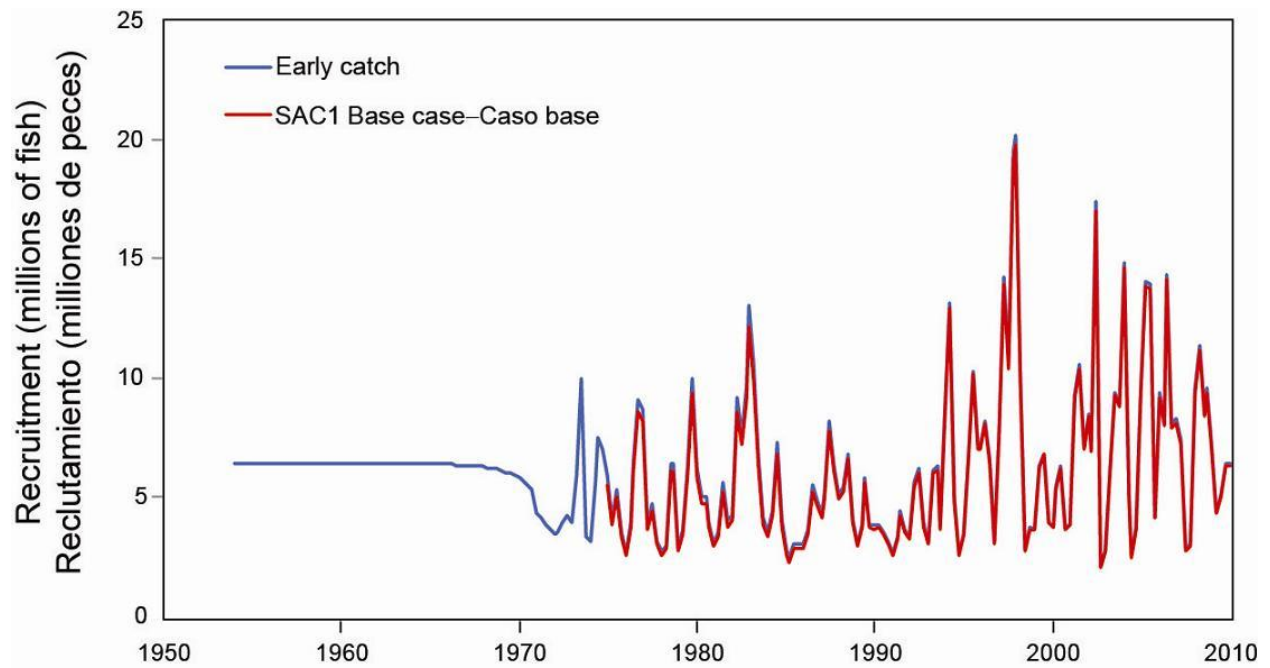


**FIGURE 5.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model of the current assessment (SAC1), with a model including early catch data for bigeye (1954-1975). The large dot represents the bigeye virgin biomass estimated by the base case model (SAC1)



**FIGURE 5.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model of the current assessment (SAC1), with a model including early catch data for bigeye (1954-1975).

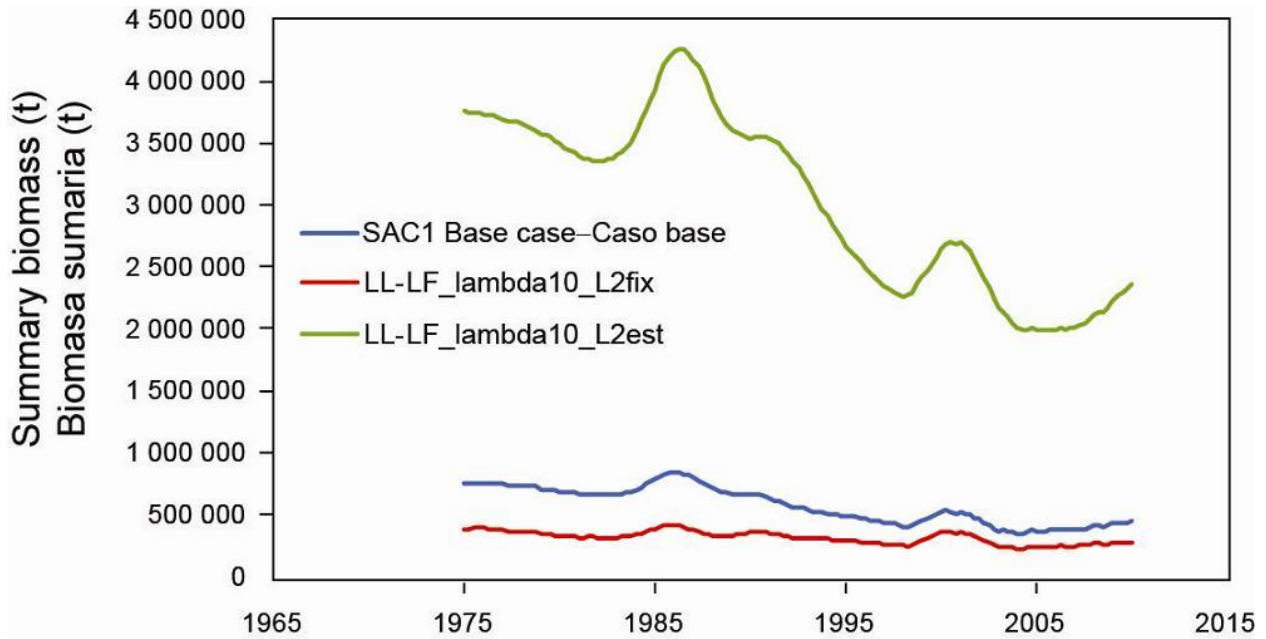




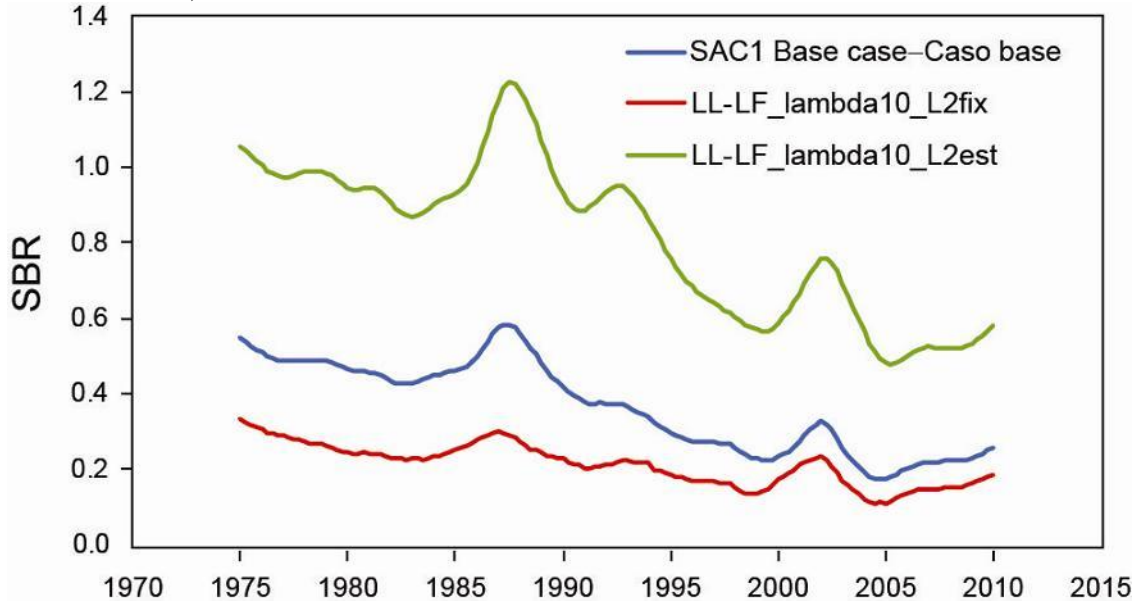
**FIGURE 5.3.** Comparison of estimated recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), with a model including early catch data for bigeye (1954-1975).



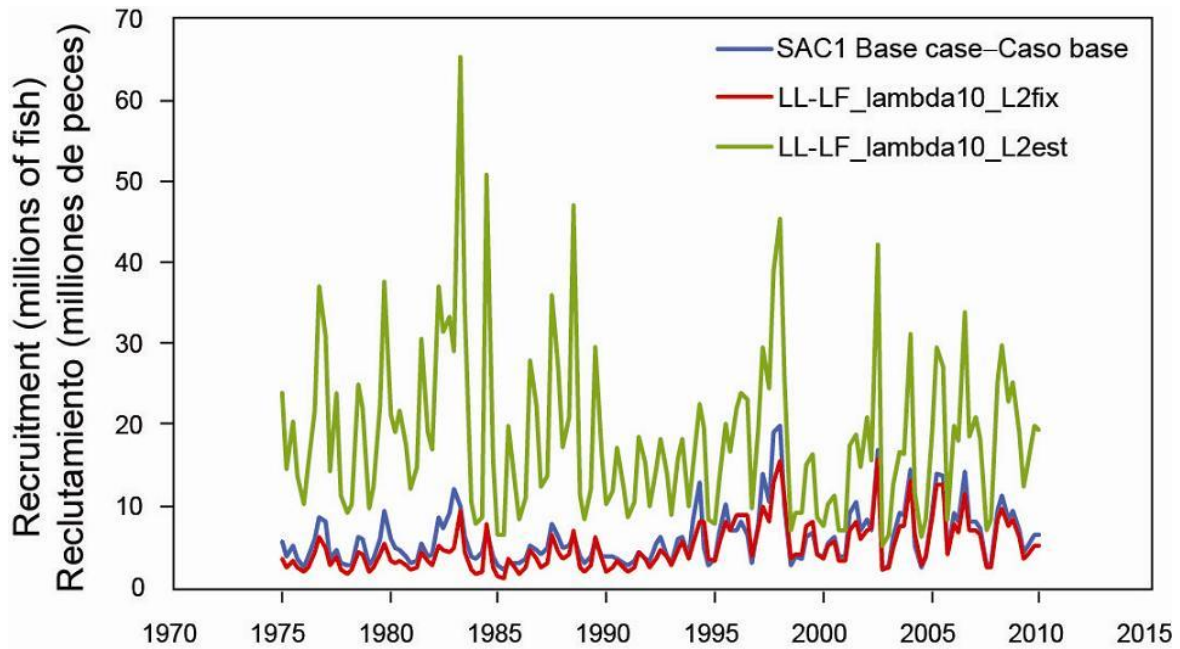
**APPENDIX 6: SENSITIVITY TO WEIGHTING OF THE LONGLINE SIZE-COMPOSITION DATA**



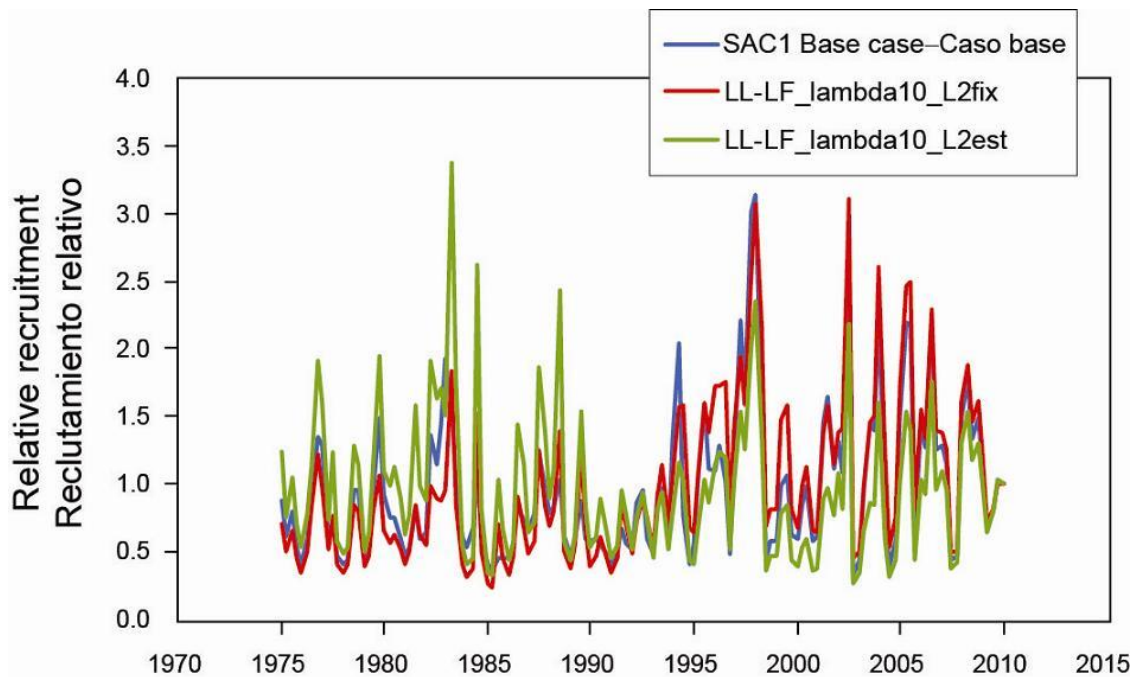
**FIGURE 6.1.** Comparison of estimates of the biomass of bigeye tuna 3+ quarters old (summary biomass) from the base case model (SAC1), a model with increased weighting of the southern and central longline fisheries while fixing  $L_2$  as in the base case (LL-LF\_lambda10\_L2fix), and estimating  $L_2$  (LL-LF\_lambda10\_L2est).



**FIGURE 6.2.** Comparison of estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO from the base case model (SAC1), a model with increased weighting of the southern and central longline fisheries while fixing  $L_2$  as in the base case (LL-LF\_lambda10\_L2fix), and estimating  $L_2$  (LL-LF\_lambda10\_L2est).



**FIGURE 6.3a.** Comparison of estimated recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), a model with increased weighting of the southern and central longline fisheries while fixing  $L_2$  as in the base case (LL-LF\_lambda10\_L2fix), and estimating  $L_2$  (LL-LF\_lambda10\_L2est).



**FIGURE 6.3b.** Comparison of estimated relative recruitment of bigeye tuna in the EPO from the base case model of the current assessment (SAC1), a model with increased weighting of the southern and central longline fisheries while fixing  $L_2$  as in the base case (LL-LF\_lambda10\_L2fix), and estimating  $L_2$  (LL-LF\_lambda10\_L2est).