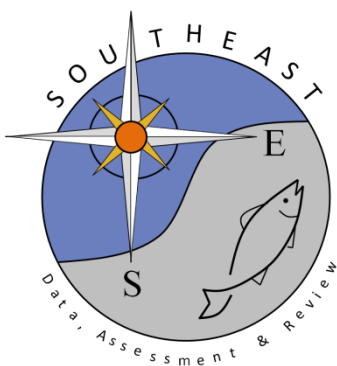# Revised Results for the Generic Implementation of Itarget0 and Ltarget0 for Lane Snapper, Wenchman, Lesser Amberjack, and Almaco Jack

Skyler R. Sagarese, J. Jeffery Isely, and Matthew W. Smith

SEDAR49-RW-01

21 October 2016

Please cite this document as:

Revised Results for the Generic Implementation of Itarget0 and Ltarget0 for Lane Snapper, Wenchman, Lesser Amberjack, and Almaco Jack

Skyler R. Sagarese, J. Jeffery Isely, and Matthew W. Smith
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL, USA 33149

Abstract

Results for the implementation of Itarget0 and Ltarget0 have been revised for four species due to concerns regarding assumptions made during the SEDAR 49 Assessment Process which removed the 0.5 smooth parameter from each equation. Both methods are now implemented in their generic forms. Changes to the management strategy evaluation results are identified, with Itarget0 now a viable method for Lane Snapper, Lesser Amberjack, and Almaco Jack and Ltarget0 now a viable method for Lane Snapper. Both Itarget0 and Ltarget0 were previously feasible for Wenchman. The Panel recommended approach for selecting methods of a joint distribution is still implemented. Methods for setting catch recommendation remain unchanged for Wenchman and Almaco Jack, whereas the recommended method has changed from Islope0 to Itarget0 for Lesser Amberjack and a joint distribution of Itarget0 and Ltarget0 for Lane Snapper. An example of additional tuning for the Itarget0 scalar values is presented to explore how different assumptions of stock depletion may impact results.

Introduction

Previous analyses were conducted using a modified Itarget0 and Ltarget0 method which was parameterized differently from to the original versions documented in Geromont and Butterworth (2014). Analyses presented in the SEDAR 49 Assessment Report were based on a smoothing parameter of 1.0, which results in a doubling of average catch when the target levels are met. The generic formulation uses a smoothing parameter of 0.5, which results in a catch recommendation of average catch when the target index level is met.

Objective

The objective of this working paper is to provide updated results from the management strategy evaluation and catch recommendations for species where Itarget0 and/or Ltarget0 were feasible, which include Lane Snapper, Wenchman, Lesser Amberjack, and Almaco Jack. Table and Figure names have been retained from the Assessment Report for ease of comparison, with additional tables identified as New Tables below.

Methods

The revised methods are described below as defined in Geromont and Butterworth (2014) and (Carruthers et al. 2015).

Itarget0:

If $I_y^{recent} > I^0$, $Catch\ Rec_{y+1} = w \times C^{AVE} \left[1 + \dfrac{(I_y^{recent} - I^0)}{(I^{target} - I^0)}\right]$

If $I_y^{recent} \leq I^0$, $Catch\ Rec_{y+1} = w \times C^{AVE} \left[\dfrac{I_y^{recent}}{I^0}\right]^2$

where:

w = the catch recommendation (termed the TAC) smoothing parameter (Assessment Report = 1.0; Revised Results = 0.5);
I_y^{recent} = mean CPUE for recent time period (2010-2014);
I^{AVE} = mean CPUE for reference period as specified in Table 3.1.2 of the Assessment Report for each species;
$I^0 = \mathbf{0.8}\ I^{AVE}$, where the scalar 0.8 may be modified during tuning;
$I^{target} = \mathbf{1.5}\ I^{AVE}$, where the scalar 1.5 may be modified during tuning; and
$C^{AVE} = \dfrac{\sum_{y=t_1}^{y=t_2} Cat_y}{1 + t_2 - t_1}$ where Cat_y is the catch during the reference period (defined by t_2 and t_1).
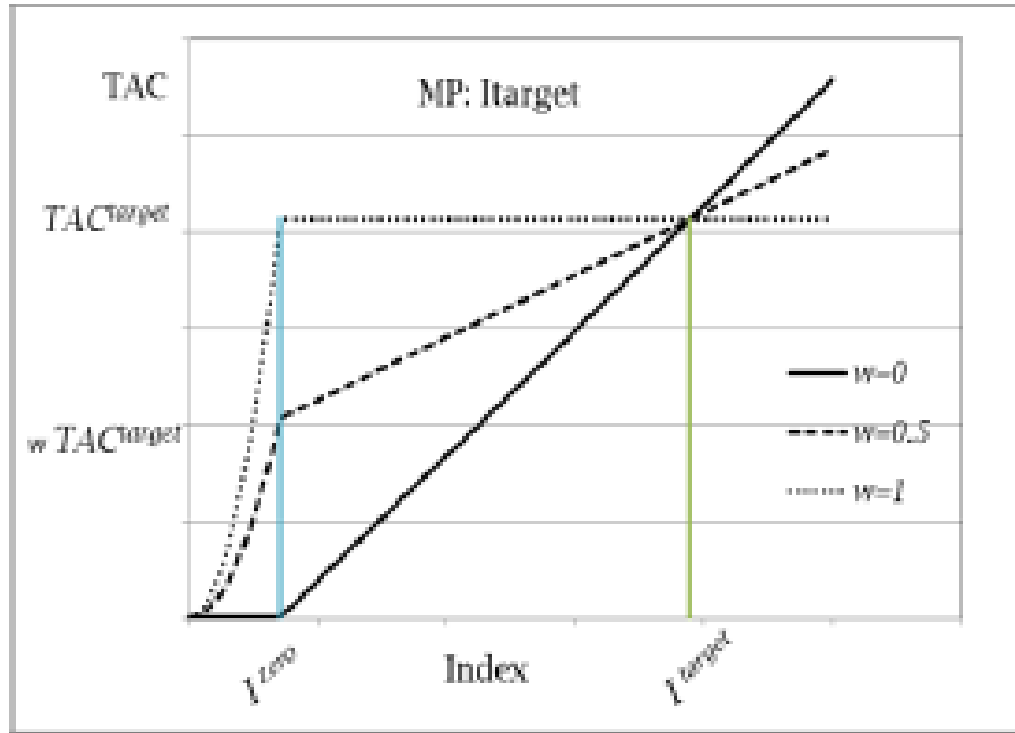

Figure 2 from Geromont and Butterworth (2014) supplementary material: Different forms of the Itarget0 method for three values of the control parameter w. Note that TAC is the terminology used for the catch recommendation.

Ltarget0:

$$\text{If } L_y^{recent} > L^0, \quad Catch\ Rec_{y+1} = w \times C^{AVE} \left[1 + \frac{(L_y^{recent} - L^0)}{(L^{target} - L^0)}\right]$$

$$\text{If } L_y^{recent} \leq L^0, \quad Catch\ Rec_{y+1} = w \times C^{AVE} \left[\frac{L_y^{recent}}{L^0}\right]^2$$

where:
w = the catch recommendation (termed the TAC) smoothing parameter (Assessment Report = 1.0; Revised Results = 0.5);
L_y^{recent} = mean length for recent time period (2010-2014);
L^{AVE} = mean length for reference period as specified in Table 3.1.2 of the Assessment Report for each species;
$L^0 = \mathbf{0.9}\ L^{AVE}$, where the scalar 0.9 may be modified during tuning;
$L^{target} = \mathbf{1.05}\ L^{AVE}$, where the scalar 1.05 may be modified during tuning; and
$C^{AVE} = \frac{\sum_{y=t_1}^{y=t_2} Cat_y}{1+t_2-t_1}$ where Cat_y is the catch during the reference period (defined by t_2 and t_1).

Results

Lane Snapper

MSE: Itarget0 and Ltarget0 met the performance metrics (Updated Table 5.3). No convergence issues were detected as performance metrics converged to within 0.05% for either method (Updated Figure 5.1). When trends over the 40 year projection period were examined, Itarget0 and Ltarget0 displayed mean ratios of biomass to biomass at maximum sustainable yield (B/B_{MSY}) above the 1.0 threshold and mean ratios of fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}) below or near the 1.0 threshold (Updated Figure 5.2). Itarget0 and Ltarget0 methods met the performance criteria regardless of the assumed depletion state, although differences in percentages were noted for all metrics (Updated Figure 5.3).

The various scalar values tested for Itarget0 indicate small to moderate differences in performance metrics (range: 12.7% [Bbelow20] to 29.9% [VY15]), with the performance metrics from the default scalars resulting in conservative PNOF, B50, VY15 and moderate LTY and STY (New Table 5.3A).

The various scalar values tested for Ltarget0 indicate small to moderate differences in performance metrics (range: 13.2% [Bbelow20] to 33% [PNOF]), with the performance metrics from the default values resulting in conservative PNOF, B50, VY15 and high LTY and STY (New Table 5.3B).

Catch Recommendation: The recommended approach for the catch recommendation now includes a joint distribution between the top performing index-based (Itarget0, higher relative LTY but lower STY) and length-based (Ltarget0, higher relative LTY and STY) (Updated Table 5.6; Updated Figure 5.4). The catch recommendations from Itarget0 and Ltarget0 are sensitive to the

magnitude of total removals (Updated Figure 5.5). If total removals in the reference period are higher than specified (e.g. due to exclusion of removals from the shrimp fishery as bycatch), a larger catch recommendation would result (Updated Figure 5.5). For Itarget0, the catch recommendation remains relatively similar with small changes to the index of abundance (Updated Figure 5.5). Overall, the CV on total removals had a minor impact on the median catch recommendations for Itarget0 and Ltarget0 (Updated Table 5.7).

Updated Table 5.3 Performance metrics for methods meeting performance criteria for Lane Snapper. Colors reflect poor performance (red), fair performance (yellow), and good performance (green). Performance metrics include PNOF = Probability of not overfishing; B50 = Probability of the biomass being above 50% B_{MSY}; VY15 = Probability of the inter-annual variability in yield remaining within 15%; LTY and STY = long and short-term yields; and Bbelow20 = Probability of the biomass being below 20% B_{MSY}. Note that performance for Bbelow20 is reversed, where a low probability is preferable.

Method	PNOF	B50	VY15	LTY	STY	Bbelow20
Islope0	69.0	75.5	87.9	49.2	73.6	14.4
Itarget0	84.9	87.6	94.3	52.3	59.3	6.1
Ltarget0	66.4	74.0	86.7	66.1	84.6	15.0
LstepCC0	70.4	76.3	88.1	46.3	73.7	14.0
Tier3AStatusQuo_ABC	29.1	45.4	53.3	55.4	92.4	33.0

New Table 5.3A Comparison of model performance for different configurations of Itarget0 by varying the scalar parameters on the threshold (I0) and the target (Itarget) values for the index of abundance with the default value highlighted in bold. Performance metrics are as defined in Table 5.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Specifics on the equation and scalars are provided in Table 3.1.3 of the Assessment Report.

Method	I0 Scalar	Itarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Itarget0	0.7	1.0	63.7	72.0	80.3	55.1	71.1	15.0
	0.7	1.1	69.6	76.1	85.2	55.2	69.5	12.7
	0.7	1.2	74.1	79.3	88.3	56.2	68.7	10.8
	0.7	1.3	77.7	82.0	90.2	56.9	67.8	9.2
	0.7	1.4	80.4	83.5	91.2	57.6	66.7	8.3
	0.7	1.5	82.0	84.7	92.2	56.9	65.2	7.7
	0.8	1.0	66.3	73.6	79.0	47.8	65.9	14.1
	0.8	1.1	72.4	78.2	84.8	49.7	64.4	11.5
	0.8	1.2	77.1	81.7	89.2	50.5	62.7	9.4
	0.8	1.3	80.8	84.2	90.7	50.1	61.3	8.1
	0.8	1.4	83.3	85.8	91.9	50.1	59.2	7.2
	0.8	**1.5**	84.9	87.0	93.0	49.8	58.4	6.5
	0.9	1.0	67.8	74.2	74.4	39.2	56.7	14.2
	0.9	1.1	74.5	79.3	83.4	41.7	55.0	10.9
	0.9	1.2	79.3	83.0	88.7	42.3	54.1	8.9
	0.9	1.3	83.0	85.6	91.2	42.4	52.6	7.2
	0.9	1.4	85.6	87.3	93.0	42.3	51.1	6.1
	0.9	1.5	87.2	88.7	94.0	42.3	50.5	5.6
	1.0	1.0	67.7	72.2	65.3	28.9	46.3	17.7
	1.0	1.1	75.2	79.5	81.0	33.3	45.9	11.0
	1.0	1.2	80.5	83.7	87.3	34.4	44.7	8.6
	1.0	1.3	83.9	86.5	91.2	34.8	43.3	6.9
	1.0	1.4	87.0	88.6	92.9	34.9	42.1	5.6
	1.0	1.5	89.0	90.0	94.1	35.1	41.2	5.0
		Minimum	63.7	72.0	65.3	28.9	41.2	5.0
		Maximum	89.0	90.0	94.1	57.6	71.1	17.7
		Difference	25.3	18.0	28.8	28.7	29.9	12.7

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New Table 5.3B Comparison of model performance for different configurations of Ltarget0 by varying the scalar parameters on the threshold (L0) and the target (Ltarget) values for the mean length, with the default value highlighted in bold. Performance metrics are as defined in Table 5.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Specifics on the equation and scalars are provided in Table 3.1.3 of the Assessment Report.

| Method	L0 Scalar	Ltarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Ltarget0	0.8	1.05	57.1	67.3	81.6	64.3	86.5	18.4
	0.8	1.10	63.5	71.6	85.2	64.9	84.7	16.3
	0.8	1.15	68.2	74.9	87.0	65.0	82.3	14.3
	0.8	1.20	71.9	77.5	88.4	66.1	81.4	12.8
	0.8	1.25	74.5	79.2	89.7	65.8	79.9	11.9
	0.9	**1.05**	63.9	71.9	84.8	64.7	84.0	16.1
	0.9	1.10	71.5	77.3	88.4	65.4	80.7	12.9
	0.9	1.15	76.5	80.7	90.4	65.6	78.4	11.0
	0.9	1.20	79.6	82.7	91.5	64.7	75.7	9.9
	0.9	1.25	81.5	84.1	92.2	64.2	74.4	9.1
	1.0	1.05	83.2	85.2	92.9	56.5	66.0	8.5
	1.0	1.10	87.8	88.4	94.9	54.2	61.8	6.4
	1.0	1.15	88.9	89.2	95.4	52.9	59.3	5.8
	1.0	1.20	89.6	89.8	95.5	52.1	58.0	5.4
	1.0	1.25	90.1	90.2	95.5	51.0	56.7	5.2
		Minimum	57.1	67.3	81.6	51.0	56.7	5.2
		Maximum	90.1	90.2	95.5	66.1	86.5	18.4
		Difference	33.0	22.9	13.9	15.1	29.8	13.2

Updated Table 5.6 Summary statistics of the catch recommendation (in pounds) for each viable method for Lane Snapper and weighted joint distributions, which was recommended for providing management advice. The Tier3AStatusQuo (i.e. current OFL) is included for comparison. Recommended method is highlighted in bold and is based on higher relative long-term yield in the management strategy evaluation.

Method	25%	40%	50%	75%	Mean	SD	CV
Tier3AStatusQuo	357,845	357,845	357,845	357,845	357,845	0	0
Islope0	301,844	307,686	311,243	321,267	311,638	14,576	0.047
Itarget0	215,566	219,912	222,623	229,469	222,702	10,334	0.046
Ltarget0	265,231	270,536	273,738	282,670	274,093	12,861	0.047
LstepCC0	300,528	306,586	310,367	319,910	310,476	14,407	0.046
Joint Distribution (Islope0, Ltarget0 equal weight)	273,666	283,636	291,852	311,375	292,866	23,267	0.079
Joint Distribution (Itarget0, Ltarget0, equal weight)	**222,624**	**231,284**	**246,905**	**273,737**	**248,397**	**28,220**	**0.114**
Joint Distribution (all 4 methods, equal weight)	246,912	276,815	289,052	310,775	279,679	38,484	0.138

Updated Table 5.7 Sensitivity of catch recommendations for Lane Snapper to the CV specified for the total removals (Cat CV) required for both methods. Statistics reported for the catch recommendation include the 25th, 40th, 50th, and 75th percentiles, the mean, standard deviation (SD), and the coefficient of variation (CV).

| Method	Cat CV	25%	40%	50%	75%	Mean	SD	CV
Islope0	0.103	301,844	307,686	311,243	321,267	311,638	14,576	0.047
	0.206	292,036	303,281	310,367	329,649	311,417	28,544	0.092
Itarget0	0.103	215,566	219,912	222,623	229,469	222,702	10,334	0.046
	0.206	208,022	216,361	221,488	235,256	222,342	20,218	0.091
LstepCC0	0.103	300,528	306,586	310,367	319,910	310,476	14,407	0.046
	0.206	290,494	302,119	309,180	329,330	310,763	28,940	0.093
Ltarget0	0.103	265,231	270,536	273,738	282,670	274,093	12,861	0.047
	0.206	255,883	266,392	272,574	290,376	273,799	25,250	0.092
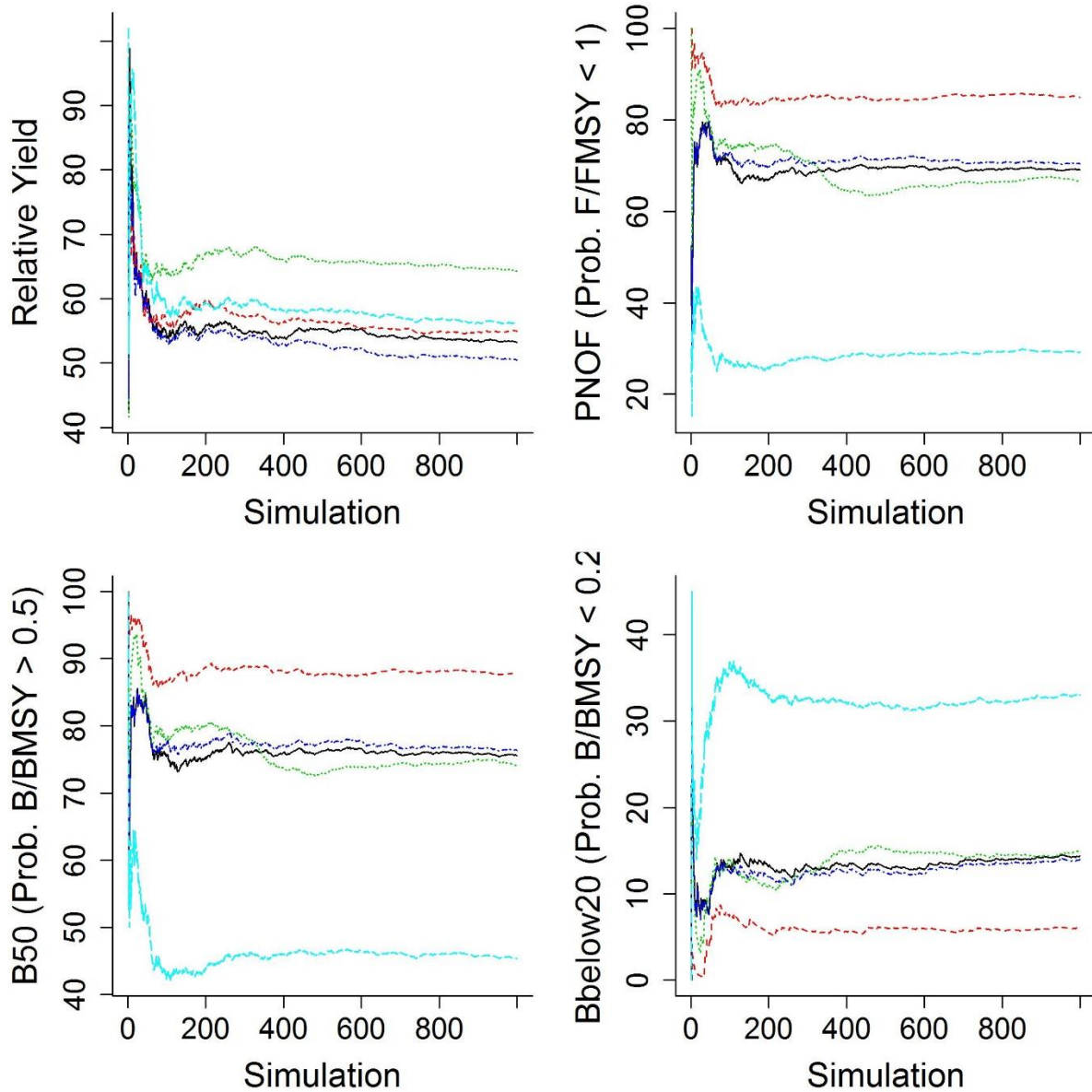
Updated Figure 5.1 Convergence plot confirming that performance criteria for each viable method converged to within 0.05%, indicating that the number of simulations was sufficient for Lane Snapper. Each colored line identifies the following method: Itarget0 (red), Islope0 (black), Ltarget0 (green), LstepCC0 (purple), and Tier3AStatusQuo_ABC (aqua). Relative yield corresponds to the LTY divided by the reference yield, which is the highest mean yield over the last five years of the projection period that can be obtained from a fixed F strategy.
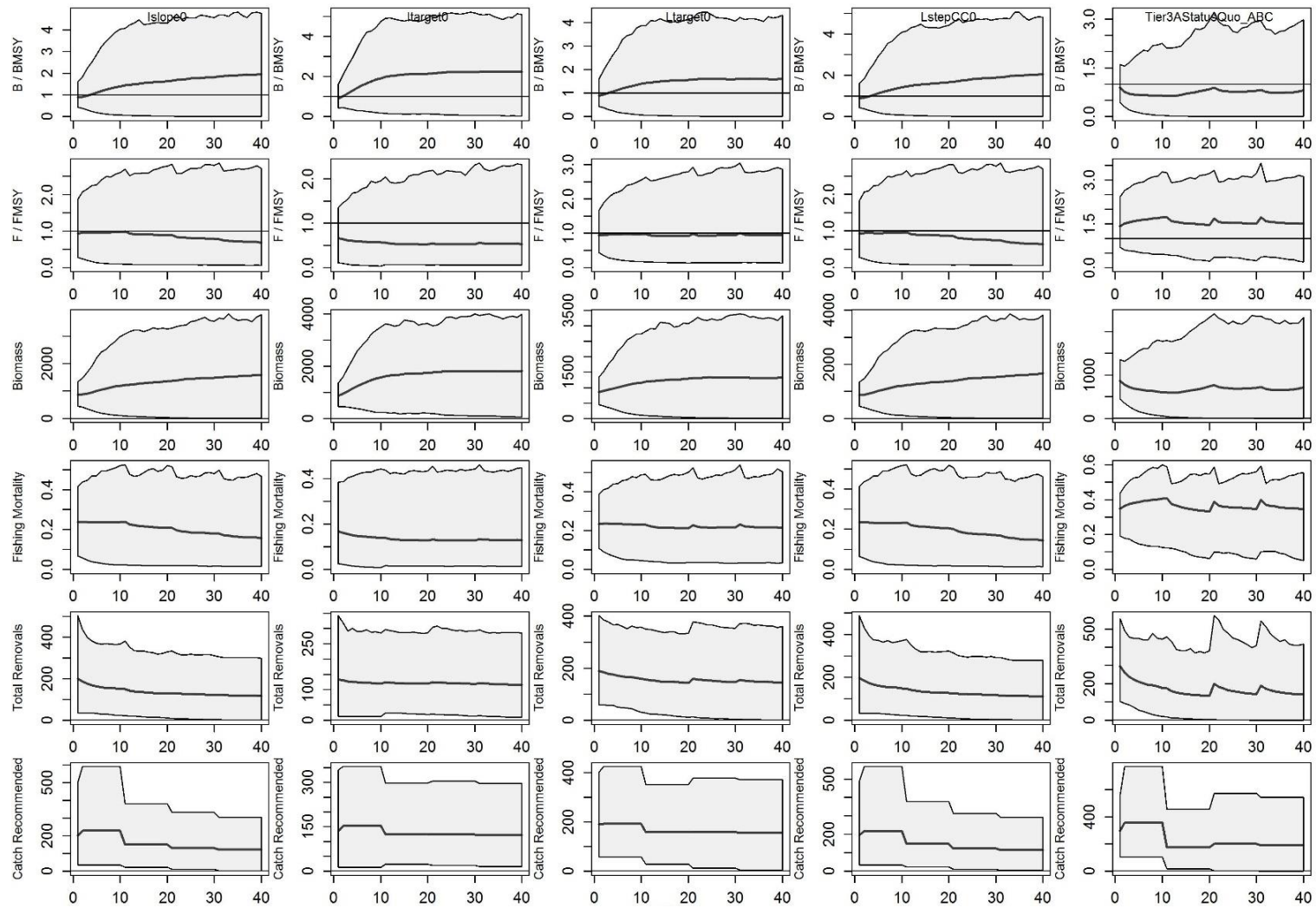
Updated Figure 5.2 Comparison of stock status outputs and catches for Lane Snapper for the 40-year projection period where an assessment is conducted in years 1, 11, 21, and 31. Outputs include the ratio of biomass to biomass at maximum sustainable yield (B/B_{MSY}), the ratio of fishing mortality (F) to fishing mortality at maximum sustainable yield (F/F_{MSY}), biomass (in pounds), fishing mortality, total removals (in pounds), and the catch recommendation (in pounds) for the viable methods. Solid black lines identify the mean across 1,000 simulations whereas the shaded area bounds the 5th and 95th percentiles.

9
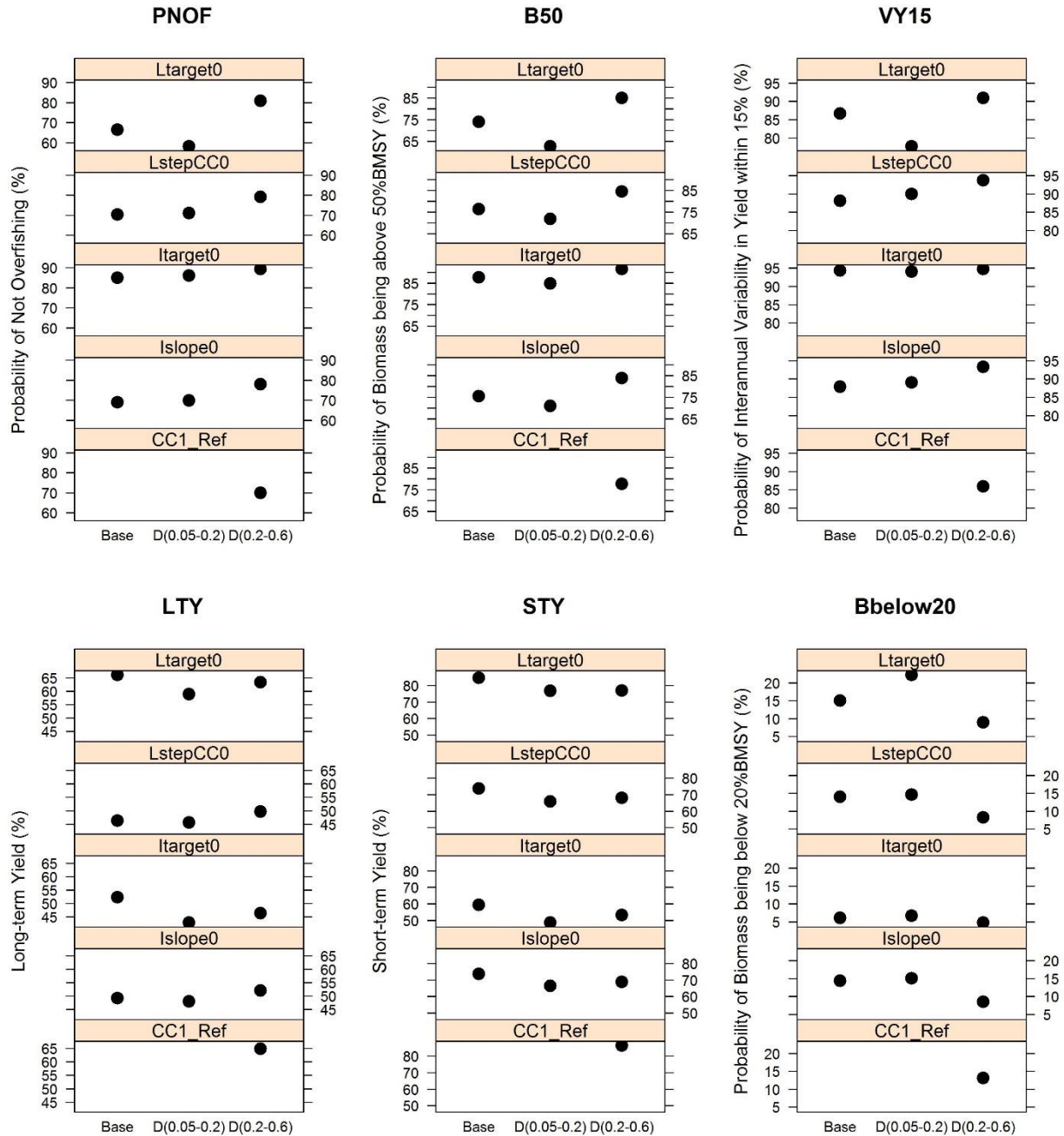
Updated Figure 5.3 Method performance for Lane Snapper assuming the base level of depletion (base; D = 0.12 − 0.31 based on other Lutjanidae), a severely depleted state (D = 0.05 − 0.2), and a moderately depleted state (D = 0.2 − 0.6). Results for the lightly depleted state (D = 0.6 − 0.9) are not shown because the depletion levels could not be reached. The absence of points indicates that the performance metric(s) did not meet the specified criteria (> 50%) for PNOF, B50, and VY15. Tier3AStatusQuo_ABC did not meet the performance metrics for any sensitivity run.

10
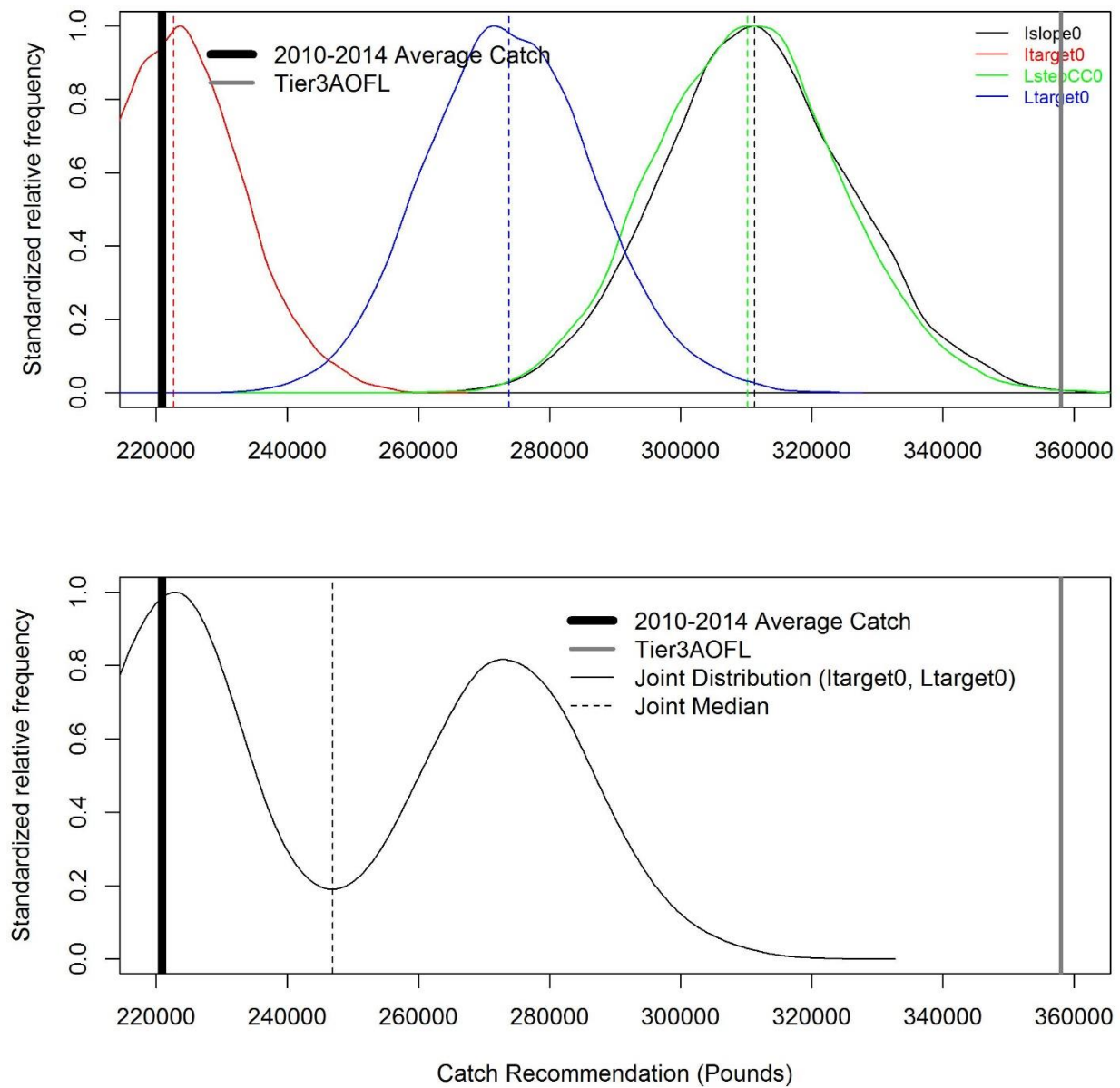
Updated Figure 5.4 Distribution of the catch recommendation (in pounds) for Lane Snapper recommended by the four viable methods, Islope0, Itarget0, LstepCC0 and Ltarget0 (top panel; dashed vertical lines identify medians) and a joint distribution assuming equal weighting between Itarget0 and Ltarget0 (bottom panel). The average catch between 2010 and 2014 (thick black line) and the OFL specified by the Tier3AStatusQuo (thick gray line) are included for comparison. The joint distribution (bottom panel) is recommended for providing management advice, with methods determined based on relatively higher long-term yield.

11
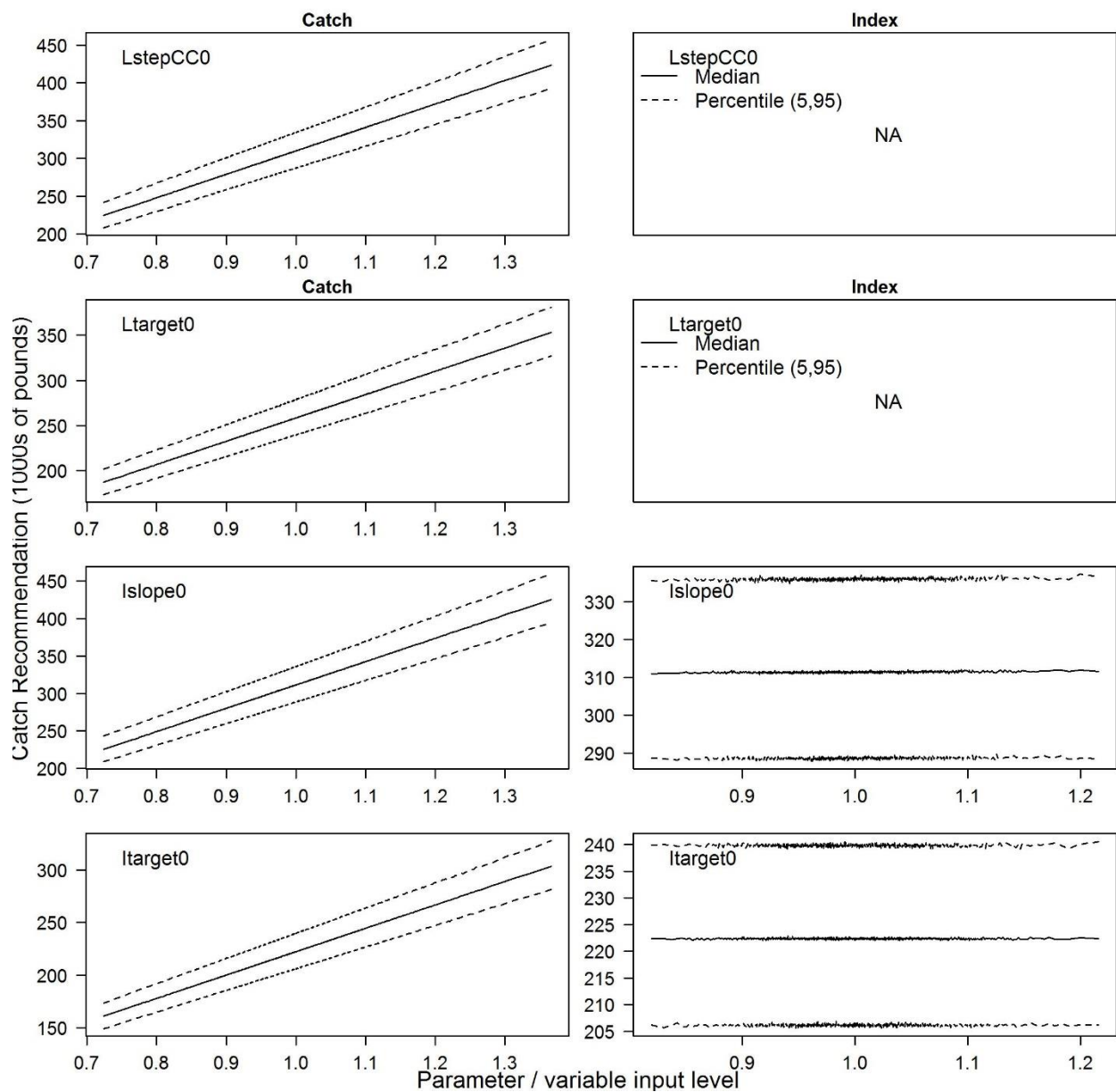
Updated Figure 5.5 Sensitivity of the catch recommendation for Lane Snapper to marginal changes in the required data inputs for LstepCC0 and Ltarget0 (only catch considered in sensitivity analysis) and Islope0 and Itarget0 (Catch and index of abundance). Note that ranges for parameter ranges are derived from the CV for each parameter. NA indicates that the data input is not required.

Wenchman

MSE: Both Itarget0 and Ltarget0 met the performance metrics (Updated Table 6.3). No convergence issues were detected as performance metrics converged to within 0.05% for both methods (Updated Figure 6.1). When trends over the 40 year projection period were examined, Itarget0 and Ltarget0 displayed mean ratios of biomass to biomass at maximum sustainable yield (B/B_{MSY}) above the 1.0 threshold and mean ratios of fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}) below the 1.0 threshold (Updated Figure 6.2). Both Itarget0 and Ltarget0 met the performance criteria regardless of the assumed depletion state (Updated Figure 6.3).

The various scalar values tested for Itarget0 indicate small to moderate differences in performance metrics (range: 7.5% [Bbelow20] to 45.1% [VY15]), with the performance metrics from the default scalars resulting in conservative PNOF, B50, VY15 and moderate LTY and STY (Updated Table 6.5).

The various scalar values tested for Ltarget0 indicate small to moderate differences in performance metrics (range: 6.2% [Bbelow20] to 29.7% [STY]), with the performance metrics from the default values resulting in relatively conservative PNOF, B50, VY15 and moderate LTY and STY (Updated Table 6.7).

Catch Recommendation: The recommended approach for the catch recommendation remains unchanged and includes a joint distribution between the top performing index-based (Itarget0, higher relative LTY and STY) and length-based (Ltarget0, higher relative LTY and STY) (Updated Table 6.8; Updated Figure 6.4). Sensitivity of the catch recommendations from Itarget0 and Ltarget0 remains the same (Updated Table 6.9; Updated Figure 6.5).

Updated Table 6.3 Performance metrics for methods meeting performance criteria for Wenchman. Colors reflect poor performance (red), fair performance (yellow), and good performance (green). Performance metrics include PNOF = Probability of not overfishing; B50 = Probability of the biomass being above 50% B_{MSY}; VY15 = Probability of the inter-annual variability in yield remaining within 15%; LTY and STY = long and short-term yields; and Bbelow20 = Probability of the biomass being below 20% B_{MSY}. Note that performance for Bbelow20 is reversed, where a low probability is preferable.

Method	PNOF	B50	VY15	LTY	STY	Bbelow20
CC1_Ref	83.9	87.4	85.5	59.6	65.2	5.4
Islope0	88.8	90.9	92.5	43.4	50.1	3.6
Itarget0	81.9	86.6	85.2	58.6	62.7	5.4
Ltarget0	87.7	90.2	87.6	49.6	55.1	4.2
LstepCC0	89.2	91.2	93.3	40.0	50.6	3.4
Tier3AStatusQuo_ABC	66.9	76.7	60.8	70.5	82.3	9.8

Updated Table 6.5 Comparison of model performance for different configurations of Itarget0 by varying the scalar parameters on the threshold (I0) and the target (Itarget) values for the index of abundance with the default value highlighted in bold. Performance metrics are as defined in Table 6.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Configurations are shown which do not meet the 50% threshold for VY15 (noted in red) to provide insight into the tradeoffs between scalar values and performance metrics. Specifics on the equation and scalars are provided in Table 3.1.3 in the Assessment Report.

Method	I0 Scalar	Itarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Itarget0	0.7	1.0	66.1	75.0	63.0	64.0	76.4	11.5
	0.7	1.1	71.0	77.9	69.9	63.8	73.2	10.2
	0.7	1.2	74.9	80.2	76.2	63.6	70.9	9.0
	0.7	1.3	77.6	82.0	79.6	61.7	68.6	8.2
	0.7	1.4	79.8	83.6	82.8	60.6	67.1	7.4
	0.7	1.5	81.6	84.7	85.0	59.5	65.9	6.9
	0.8	1.0	63.7	73.5	57.4	62.5	75.8	12.1
	0.8	1.1	69.0	77.0	67.0	62.0	72.9	10.6
	0.8	1.2	73.7	79.7	73.7	62.4	69.9	9.3
	0.8	1.3	77.0	81.8	78.6	60.7	67.6	8.3
	0.8	1.4	79.5	83.5	82.2	59.4	65.5	7.4
	0.8	**1.5**	81.6	84.8	84.5	58.0	63.4	6.9
	0.9	1.0	60.7	71.4	50.3	59.7	75.3	12.8
	0.9	1.1	66.7	75.6	61.2	59.1	71.1	11.1
	0.9	1.2	72.0	78.9	69.9	59.4	67.9	9.6
	0.9	1.3	76.3	81.5	75.9	58.6	64.7	8.4
	0.9	1.4	79.2	83.3	81.2	57.3	62.6	7.4
	0.9	1.5	81.6	84.9	83.4	56.5	60.1	6.7
	1.0	1.0	57.3	69.3	39.9	56.6	73.9	14.0
	1.0	1.1	63.9	73.7	54.8	57.6	70.8	11.8
	1.0	1.2	70.2	77.8	65.3	57.1	67.2	10.0
	1.0	1.3	75.2	81.1	73.8	57.2	63.8	8.6
	1.0	1.4	78.7	83.2	79.5	55.8	61.1	7.5
	1.0	1.5	81.7	85.0	83.3	55.3	58.5	6.5
		Minimum	57.3	69.3	39.9	55.3	58.5	6.5
		Maximum	81.7	85.0	85.0	64.0	76.4	14.0
		Difference	24.4	15.7	45.1	8.7	17.9	7.5

Updated Table 6.7 Comparison of model performance for different configurations of Ltarget0 by varying the scalar parameters on the threshold (L0) and the target (Ltarget) values for the mean length, with the default value highlighted in bold. Performance metrics are as defined in Table 6.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Specifics on the equation and scalars are provided in Table 3.1.3 in the Assessment Report.

Method	L0 Scalar	Ltarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Ltarget0	0.8	1.00	82.7	85.4	84.4	54.4	62.3	7.0
	0.8	1.05	85.4	87.1	87.5	53.3	59.5	6.2
	0.8	1.10	87.0	88.2	89.7	49.9	56.1	5.6
	0.8	1.15	88.1	89.1	91.1	48.4	54.4	5.2
	0.8	1.20	89.2	89.8	91.7	47.1	52.0	4.8
	0.8	1.25	90.0	90.4	92.6	45.1	49.6	4.5
	0.9	1.00	83.4	86.0	84.3	49.7	56.3	6.6
	0.9	**1.05**	87.3	88.6	89.1	46.6	52.3	5.4
	0.9	1.10	89.3	89.9	91.6	43.7	48.5	4.7
	0.9	1.15	90.4	90.8	93.1	42.3	46.4	4.3
	0.9	1.20	91.5	91.4	93.8	40.5	44.2	3.8
	0.9	1.25	92.2	91.9	94.6	38.2	41.7	3.5
	1.0	1.00	76.4	81.5	68.3	39.8	50.4	8.8
	1.0	1.05	88.6	89.9	89.3	37.0	41.7	4.7
	1.0	1.10	92.0	92.1	93.8	34.2	38.3	3.7
	1.0	1.15	93.3	93.1	95.3	31.9	35.3	3.1
	1.0	1.20	94.1	93.5	95.9	30.2	33.2	2.8
	1.0	1.25	94.7	93.8	96.3	29.9	32.6	2.6
		Minimum	76.4	81.5	68.3	29.9	32.6	2.6
		Maximum	94.7	93.8	96.3	54.4	62.3	8.8
		Difference	18.3	12.3	28.0	24.5	29.7	6.2

Updated Table 6.8 Summary statistics of the catch recommendations (in pounds) for each viable method for Wenchman and multiple weighted joint distributions in comparison to the Tier3AStatusQuo (i.e. current OFL). The recommended method, a joint distribution of the top index-based (Itarget0) and length-based (Ltarget0) methods as determined by MSE is highlighted in bold.

Method	25%	40%	50%	75%	Mean	SD	CV
Tier3AStatusQuo	99,669	99,669	99,669	99,669	99,669	0	0
Itarget0	42,581	45,395	47,167	52,542	47,825	7,563	0.158
Ltarget0	20,083	21,429	22,272	24,759	22,591	3,521	0.156
CC1_Ref	48,023	51,373	53,546	59,316	54,075	8,519	0.158
Islope0	55,798	60,060	62,718	70,433	63,534	10,905	0.172
LstepCC0	43,272	46,165	48,031	53,224	48,520	7,548	0.156
Joint Distribution (Itarget0, Ltarget0, equal weight)	**22,272**	**25,365**	**32,471**	**47,167**	**35,208**	**13,928**	**0.396**
Joint Distribution (Itarget0, Ltarget0, CC1_Ref, equal weight)	24,760	40,491	44,785	53,125	41,497	15,252	0.368
Joint Distribution (All, equal weight)	39,280	45,769	48,906	57,403	47,309	15,747	0.333

Updated Table 6.9 Sensitivity of catch recommendations for Wenchman to the CV specified for the total removals (Cat CV) required for all methods. Statistics reported for the catch recommendation include the 25th, 40th, 50th, and 75th percentiles, the mean, standard deviation (SD), and the coefficient of variation (CV).

| Method	Cat CV	25%	40%	50%	75%	Mean	SD	CV
Itarget0	0.35	42,581	45,395	47,167	52,542	47,825	7,563	0.158
	0.70	37,289	42,336	45,818	56,596	47,946	14,855	0.310
Ltarget0	0.35	20,083	21,429	22,272	24,759	22,591	3,521	0.156
	0.70	17,643	20,050	21,661	26,635	22,687	6,991	0.308
CC1_Ref	0.35	48,023	51,373	53,546	59,316	54,075	8,519	0.158
	0.70	42,072	47,859	51,420	63,209	53,939	16,630	0.308
Islope0	0.35	55,798	60,060	62,718	70,433	63,534	10,905	0.172
	0.70	48,997	55,929	60,555	75,201	63,796	20,527	0.322
LstepCC0	0.35	43,272	46,165	48,031	53,224	48,520	7,548	0.156
	0.70	37,566	43,104	46,573	57,226	48,639	15,144	0.311
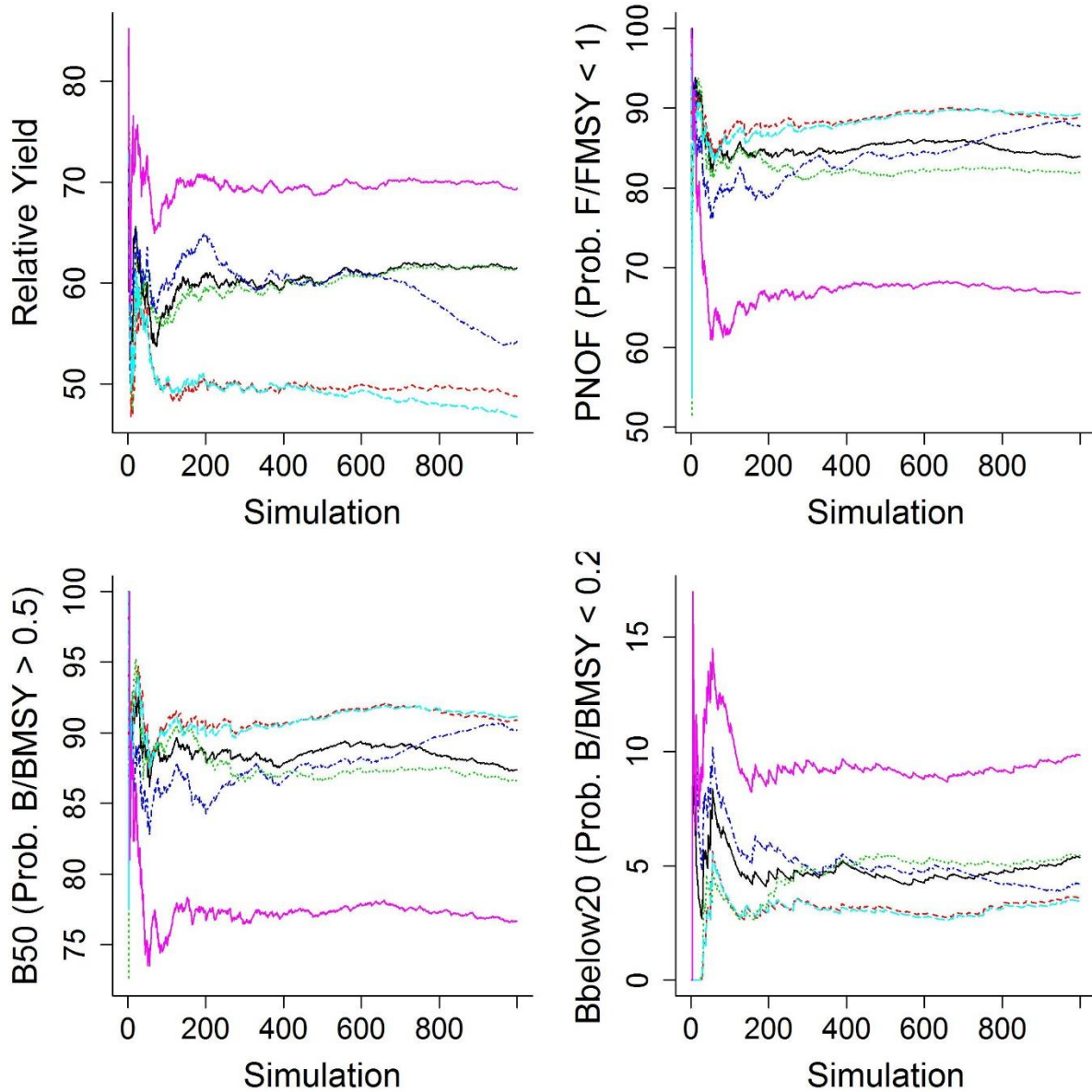
Updated Figure 6.1 Convergence plot confirming that performance criteria for each viable method converged to within 0.05%, indicating that the number of simulations was sufficient for Wenchman. Each colored line identifies the following method: Islope0 (red), CC1_Ref (black), Itarget0 (green), LstepCC0 (aqua), Ltarget0 (purple), Tier3AStatusQuo_ABC (pink), and. Relative yield corresponds to the LTY divided by the reference yield, which is the highest mean yield over the last five years of the projection period that can be obtained from a fixed F strategy.
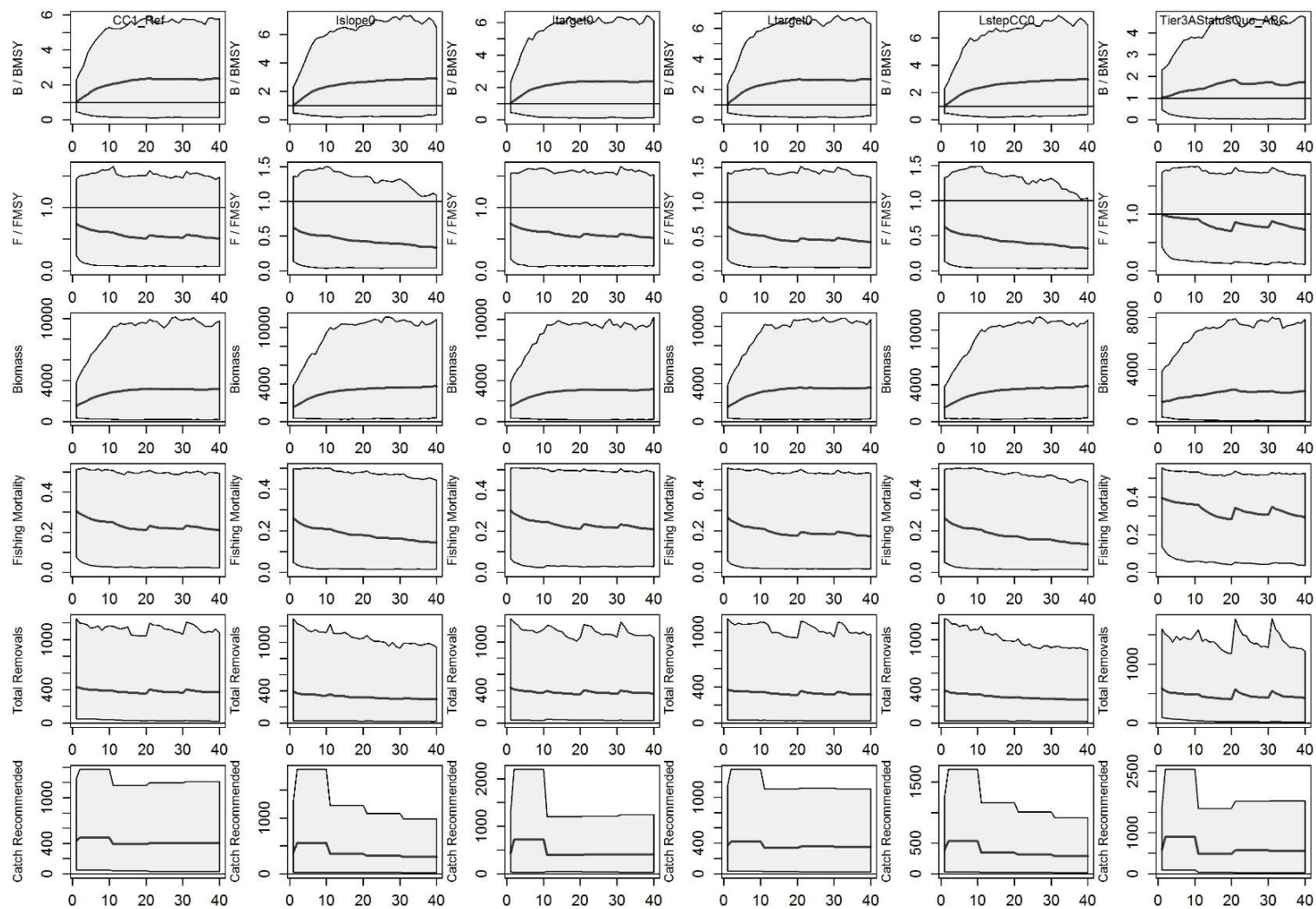
Updated Figure 6.2 Comparison of stock status outputs and catches for Wenchman for the 40-year projection period where an assessment is conducted in years 1, 11, 21, and 31. Outputs include the ratio of biomass to biomass at maximum sustainable yield (B/B_{MSY}), the ratio of fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}), biomass (in pounds), fishing mortality, total removals (in pounds), and the catch recommendation (in pounds) for each viable method. Solid black lines identify the mean across 1,000 simulations whereas the shaded area bounds the 5th and 95th percentiles.

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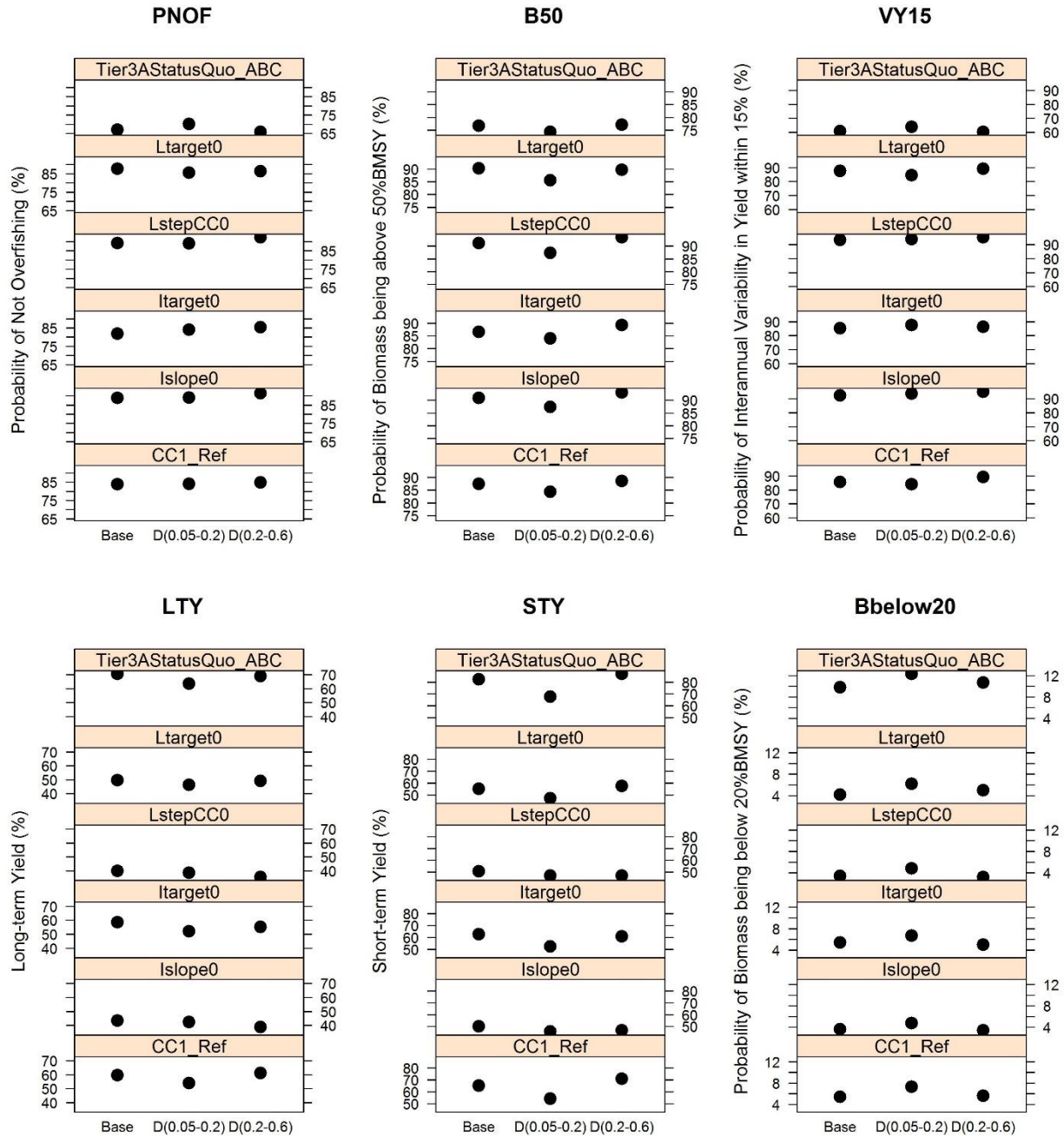
Updated Figure 6.3 Method performance for Wenchman assuming the base level of depletion (base; D = 0.12 – 0.31 based on other Lutjanidae), a severely depleted state (D = 0.05 – 0.2), and a moderately depleted state (D = 0.2 – 0.6). Results for the lightly depleted state (D = 0.6 – 0.9) are not shown because the depletion levels could not be reached. The absence of points indicates that the performance metric(s) did not meet the specified criteria (> 50%) for PNOF, B50, and VY15.
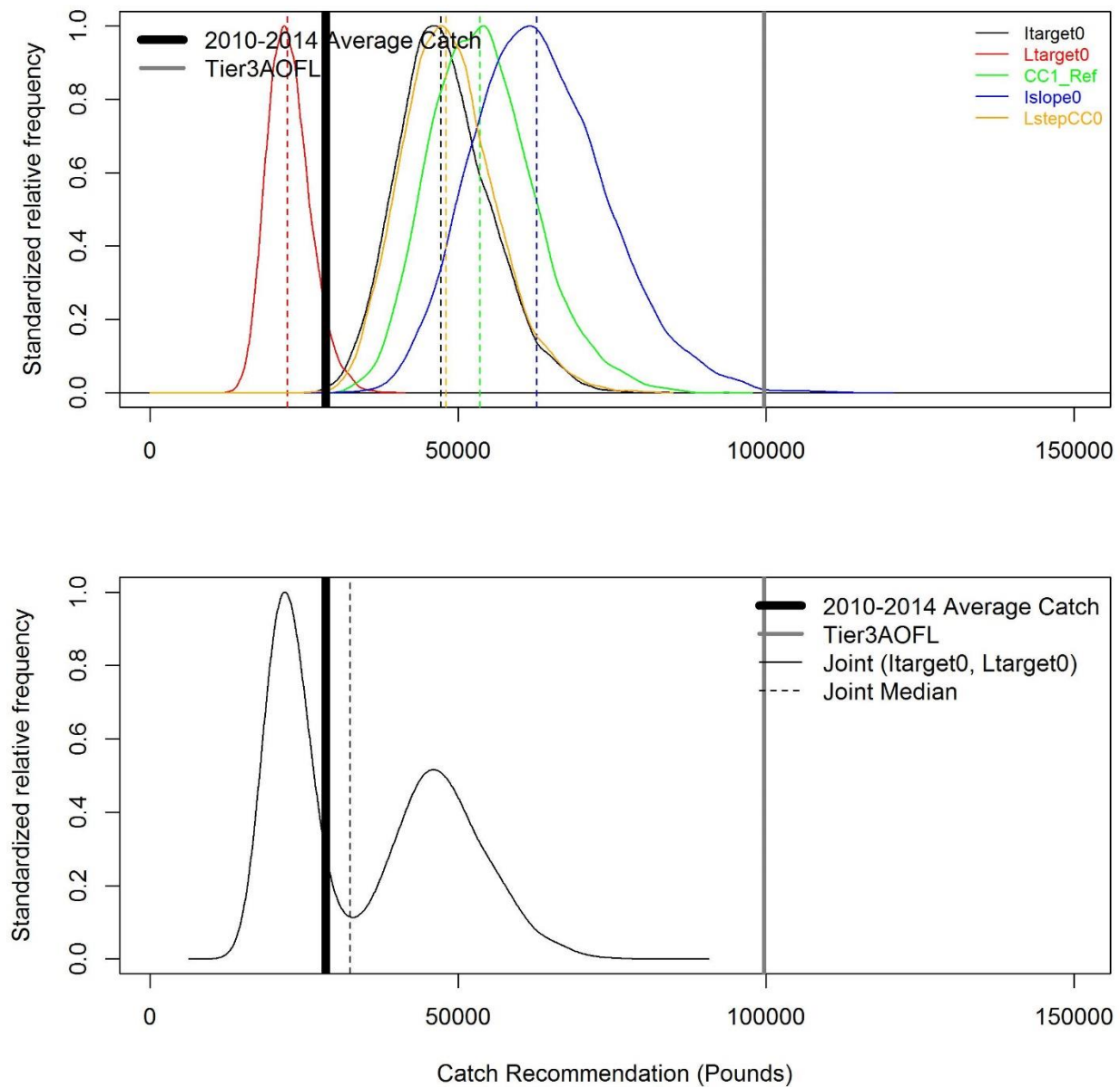
Updated Figure 6.4 Distribution of the catch recommendation (in pounds) for Wenchman recommended by the five viable methods (top panel; dashed vertical lines identify medians) and a joint distribution assuming equal weighting of the top index-based (Itarget0) and length-based (Ltarget0) methods according to performance in the MSE (bottom panel). The average catch between 2010 and 2014 (thick black line) and the OFL specified by the Tier3AStatusQuo (thick gray line) are included for comparison. The joint distribution (bottom panel) is recommended for providing management advice.
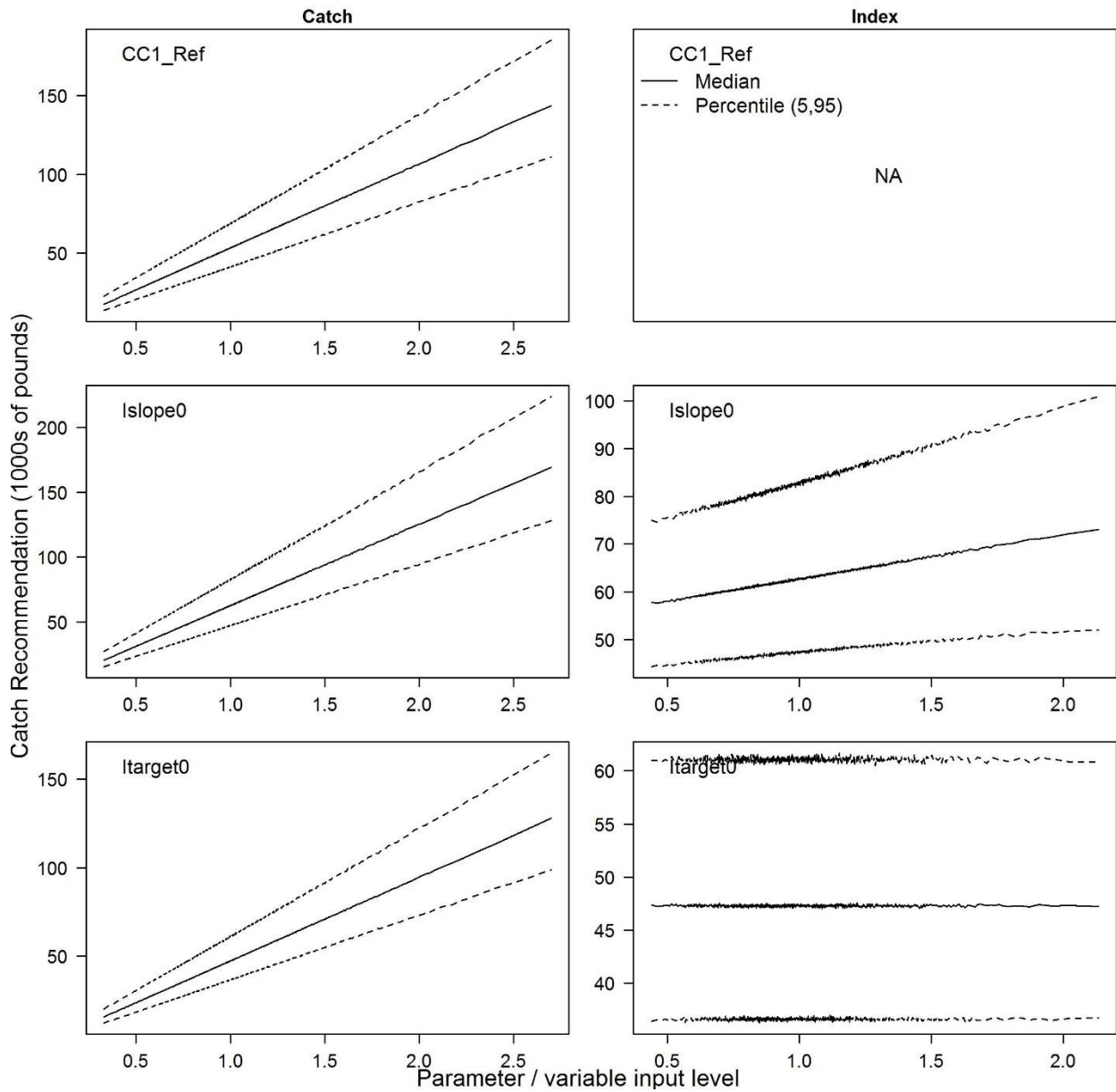
Updated Figure 6.5 Sensitivity of the catch recommendation for Wenchman to marginal inputs in the required data inputs for CC1_Ref (catch only) and the index-based methods Islope0 and Itarget0 (Catch and index of abundance). Note that ranges for parameter ranges are derived from the CV for each parameter. NA indicates that the data input is not required. Sensitivity runs resulted in errors for both LstepCC0 and Ltarget0 and are therefore not shown.

Lesser Amberjack

MSE: Itarget0 met the performance metrics (Updated Table 10.3). No convergence issues were detected as performance metrics converged to within 0.05% for Itarget0 (Updated Figure 10.1). When trends over the 40 year projection period were examined, Itarget0 displayed mean ratios of biomass to biomass at maximum sustainable yield (B/B_{MSY}) above the 1.0 threshold and mean ratios of fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}) below the 1.0 threshold (Updated Figure 10.2). Itarget0 met the performance criteria regardless of the assumed depletion state (Updated Figure 10.3).

The various scalar values tested for Itarget0 indicate small to moderate differences in performance metrics (range: 8.2% [LTY] to 19.9% [PNOF, VY15]), with the performance metrics from the default scalars resulting in the most conservative PNOF and VY15 and relatively low LTY and STY (Updated Table 10.3A).

Catch Recommendation: The recommended approach has changed from Islope0 to Itarget0 (higher LTY) for the catch recommendation (Updated Table 10.5; Updated Figure 10.4). For Itarget0, the catch recommendations are sensitive to the magnitude of total removals but not to small changes in the index of abundance (Updated Figure 10.5). Overall, the CV on total removals had a minor impact on the median catch recommendations for Itarget0 (Updated Table 10.6).

Updated Table 10.3 Performance metrics for methods meeting performance criteria for Lesser Amberjack. Colors reflect poor performance (red), fair performance (yellow), and good performance (green). Performance metrics include PNOF = Probability of not overfishing; B50 = Probability of the biomass being above 50% B_{MSY}; VY15 = Probability of the inter-annual variability in yield remaining within 15%; LTY and STY = long and short-term yields; and Bbelow20 = Probability of the biomass being below 20% B_{MSY}. Note that performance for Bbelow20 is reversed, where a low probability is preferable.

Method	PNOF	B50	VY15	LTY	STY	Bbelow20
Tier3AStatusQuo_ABC	52.4	59.4	67.3	56.2	72.2	21.0
CC1_Ref	76.5	78.8	88.7	47.3	53.0	9.8
Islope0	61.5	64.1	84.9	42.9	67.4	20.2
Itarget0	70.7	73.5	85.8	51.0	58.4	13.0

New Table 10.3A Comparison of model performance for different configurations of Itarget0 by varying the scalar parameters on the threshold (I0) and the target (Itarget) values for the index of abundance with the default value highlighted in bold. Performance metrics are as defined in Table 10.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Specifics on the equation and scalars are provided in Table 3.1.3 in the Assessment Report.

Method	I0 Scalar	Itarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Itarget0	0.7	1.1	55.1	61.4	70.0	51.7	69.3	21.3
	0.7	1.2	61.5	66.6	75.8	52.0	65.7	17.9
	0.7	1.3	65.9	70.4	80.3	50.9	62.5	15.7
	0.7	1.4	69.4	73.2	83.1	49.1	59.0	14.2
	0.7	1.5	72.3	75.4	84.5	47.0	57.2	12.8
	0.8	1.1	52.7	59.3	67.2	51.7	69.0	22.7
	0.8	1.2	59.5	65.2	74.0	50.8	66.0	18.8
	0.8	1.3	65.0	69.7	79.7	50.2	61.8	15.9
	0.8	1.4	69.3	73.2	82.9	48.9	58.4	14.0
	0.8	**1.5**	72.5	75.6	85.0	46.7	55.7	12.6
	0.9	1.2	57.3	63.1	70.7	48.3	64.3	20.3
	0.9	1.3	64.0	68.7	77.5	48.0	60.5	16.5
	0.9	1.4	68.8	72.8	82.9	46.6	56.7	14.1
	0.9	1.5	72.6	75.7	84.9	45.0	53.8	12.6
	1.0	1.2	53.9	59.9	65.1	46.7	62.2	22.4
	1.0	1.3	61.9	66.9	73.3	45.4	58.4	18.0
	1.0	1.4	68.1	72.1	80.6	44.4	54.6	14.5
	1.0	1.5	72.3	75.4	84.5	43.8	51.2	12.7
		Minimum	52.7	59.3	65.1	43.8	51.2	12.6
		Maximum	72.6	75.7	85.0	52.0	69.3	22.7
		Difference	19.9	16.4	19.9	8.2	18.1	10.1

Updated Table 10.5 Summary statistics of the catch recommendation (in pounds) for each viable method for Lesser Amberjack and equally weighted joint distributions in comparison to the Tier3AStatusQuo (i.e. current OFL). Recommended method is highlighted in bold.

Method	25%	40%	50%	75%	Mean	SD	CV
Tier3AStatusQuo	114,825	114,825	114,825	114,825	114,825	0	0
Islope0	47,563	51,632	54,269	62,215	55,442	11,243	0.203
Itarget0	**32,754**	**35,710**	**37,654**	**42,927**	**38,298**	**7,746**	**0.202**
CC1_Ref	47,624	51,923	54,750	62,416	55,685	11,262	0.202
Joint Distribution (Islope0, CC1_Ref, Equal weight)	47,583	51,769	54,506	62,344	55,564	11,253	0.203
Joint Distribution (Itarget0, CC1_Ref, Equal weight)	37,148	41,907	45,132	55,344	46,909	12,888	0.275
Joint Distribution (Itarget0, CC1_Ref, Islope0, Equal weight)	40,032	45,407	48,862	58,203	49,753	13,002	0.261

Updated Table 10.6 Sensitivity of catch recommendations for Lesser Amberjack to the CV specified for total removals (Cat CV) required for CC1_Ref, Islope0 and Itarget0. Statistics reported for the catch recommendation include the 25th, 40th, 50th, and 75th percentiles, the mean, standard deviation (SD), and the coefficient of variation (CV).

Method	Cat CV	25%	40%	50%	75%	Mean	SD	CV
Islope0	0.45	47,563	51,632	54,269	62,215	55,442	11,243	0.203
	0.90	39,560	46,645	51,342	66,451	55,064	21,374	0.388
Itarget0	0.45	32,754	35,710	37,654	42,927	38,298	7,746	0.202
	0.90	27,247	32,065	35,540	45,825	37,975	14,908	0.393
CC1_Ref	0.45	47,624	51,923	54,750	62,416	55,685	11,262	0.202
	0.90	39,769	46,740	51,559	66,527	55,142	21,571	0.391

Updated Table 10.7 Sensitivity of catch recommendations for Lesser Amberjack to the terminal year selected for assessment. Statistics reported for the catch recommendation include the 25th, 40th, 50th, and 75th percentiles, the mean, standard deviation (SD), and the coefficient of variation (CV). Note that the terminal year influences the portion of the index of abundance used in Islope0 and Itarget0.

| Method	Terminal Year	25%	40%	50%	75%	Mean	SD	CV
Islope0	2009	47,563	51,632	54,269	62,215	55,442	11,243	0.203
	2014	24,263	26,428	27,855	31,857	28,420	5,769	0.203
Itarget0	2009	32,754	35,710	37,654	42,927	38,298	7,746	0.202
	2014	15,378	16,794	17,626	20,061	17,920	3,591	0.200
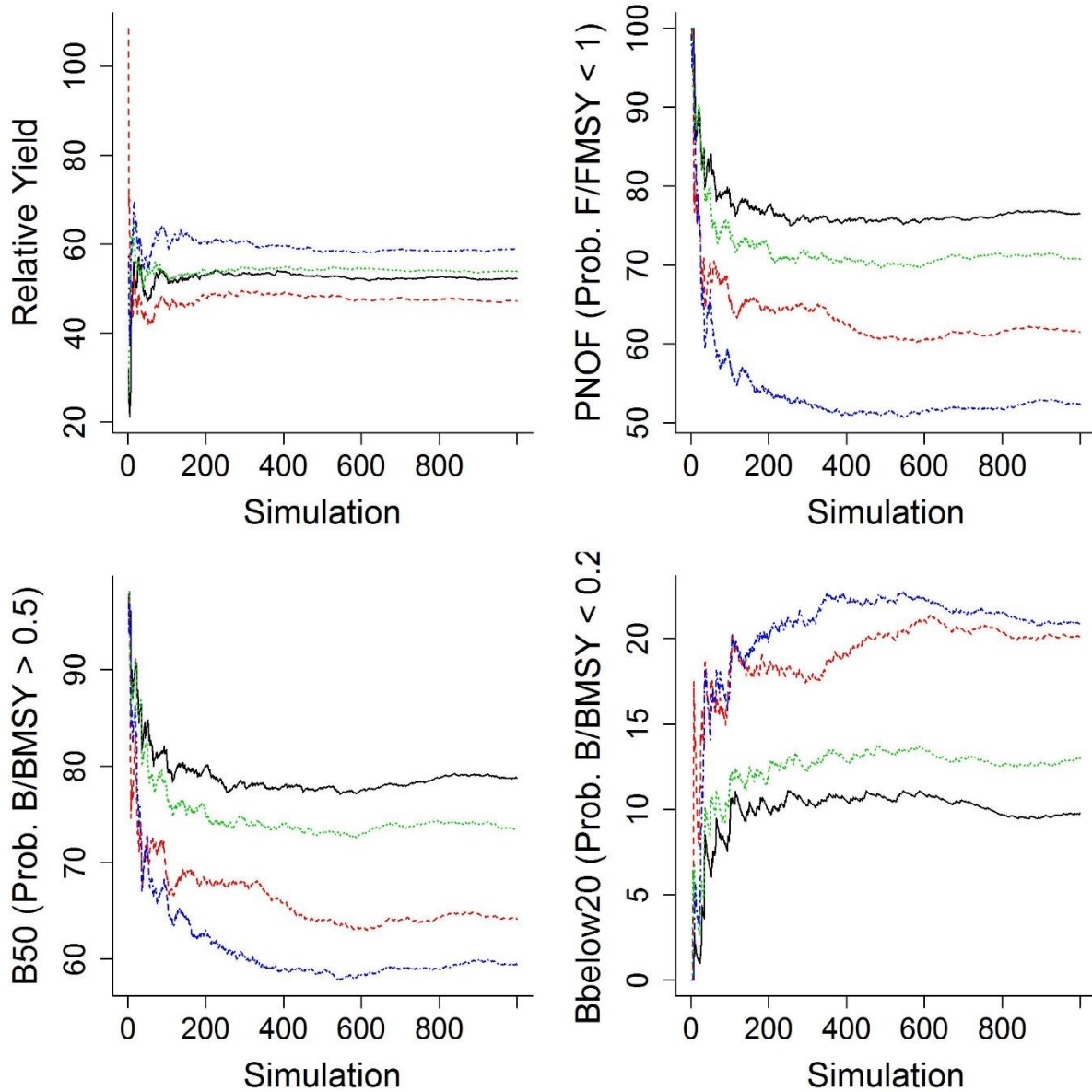
Updated Figure 10.1 Convergence plot confirming that performance criteria for each viable method converged to within 0.05%, indicating that the number of simulations was sufficient for Lesser Amberjack. Each colored line identifies the following methods: Islope0 (red), CC1_Ref (black), Itarget0 (green) and Tier3AStatusQuo_ABC (purple). Relative yield corresponds to the LTY divided by the reference yield, which is the highest mean yield over the last five years of the projection period that can be obtained from a fixed *F* strategy.
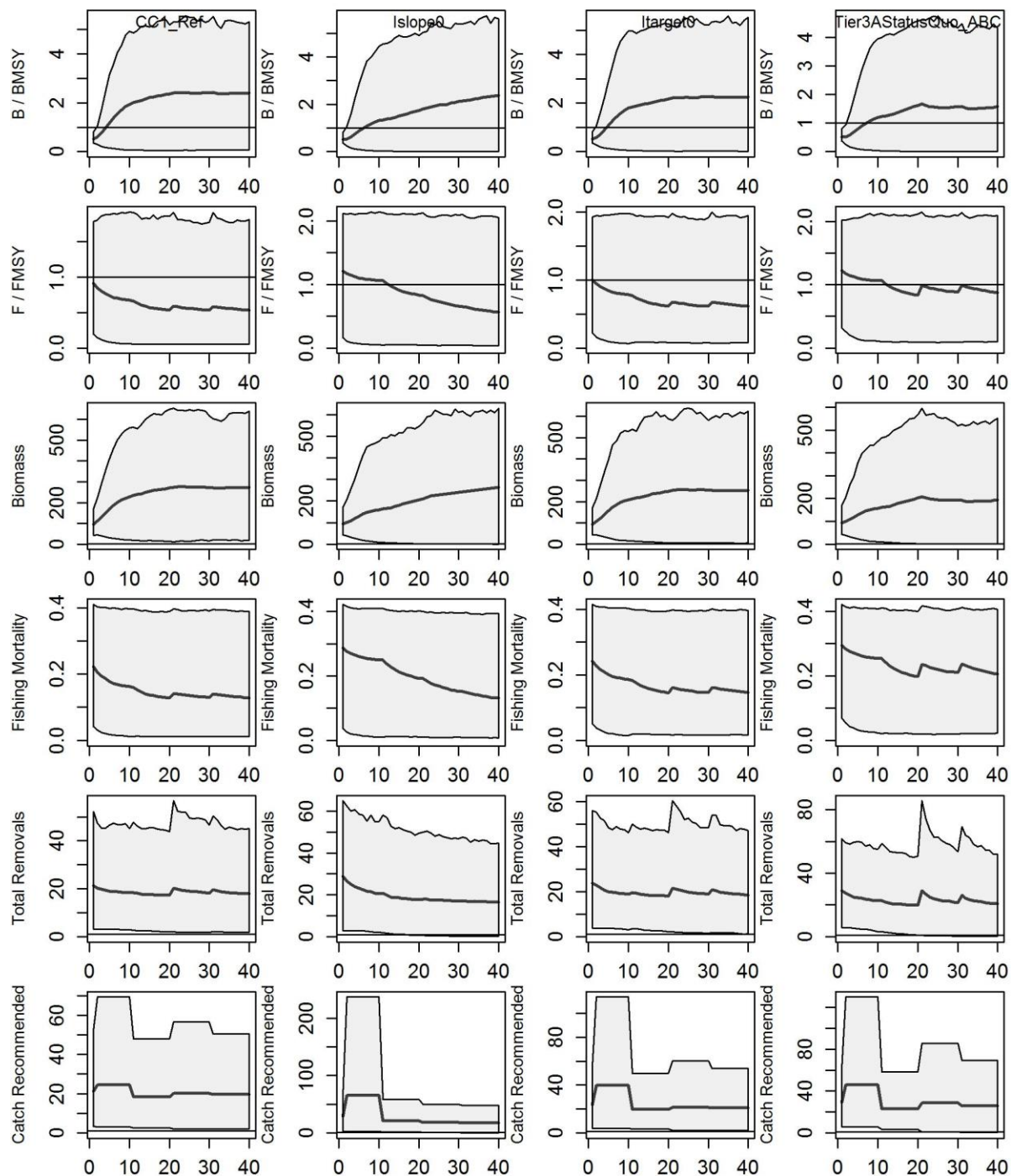
Updated Figure 10.2 Comparison of stock status outputs and catches for Lesser Amberjack for the 40-year projection period where an assessment is conducted in years 1, 11, 21, and 31. Outputs include the ratio of biomass to biomass at maximum sustainable yield (B/B_{MSY}), the ratio of fishing mortality (F) to fishing mortality at maximum sustainable yield (F/F_{MSY}), biomass (in pounds), fishing mortality, total removals (in pounds), and the catch recommendation (in pounds) for each viable method. Solid black lines identify the mean across 1,000 simulations whereas the shaded area bounds the 5th and 95th percentiles.
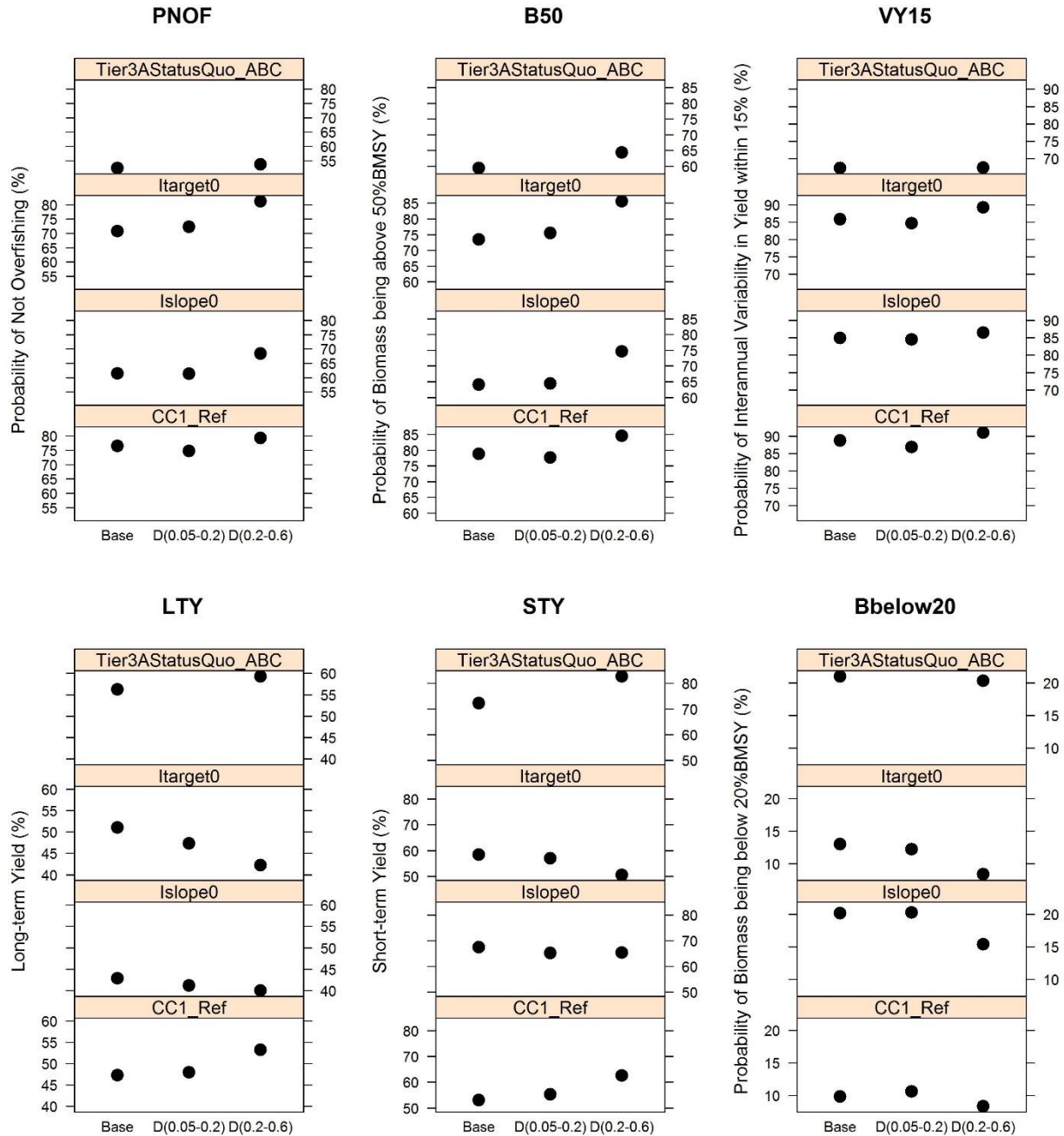
Updated Figure 10.3 Method performance for Lesser Amberjack assuming the base level of depletion (base; D = 0.10 – 0.13 based on recent depletion estimated for Greater Amberjack), a severely depleted state (D = 0.05 – 0.2), and a moderately depleted state (D = 0.2 – 0.6). Results for the lightly depleted state (D = 0.6 – 0.9) are not shown because the depletion levels could not be reached. The absence of points indicates that the performance metric(s) did not meet the specified criteria (> 50%) for PNOF, B50, and VY15.

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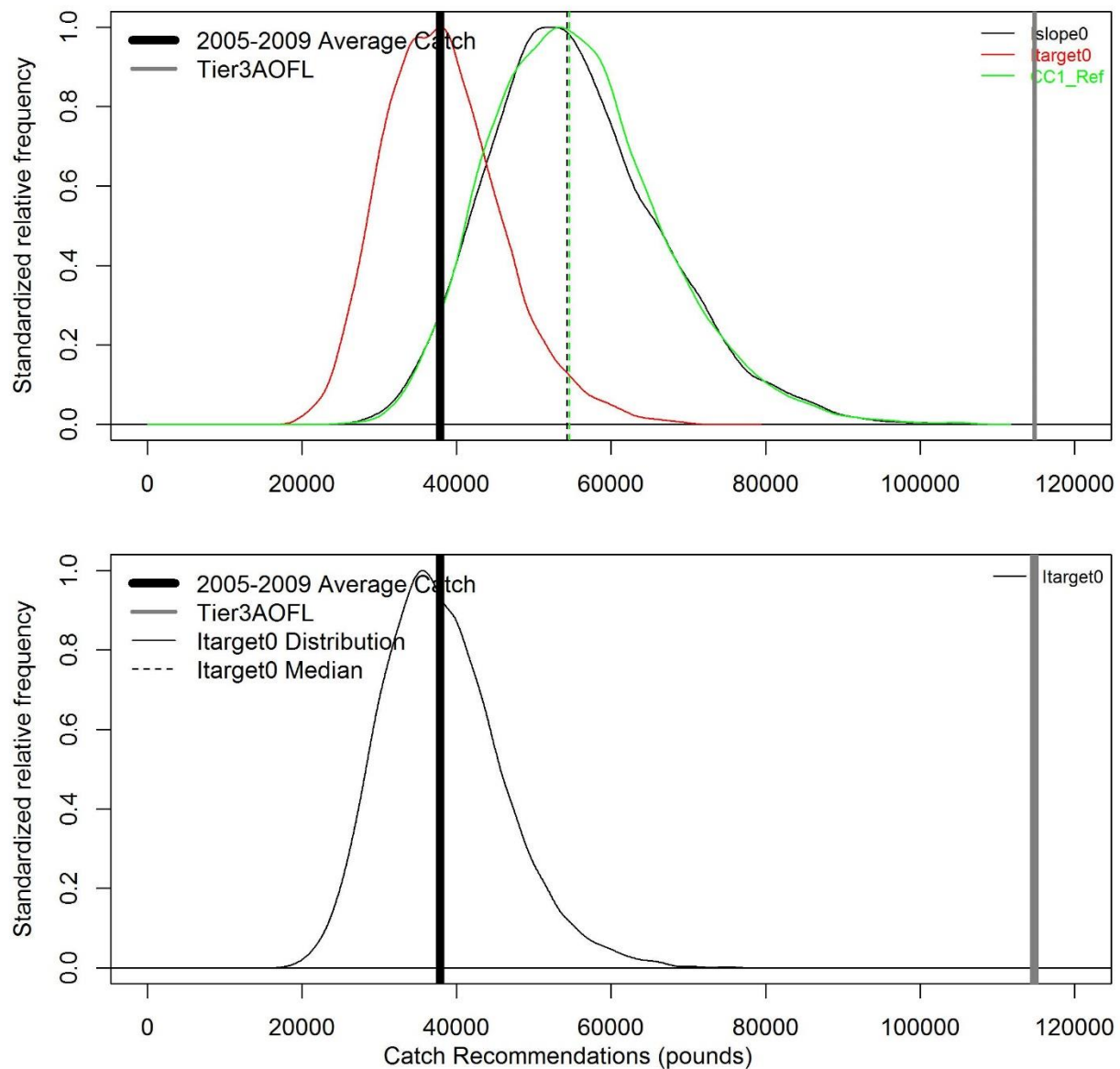
Updated Figure 10.4 Distribution of the catch recommendation (in pounds) for Lesser Amberjack recommended for each viable method, Islope0, Itarget0 and CC1_Ref (top panel; dashed vertical lines identify medians). The average catch in 2005-2009 (thick black line) and the OFL specified by the Tier3AStatusQuo (thick gray line) are included for comparison. The Itarget0 distribution (bottom panel) is recommended for providing management advice because this method resulted in higher long-term yield within the management strategy evaluation.
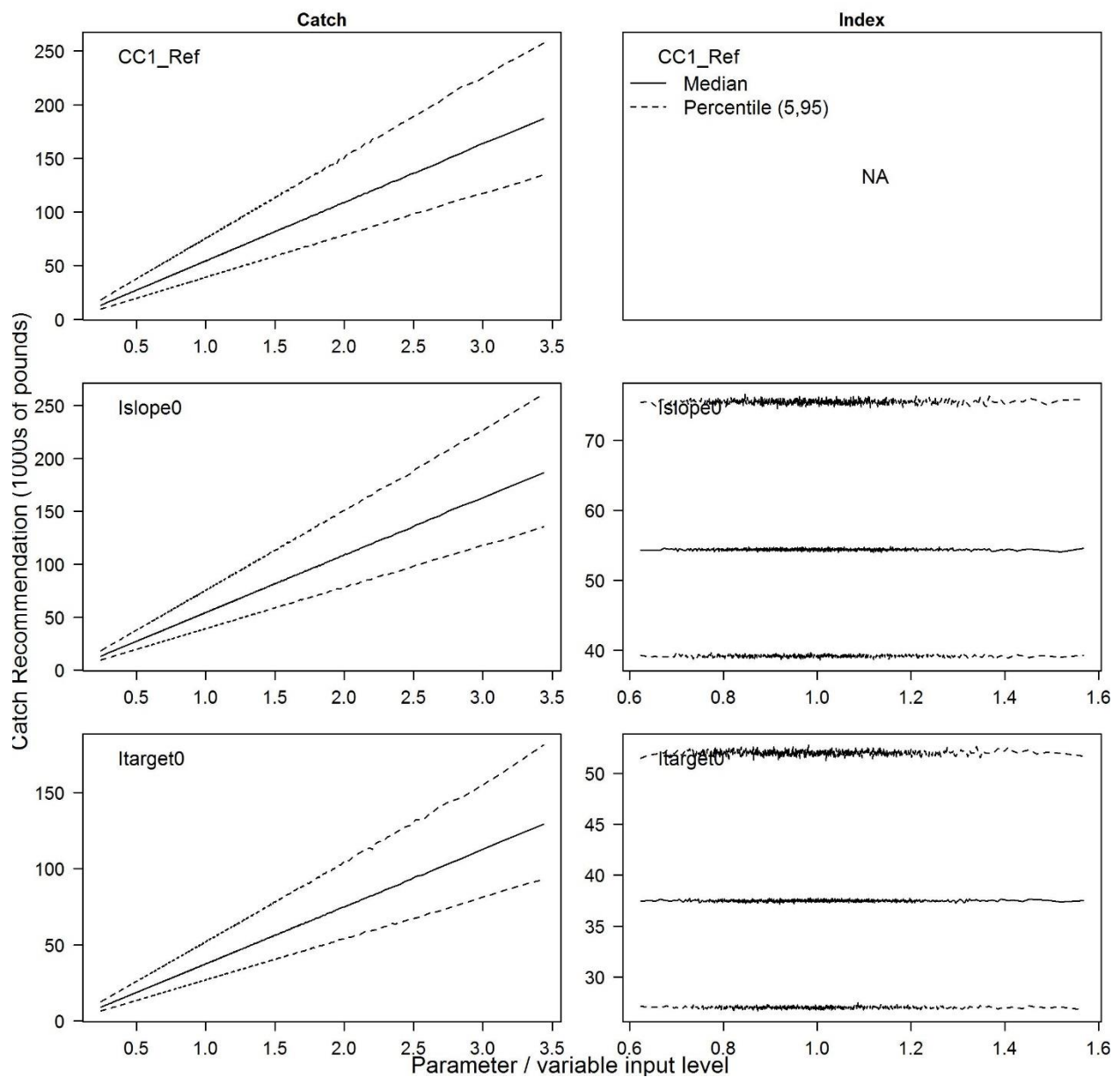
Updated Figure 10.5 Sensitivity of the catch recommendations for Lesser Amberjack to marginal changes in the required data inputs for CC1_Ref (catch only) and Islope0 and Itarget0 (catch and index of abundance). Note that ranges for parameter ranges are derived from the CV for each parameter. NA indicates that the data input is not required.

Almaco Jack

MSE: Itarget0 met the performance metrics (Updated Table 11.3). No convergence issues were detected as performance metrics converged to within 0.05% for Itarget0 (Updated Figure 11.1). When trends over the 40 year projection period were examined, Itarget0 and Ltarget0 displayed mean ratios of biomass to biomass at maximum sustainable yield (B/B_{MSY}) above the 1.0 threshold and mean ratios of fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}) below or near the 1.0 threshold (Updated Figure 11.2). Itarget0 met the performance criteria regardless of the assumed depletion state (Updated Figure 11.3).

The various scalar values tested for Itarget0 indicate moderate differences in performance metrics (range: 18.8% [Bbelow20] to 32.1% [STY]), with the performance metrics from the default scalars resulting in conservative PNOF, B50, VY15, moderate STY and high LTY (Updated Table 11.3A).

Catch Recommendation: The recommended approach for the catch recommendation remains unchanged and includes a joint distribution between the top performing index-based (Islope0, higher relative LTY and STY) and LstepCC0 (Updated Table 11.6; Updated Figure 11.4). For Itarget0, the catch recommendations are sensitive to the magnitude of total removals but not to small changes in the index of abundance (Updated Figure 11.5). Overall, the CV on total removals had a minor impact on the median catch recommendations for Itarget0 (Updated Table 11.7).

Updated Table 11.3 Performance metrics for methods meeting performance criteria for Almaco Jack. Colors reflect poor performance (red), fair performance (yellow), and good performance (green). Performance metrics include PNOF = Probability of not overfishing; B50 = Probability of the biomass being above 50% B_{MSY}; VY15 = Probability of the inter-annual variability in yield remaining within 15%; LTY and STY = long and short-term yields; and Bbelow20 = Probability of the biomass being below 20% B_{MSY}. Note that performance for Bbelow20 is reversed, where a low probability is preferable.

Method	PNOF	B50	VY15	LTY	STY	Bbelow20
Islope0	69.0	72.8	85.5	45.3	68.7	19.9
Itarget0	82.1	84.5	91.9	43.2	56.6	10.6
LstepCC0	68.9	72.9	84.6	42.2	69.1	20.2
Tier3AStatusQuo_ABC	16.2	24.1	34.4	30.9	93.1	62.4

New Table 11.3A Comparison of model performance for different configurations of Itarget0 by varying the scalar parameters on the threshold (I0) and the target (Itarget) values for the index of abundance with the default value highlighted in bold. Performance metrics are as defined in Table 11.3. Note that a gradation color scheme (for PNOF across to STY: low [red] to high [green]; for Bbelow20: low [green] to high [red]) is used to highlight differences between metrics. Specifics on the equation and scalars are provided in Table 3.1.3 in the Assessment Report.

Method	I0 Scalar	Itarget Scalar	PNOF	B50	VY15	LTY	STY	Bbelow20
Itarget0	0.7	1.0	62.1	67.4	76.8	39.5	68.7	25.0
	0.7	1.1	68.4	73.3	83.0	41.9	66.2	20.2
	0.7	1.2	72.6	77.0	86.4	44.3	64.7	16.8
	0.7	1.3	75.8	79.9	88.7	45.2	63.1	14.5
	0.7	1.4	78.6	82.2	90.7	46.4	62.2	12.6
	0.7	1.5	80.5	83.7	91.6	45.9	60.4	11.4
	0.8	1.0	65.8	69.9	77.0	33.2	60.9	23.3
	0.8	1.1	72.5	76.3	84.6	37.5	58.9	17.6
	0.8	1.2	76.7	80.2	88.2	39.5	57.8	14.3
	0.8	1.3	79.9	83.1	90.4	40.8	56.1	12.2
	0.8	1.4	82.3	85.3	92.8	42.0	54.6	10.2
	0.8	**1.5**	84.6	87.2	93.6	42.3	53.7	8.7
	0.9	1.0	68.4	71.1	76.2	26.6	51.9	22.6
	0.9	1.1	75.6	78.2	84.3	31.0	49.5	16.4
	0.9	1.2	80.4	82.7	89.2	33.5	49.0	12.7
	0.9	1.3	83.3	85.3	91.8	34.9	47.2	10.4
	0.9	1.4	85.6	87.7	93.5	36.1	46.3	8.6
	0.9	1.5	87.7	89.3	94.6	36.0	45.0	7.4
	1.0	1.0	69.4	69.7	69.7	18.2	41.6	24.4
	1.0	1.1	77.3	78.8	83.0	22.8	40.7	16.3
	1.0	1.2	82.4	84.1	89.4	26.3	40.0	11.6
	1.0	1.3	85.5	86.8	92.1	26.6	38.6	9.5
	1.0	1.4	87.8	89.1	94.0	27.7	37.5	7.5
	1.0	1.5	89.7	90.8	95.2	27.9	36.6	6.2
		Minimum	62.1	67.4	69.7	18.2	36.6	6.2
		Maximum	89.7	90.8	95.2	46.4	68.7	25.0
		Difference	27.6	23.4	25.5	28.2	32.1	18.8

Updated Table 11.6 Summary statistics of the recommended catch for each viable method for Almaco Jack, an equally weighted joint distribution of both methods, and a joint distribution reflecting a higher weight on the index-based method due to better data quality. The Tier3AStatusQuo (i.e. current OFL) is included for comparison. The weighted joint distribution is recommended and highlighted in bold.

Method	25%	40%	50%	75%	Mean	SD	CV
Tier3AStatusQuo	151,514	151,514	151,514	151,514	151,514	0	0
Islope0	109,488	114,063	116,896	125,067	117,517	11,740	0.099
Itarget0	25,086	26,176	26,869	28,661	26,959	2,671	0.099
LstepCC0	113,837	118,785	121,930	130,062	122,338	12,121	0.099
Joint Distribution (equal weight of Islope0, LstepCC0)	111,478	116,269	119,328	127,890	119,928	12,173	0.102
Joint Distribution (Islope0, LstepCC0; 2X weight to Islope0)	**110,804**	**115,546**	**118,451**	**126,986**	**119,124**	**12,084**	**0.101**
Joint Distribution (equal weighting all 3 methods)	28,662	104,844	111,430	123,186	88,882	44,913	0.510

Updated Table 11.7 Sensitivity of catch recommendations for Almaco Jack to the CV specified for the total removals (Cat CV) required for both methods. Statistics reported for the catch recommendation include the 25th, 40th, 50th, and 75th percentiles, the mean, standard deviation (SD), and the coefficient of variation (CV).

| Method	Cat CV	25%	40%	50%	75%	Mean	SD	CV
Islope0	0.22	109,488	114,063	116,896	125,067	117,517	11,740	0.099
	0.44	100,860	109,872	115,421	131,125	117,401	23,134	0.197
Itarget0	0.22	25,086	26,176	26,869	28,661	26,959	2,671	0.099
	0.44	23,103	25,109	26,439	30,123	26,944	5,340	0.198
LstepCC0	0.22	113,837	118,785	121,930	130,062	122,338	12,121	0.099
	0.44	105,393	114,414	119,776	136,631	122,224	23,824	0.195
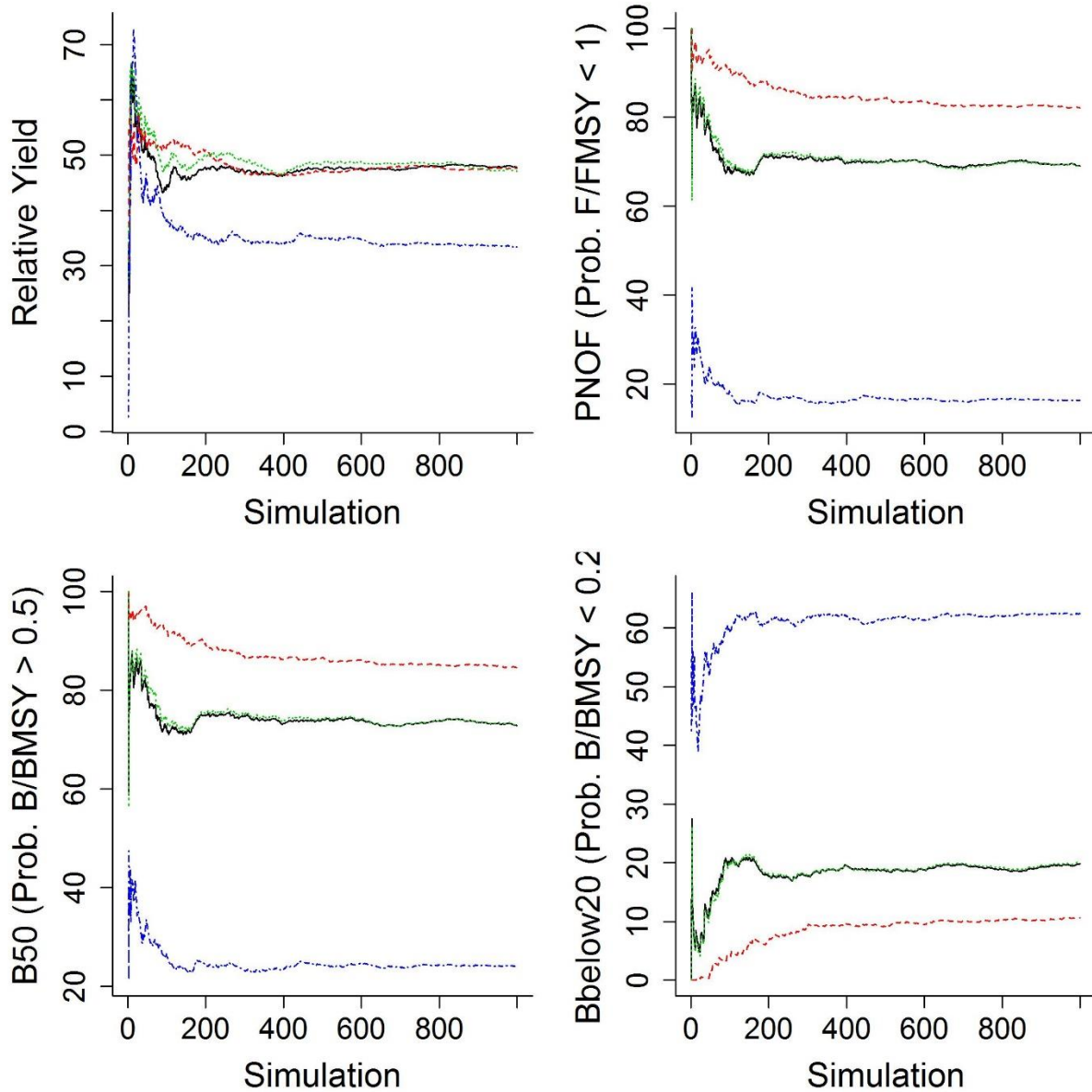
Updated Figure 11.1 Convergence plot confirming that performance criteria for each viable method converged to within 0.05%, indicating that the number of simulations was sufficient for Almaco Jack. Each colored line identifies the following methods: Islope0 (black), Itarget0 (red), LstepCC0 (green), and Tier3AStatusQuo_ABC (purple). Relative yield corresponds to the LTY divided by the reference yield, which is the highest mean yield over the last five years of the projection period that can be obtained from a fixed *F* strategy.
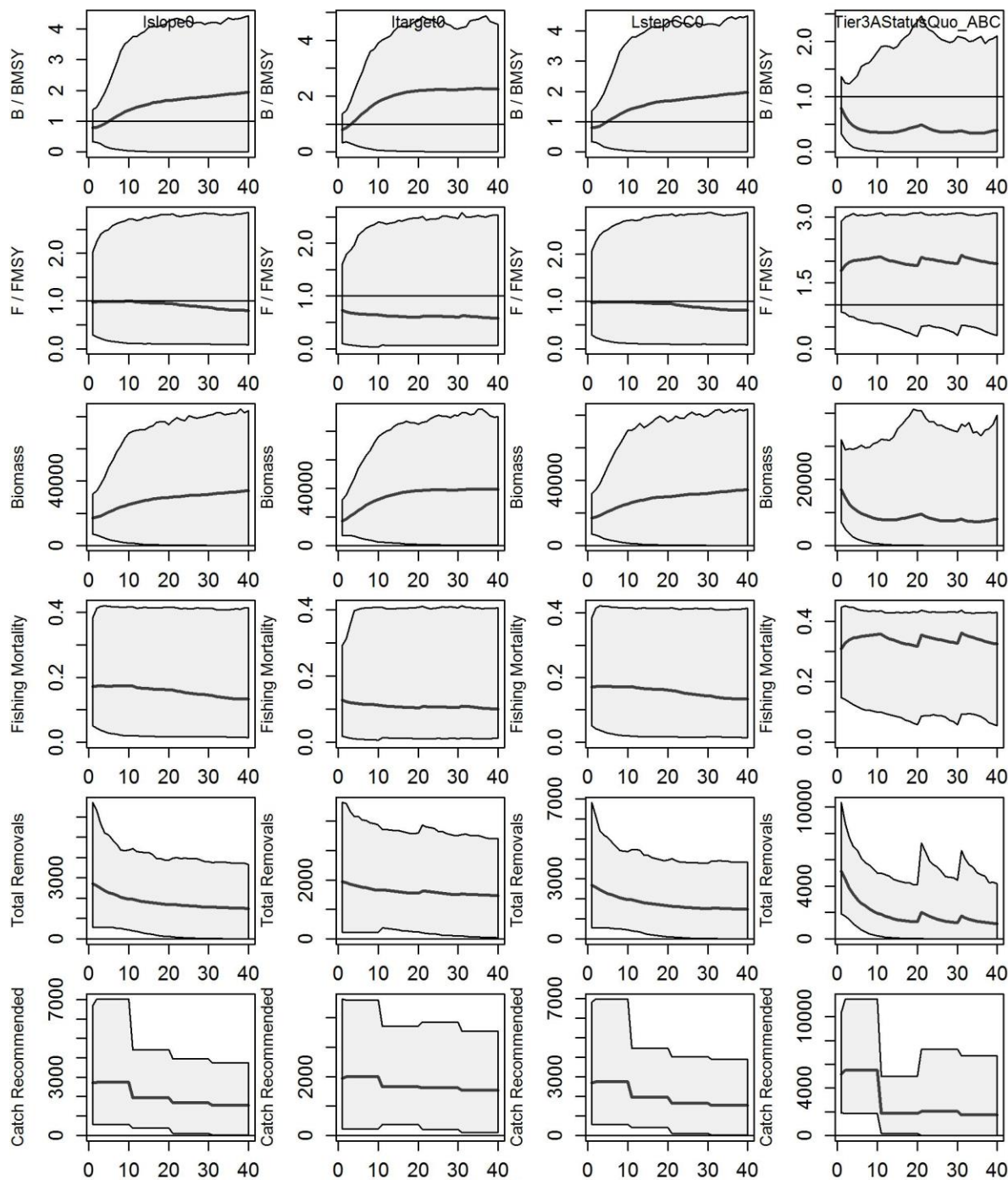
Updated Figure 11.2 Comparison of management strategy outputs for Almaco Jack for the 40-year projection period where an assessment is conducted in years 1, 11, 21, and 31. Outputs include the ratio of biomass to biomass at maximum sustainable yield (B/B_{MSY}), the ratio of fishing mortality (F) to fishing mortality at maximum sustainable yield (F/F_{MSY}), fishing mortality, total removals (in pounds), and the catch recommendation (in pounds) for each viable method. Solid black lines identify the mean across 1,000 simulations whereas the shaded area bounds the 5th and 95th percentiles.
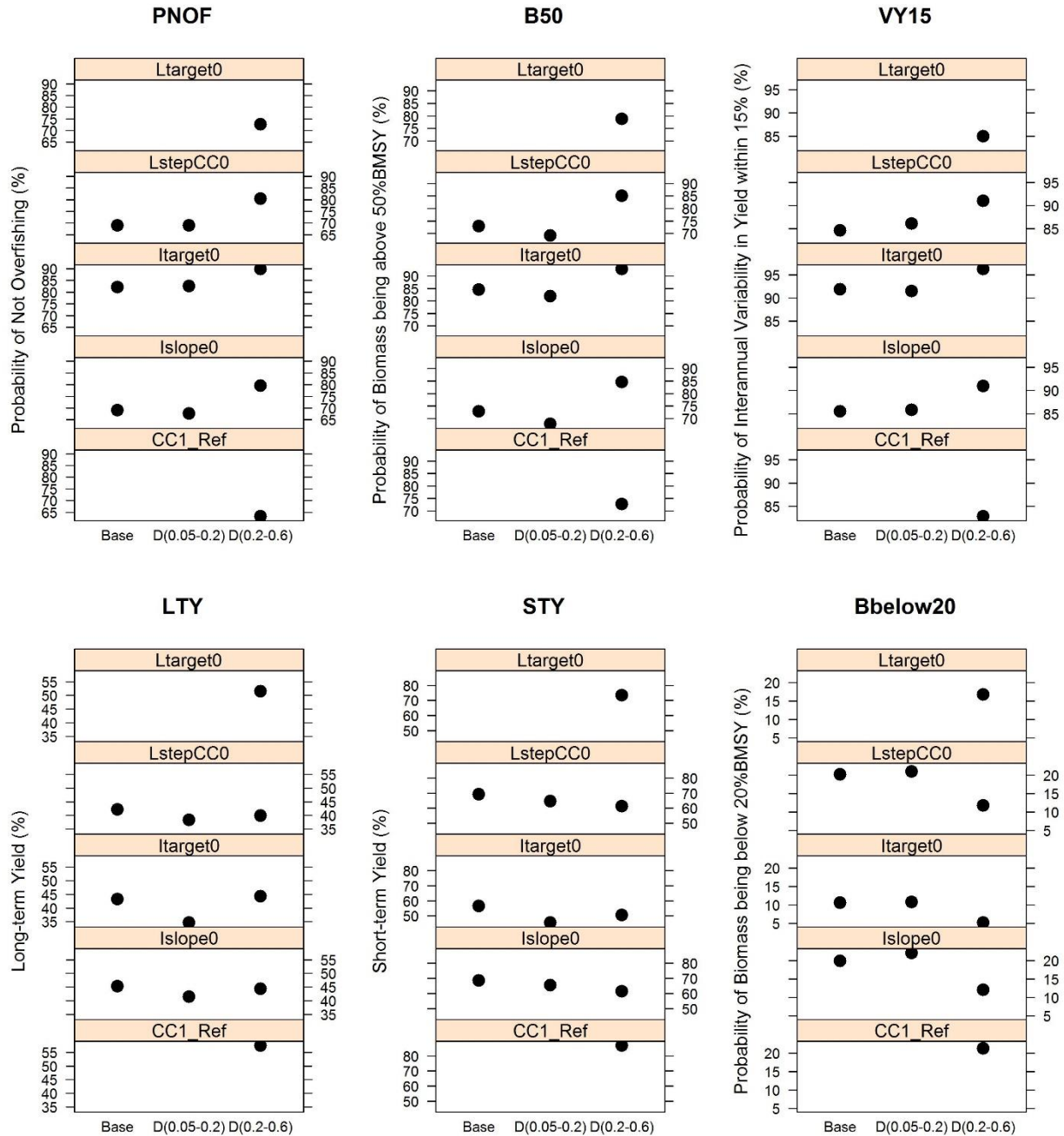
Updated Figure 11.3 Method performance for Almaco Jack assuming the base level of depletion (base; D = 0.08 – 0.32 based on recent mean length and the ML2D function in the DLMtool), a severely depleted state (D = 0.05 – 0.2), and a moderately depleted state (D = 0.2 – 0.6). Results for the lightly depleted state (D = 0.6 – 0.9) are not shown because the depletion levels could not be reached. The absence of points indicates that the performance metric(s) did not meet the specified criteria (> 50%) for PNOF, B50, and VY15. Tier3AStatusQuo_ABC did not meet the performance metrics for any sensitivity run.
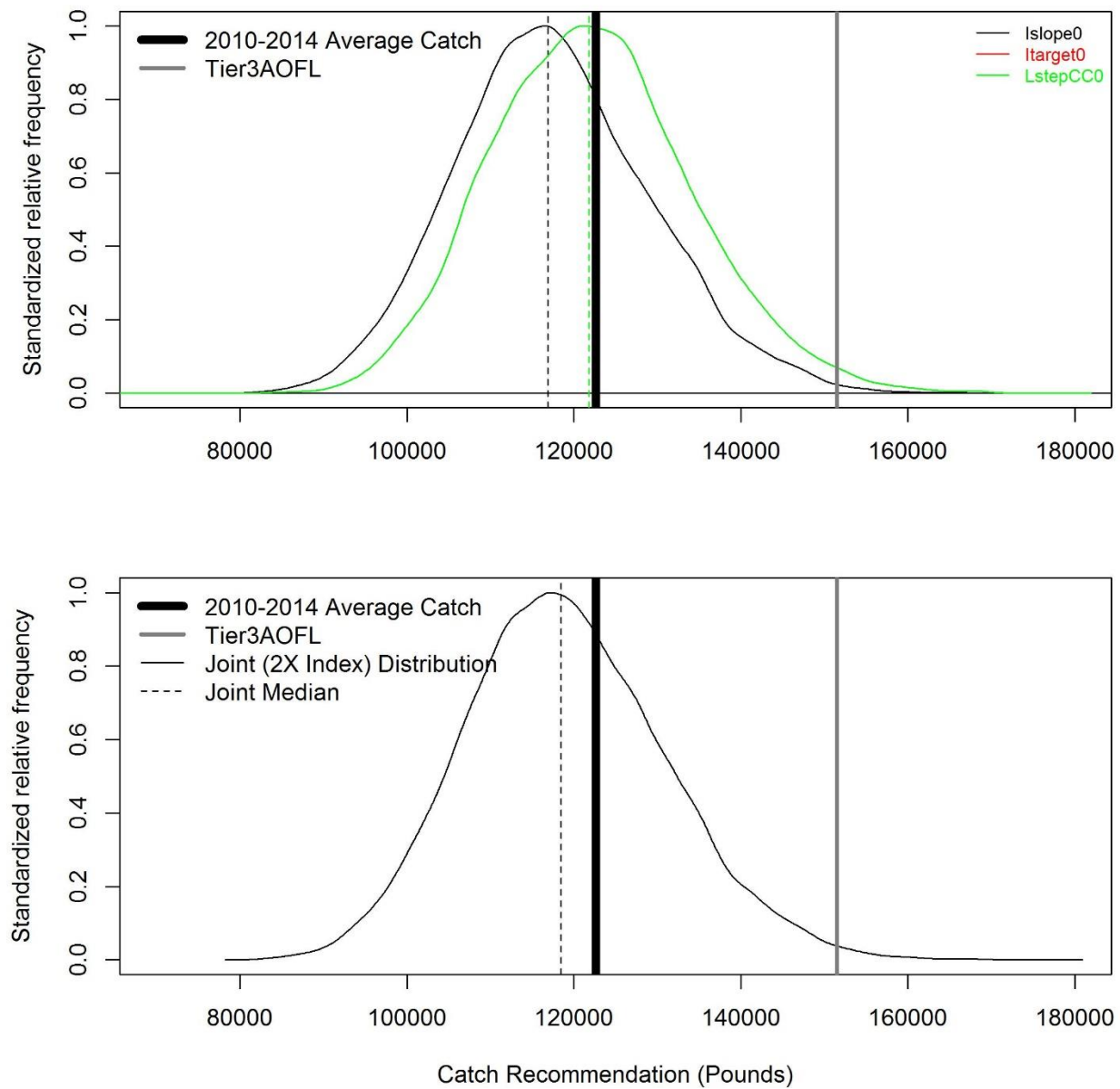
Updated Figure 11.4 Distribution of the catch recommendation (in pounds) for Almaco Jack recommended by the three viable methods, Islope0, Itarget0 and LstepCC0 (top panel; dashed vertical lines identify medians) and a joint distribution assuming a greater weight (double weighting to Islope0) for Islope0 (higher long-term yield in the MSE) than the length-based method due to differences in data quality (bottom panel). The average catch between 2010 and 2014 (thick black line) and the OFL specified by the Tier3AStatusQuo (thick gray line) are included for comparison. The joint distribution (bottom panel) is recommended for providing management advice.
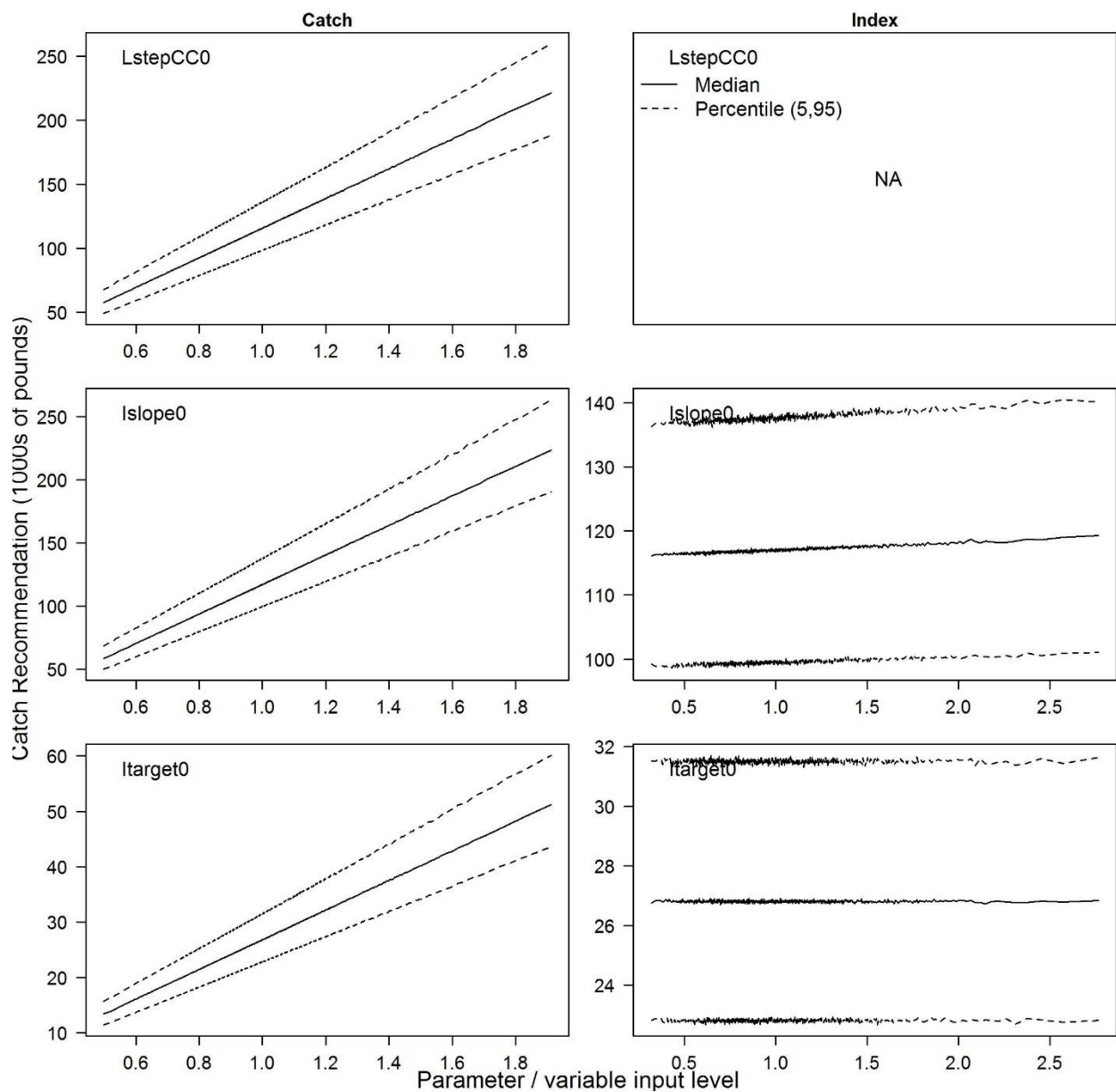
Updated Figure 11.5 Sensitivity of the catch recommendation for Almaco Jack to marginal changes in the required data inputs for LstepCC0 (only catch considered in sensitivity analysis) and Islope0 and Itarget0 (Catch and index of abundance). Note that ranges for parameter ranges are derived from the CV for each parameter. NA indicates that the data input is not required.

Additional Considerations: Tuning of scalar values

In Itarget0 and Ltarget0, both I^{AVE} and L^{AVE} are based on subjective criteria. In Itarget0, Itarget is the desired level of index to achieve whereas in Ltarget0, Ltarget is the desired level of mean length to achieve. The assumption of stock depletion in the management strategy evaluation has an important impact on the outcome of catch recommendations using various scalar values. The generic implementation of both Itarget0 and Ltarget0, which are described in Geromont and Butterworth (2014), were tested on stocks assumed to be severely depleted (between 0.1 and 0.3). As an example, the target level for Itarget was chosen as $1.5 * I^{AVE}$, i.e., to achieve a target 50% higher than the average, in an effort to rebuild the stock. As a general example, we examined the various scalars under a severely-depleted (D = 0.05 − 0.2) and moderately depleted (D = 0.2 − 0.6) stock condition for Almaco Jack (Figure 1). Regardless of depletion level, PNOF becomes more conservative at larger Itarget scalars (i.e., achieving a greater percentage of the average index) and larger thresholds (i.e., recent index being above a greater percentage of the average index) (Figure 1).
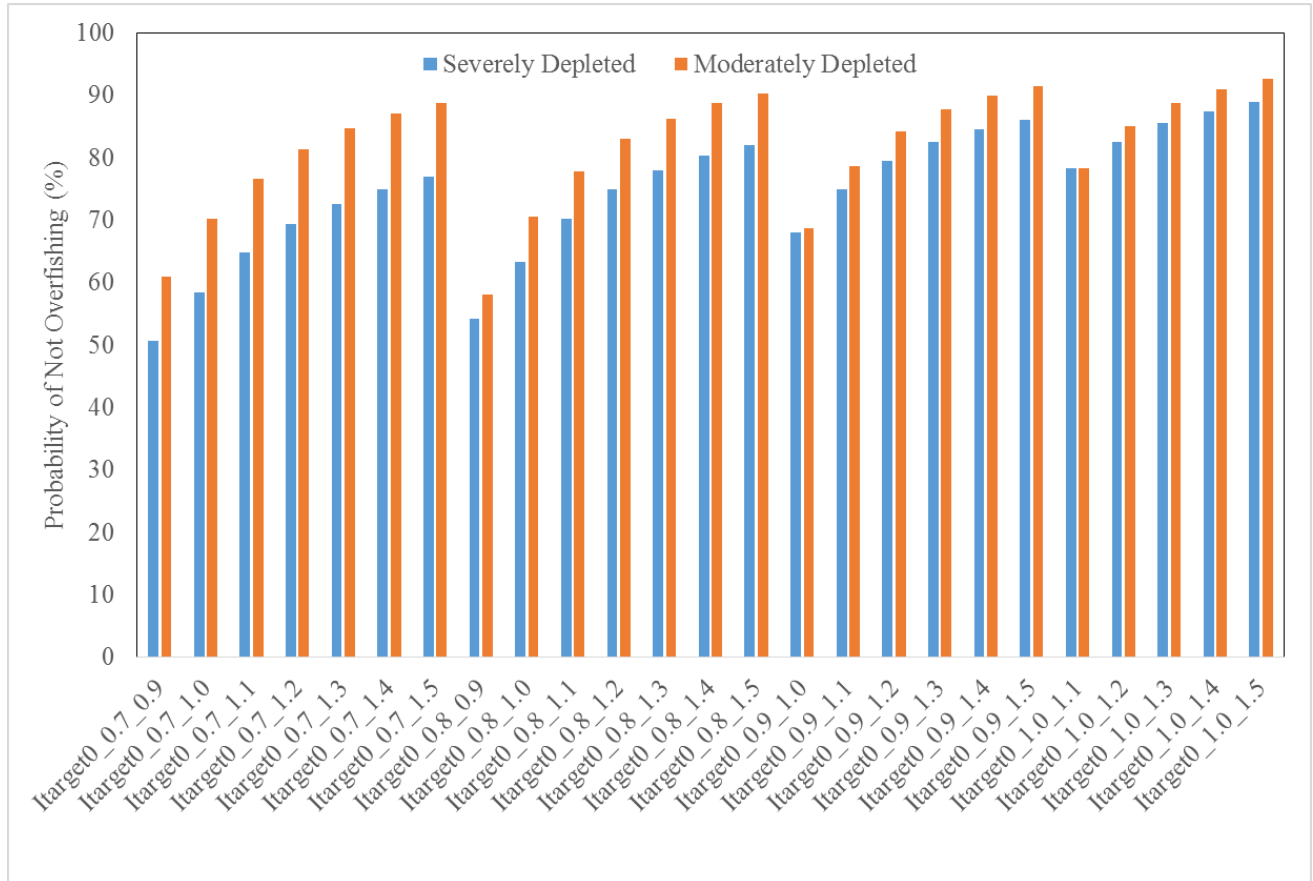

Figure 1. Comparison of the probability of not overfishing for various I0 scalar values (0.7 − 1.0) and Itarget scalar values (0.7 0.75, 0.8-1.5) assuming a severely depleted stock (0.05 − 0.2) and a moderately depleted stock (0.2 − 0.6). Method name includes the I0 scalar (first number) and the Itarget scalar (second number).

Literature Cited

Carruthers, T., L. Kell, D. Butterworth, M. Maunder, H. Geromont, C. Walters, M. McAllister, R. Hillary, P. Levontin, T. Kitakado, and C. Davies. 2015. Performance review of simple management procedures. ICES Journal of Marine Science **73**:464-482.

Geromont, H., and D. Butterworth. 2014. Generic management procedures for data-poor fisheries: forecasting with few data. ICES Journal of Marine Science **72**:251-261.