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DRAFT RECOMMENDATION BY ICCAT ESTABLISHING A MANAGEMENT PROCEDURE FOR ATLANTIC BLUEFIN TUNA TO BE USED FOR BOTH THE WESTERN ATLANTIC AND EASTERN ATLANTIC AND MEDITERRANEAN MANAGEMENT AREAS

(Panel 2 Chair's Proposal)

NOTING that the objective of the Convention is to maintain populations of tuna and tuna-like species at levels that will support maximum sustainable catch (usually referred to as Maximum Sustainable Yield (MSY));

RECALLING that the Commission often had difficulties in deciding the total allowable catch (TAC) based on advice from the SCRS;

ALSO RECALLING that the SCRS had difficulties in providing robust scientific advice to the Commission due to various uncertainties such as the low quality of data;

RECOGNIZING that Harvest Control Rules (HCRs) and Management Procedures (MPs) developed using Management Strategy Evaluation (MSE) provides a more robust management framework than that based on a conventional stock assessment, ensuring a more precautionary approach and better stability of TACs;

ALSO RECOGNIZING the intent of the Commission to adopt HCRs and MPs developed using MSE, as established in *Recommendation by ICCAT on the development of harvest control rules and of management strategy evaluation* (Rec. 15-07);

NOTING the *Resolution by ICCAT on Developing Initial Management Objectives for Eastern and Western Bluefin Tuna* [Res. 18-03], which outlined the conceptual objectives for the Atlantic bluefin tuna MSE;

RECALLING that the Commission requested the SCRS to continue testing various candidate MP in 2022 and to meet with Panel 2 to review the results and support the panel in selecting one to adopt and apply for 2023 as in Rec. 21-07 and Rec. 21-08 and for this purpose Panel 2 held four intersessional meetings in 2022;

STRESSING the importance that all the stakeholders are involved in the MSE process since the MP automatically calculates the TAC to be adopted by the Commission unless it encountered an exceptional circumstance that is not envisaged by the MP;

APPRECIATING the efforts of all the scientists involved in the MSE process who made tremendous contribution not only to the scientific work but also to better communication of the results to various stakeholders involved in the bluefin tuna fisheries, including through informal ambassador meetings in three languages; and

NOTING the importance of establishing an exceptional circumstances protocol in 2023 that would result in suspending or modifying the application of the MP;

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION
OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

PART I
GENERAL PROVISIONS

1. Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities (CPCs) whose vessels fish for Atlantic bluefin tuna (*Thunnus thynnus*) in the Convention area shall implement the following management procedure. This MP shall be used to calculate the TAC for both the western Atlantic management area (hereafter called "the western management area") and the eastern Atlantic and the Mediterranean management area (hereafter called "the eastern management area").

Management Objectives

2. The management objectives for Atlantic bluefin tuna are:

(a) Stock Status:
- Both the western and eastern stocks should have a greater than [60%, 65%, 70%] probability of occurring in the green quadrant of the Kobe plot (not overfishing and not overfished) in 2052;

(b) Safety:
- There should be a less than 15% probability of either stock falling below B_{LIM}[1] at any point during years 2033 through 2052;

(c) Yield:
- Maximize overall catch levels in both western and eastern management areas; and,

(d) Stability:
- Any change in TAC between consecutive management periods in both the western and the eastern management areas should be no more than a 20% increase or a [30%][35%] decrease.

PART II
MANAGEMENT PROCEDURE AND CATCH LIMITS

3. The [BR or FO] management procedure has been selected and is fully described in **Annex 1**.

Total Allowable Catch Setting

4. The first TACs derived from the MP shall apply in 2023 [and 2024][2024, and 2025]. The management cycle length shall be [two/three] years; therefore, the MP shall be applied every [two/three] years.

5. Notwithstanding the stability management objective in paragraph 2d, there will be a phase-in period of [one/two] management cycles where decreases in TAC shall be no more than 10%.

6. According to the timeline set out in **Annex 2**, the SCRS shall run the MP specified in **Annex 1** and advise the Commission of the resulting TAC for both the western management area and the eastern management area.

7. The Commission shall then adopt the TACs based on the outcome of the MP, unless the SCRS identifies exceptional circumstances that require consideration of alternative management actions to be taken by the Commission.

8. The SCRS shall assess the occurrence of exceptional circumstances annually and the Commission shall act in accordance with the exceptional circumstances protocol based on scientific advice by the SCRS and adopted by the Commission.

TAC Implementation

9. As the MP is run and adopted according to the determined schedule and procedure, the eastern and western management area TACs shall be implemented and monitored according to the provisions set out in the respective eastern and western management area Recommendations.

[1] For the purposes of this bluefin tuna MSE, the Commission has agreed to use a B_{LIM} of 40% of the dynamic spawning stock biomass at maximum sustainable yield.

PART III
FINAL PROVISIONS

10. A review of the performance of the MP, by the Commission and the SCRS, is to be completed by 2028 (6 years). The aim of the review is to ensure the MP is performing as expected and determine whether there are conditions that warrant: reconditioning the operating models; retuning the existing MP; and/or, consideration of alternate candidate management procedures or a new full management strategy evaluation.

11. Panel 2, with scientific guidance from the SCRS, shall develop the exceptional circumstances protocol for this MP, for review and adoption at the 2023 annual Commission meeting. The protocol will become **Annex Y** of this recommendation once adopted.

12. This Recommendation repeals and replaces *Resolution by ICCAT on development of initial management objectives for eastern and western bluefin tuna* (Res. 18-03).

Annex 1

Description and formulae for calculating TACs for western Atlantic and eastern Atlantic and Mediterranean bluefin tuna management areas using the [BR or FO] Management Procedure

The BR CMP is empirical, based on inputs related to abundance indices which are first standardised for magnitude, then aggregated by way of a weighted average of all indices available for the East or for the West areas as appropriate (**Table A1**, 5 indices in each management area), and finally smoothed over years to reduce observation error variability effects. TACs are then set based on the concept of taking a fixed proportion of the abundance present, as indicated by these aggregated and smoothed abundance indices.

Aggregate abundance indices

An aggregate abundance index is developed for each of the East and the West areas by first standardising each index available for that area to an average value of 1 over the past years for which the index appeared reasonably stable, and then taking a weighted average of the results for each index, where the weight is inversely proportional to the variance[2] of the residuals used to generate future values of that index in the future modified to take into account the loss of information content as a result of autocorrelation. The mathematical details are as follows.

The indices, I_y^i, are first standardised to an average value of 1 over the past years for which the index appeared reasonably stable:

$$I_y^{i*} = \frac{I_y^i}{\sum_{y_1^i}^{y_2^i} I_y^i / (y_2^i - y_1^i + 1)} \quad \text{(A1)}$$

where y_1^i and y_2^i specify the period to which each index (i) is standardised (**Table A1**).

$J_y^{E/W}$ is an average index over n series (n=5 for the East area and n=5 for the West area):

$$J_y^{E/W} = \frac{\sum_i^n w_i \times I_y^{i*}}{\sum_i^n w_i} \quad \text{(A2)}$$

where $w_i = \frac{1}{\sqrt{\sigma^i}}$ (i.e., effective inverse variance to the power ¼ weighting). σ^i is computed as $\sigma^i = \frac{SD^i}{1-AC^i}$, where SD^i is the standard deviation of the residuals in log space and AC^i is their autocorrelation, averaged over the OMs, as used for generating future pseudo-data. **Table A1** lists these values for w_i.

For the West, the weights computed above for US_RR_66_144, JPN_LL_West2 and CAN_SWNS have been multiplied by 3 (i.e., $w_i \rightarrow 3w_i$). This change has been implemented to avoid a steep drop in the median TAC for the West area during the 2030s.

In case of a missing index value in year y, $J_y^{E/W}$, is computed by setting w_i to zero, i.e., that index is disregarded when averaging over indices for that year only.

The actual index used in the CMPs, $J_{av,y-2}^{E/W}$, is the average over the last three years for which data would be available at the time the MP would be applied, hence:

$$J_{av,y-2}^{E/W} = \frac{1}{3}\left(J_{y-2}^{E/W} + J_{y-3}^{E/W} + J_{y-4}^{E/W}\right) \quad \text{(A3)}$$

where the $J_{av,y-2}^{E/W}$ applies either to the East or to the West area.

[2] This is modified somewhat in a few cases to provide the smoother TAC trend over time., as explained further below.

CMP specifications

The BR Fixed Proportion CMP variants set the TAC (in mt) every management cycle simply as a multiple of the J_{av} value for the area at the time (**Figure A1**), but subject to the change in the TAC for each area being restricted to a maximum of 20% up and 30% down (10% down for the phase-in period, and 35% down only for PGK 60% with a 3-year management cycle).

For the East area:

$$TAC_{E,y} = \begin{cases} \left(\frac{35032.31}{J^E_{2017}}\right) \cdot \alpha_y \cdot J^E_{av,y-2} & \text{for } J^E_{av,y-2} \geq T^E \\ \left(\frac{35032.31}{J^E_{2017}}\right) \cdot \alpha_y \cdot \frac{\left(J^E_{av,y-2}\right)^2}{T^E} & \text{for } J^E_{av,y-2} < T^E \end{cases} \quad \text{(A4a)}$$

$$\alpha_y = \begin{cases} \alpha_0 + \Delta\alpha(y - 2021) & \text{for } 2021 \leq y \leq 2025 \\ \alpha_0 + 4\Delta\alpha & \text{for } y > 2025 \end{cases}$$

For the West area:

$$TAC_{W,y} = \begin{cases} \left(\frac{2269.362}{J^W_{2017}}\right) \cdot \beta_y \cdot J^W_{av,y-2} & \text{for } J^W_{av,y-2} \geq T^W \\ \left(\frac{2269.362}{J^W_{2017}}\right) \cdot \beta_y \cdot \frac{\left(J^W_{av,y-2}\right)^2}{T^W} & \text{for } J^W_{av,y-2} < T^W \end{cases} \quad \text{(A4b)}$$

$$\beta_y = \begin{cases} \beta_0 + \Delta\beta(y - 2021) & \text{for } 2021 \leq y \leq 2028 \\ \beta_0 + 7\Delta\beta & \text{for } y > 2028 \end{cases}$$

The values 35032.314 mt and 2269.362 mt used in equations A4a and b respectively are the ICCAT Task 1 catch by management area in 2020 as at April 2022.

Note that in equation (A4a), setting $\alpha_y = 1$ would amount to keeping the East area TAC the same as the corresponding catch in 2020 (as explained above) if the abundance indices stayed at their 2017 level. If α_y or $\beta_y > 1$ harvesting would be more intensive than at that time, and for α_y or $\beta_y < 1$ it would be less intensive.

Below *T*, the law is parabolic rather than linear at low abundance (i.e., below some threshold, so as to reduce the proportion taken by the fishery as abundance drops); this is to better enable resource recovery in the event of unintended depletion of the stock. For the BR CMP, the choices of $T^E = 1$ and $T^W = 1$ have been made.

Constraints on the extent of TAC increase and decrease

$$\Delta TAC^{E/W} = \frac{TAC^{E/W}_y}{TAC^{E/W}_{y-1}} \quad \text{(A5)}$$

with $TAC^{E/W}_y$ from equation A4. $\Delta TAC^{E/W}$ is then modified as follows:

$$\Delta TAC^{E/W\prime} = \exp\left(\ln(\Delta TAC^{E/W}) VarCadj\right) \quad \text{(A6)}$$

with a control parameter, *VarCadj*, taken for the BR CMP to be 0.5. This parameter is introduced to reduce the magnitude of the TAC changes; the smaller the value of this parameter the smaller the TAC change.

$\Delta TAC^{E/W\prime}$ is then constrained to a maximum of 20% up and 30% down ((or 35% if PGK 60% with a 3-year management cycle is chosen) and 10% down for the phase-in period[3],

$$\text{if } \Delta TAC^{E/W\prime} > (1 + maxUp^{E/W}) \text{ then } \Delta TAC^{E/W\prime} = (1 + maxUp^{E/W}), \text{ or}$$
$$\text{if } \Delta TAC^{E/W\prime} < (1 - maxDown^{E/W}) \text{ then } \Delta TAC^{E/W\prime} = (1 - maxDown^{E/W})$$

[3] This is for two cycles if the cycle period is two years, but only one cycle if this period is three years.

The TAC is then computed as:

$$TAC_y^{E/W\prime} = TAC_{y-1}^{E/W} \cdot \Delta TAC^{E/W\prime} \quad \text{(A7)}$$

If minimum TAC change constraints are accepted, the following revisions to these TACs apply:

$$\begin{aligned} &\text{if} \quad \left|TAC_{y-1}^{E/W} - TAC_y^{E/W\prime}\right| < min\Delta TAC^{E/W} \\ &\text{then} \quad TAC^{E/W\prime\prime} = TAC_{y-1}^{E/W} \end{aligned} \quad \text{(A8)}$$

where values suggested for $min\Delta TAC^{E/W}$ have been 100 mt for the West and 1000 mt for the East.

Table A1. The index periods y_1^i and y_2^i (equation A1).and w^i weights used when averaging over the indices to provide composite indices for the East and the West areas (equation A2).

	East				West			
i	Index	y_1^i	y_2^i	w^i	Index	y_1^i	y_2^i	w^i
1	FR_AER_SUV2	2014	2017	1.33	GOM_LAR_SUV	2006	2017	1.33
2	MED_LAR_SUV	2012	2016	1.66	US_RR_66_144	2006	2018	2.55
3	GBYP_AER_SUV_BAR[4]	2015	2018	1.06	MEXUS_GOM_PLL2	2006	2018	1.39
4	MOR_POR_TRAP	2012	2018	1.43	JPN_LL_West2	2010	2019	3.96
5	JPN_LL_NEAtl2	2012	2019	1.33	CAN_SWNS	2006	2017	2.88

Table A2. Control parameter values for each of the CMPs (equation A4). A TAC variation reduction adjustment factor with VarCadj=0.5 has been applied.

CMP name	PGK	Cycle	stability	α_0	$\Delta\alpha$	β_0	$\Delta\beta$
B260	60	2	+20/-30	1.235	0.218	0.81	-0.0296
B360	60	3	+20/-35	1.235	0.204	0.81	-0.0315
B265	65	2	+20/-30	1.235	0.174	0.81	-0.0366
B365	65	3	+20/-30	1.235	0.142	0.81	-0.0411
B270	70	2	+20/-30	1.235	0.130	0.81	-0.0435
B370	70	3	+20/-30	1.235	0.096	0.81	-0.0475

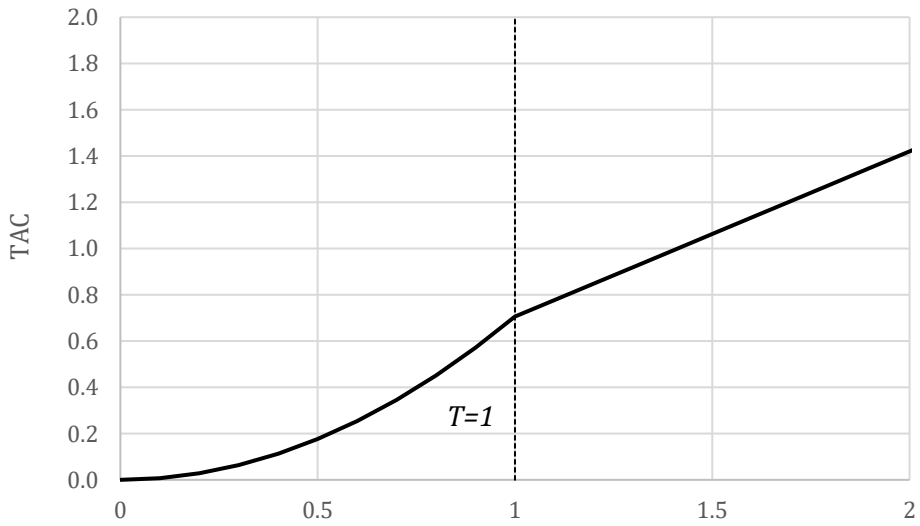

Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below *T*.

[4] For the GBYP aerial survey, there is no value for 2016 and that year was therefore omitted from this averaging.

FO CMP

This CMP sets the TAC using an estimate of $F_{0.1}$ and the current abundance of the stock. The $F_{0.1}$ calculation depends on choosing 3 indicators from each management area that represent the relative abundance of young (age 1-4, I_{sm}), middle (age 5-6, I_{md}), and older (age 7 and older, I_{lg}) stock components (**Table A3**). Prior to use, these indicators are subjected to a range normalization, following which the average index value for the most recent 3 years (y-2 to y) is determined. A partial recruitment vector, *PR*, is developed from the age group means relative to the total. The calculations are as follows:

$$I'_{sm} = (((I_{sm} - min(I_{sm})) * 0.9)/(max(I_{sm}) - min(I_{sm}))) + 0.1$$
$$I'_{md} = (((I_{md} - min(I_{md})) * 0.9)/(max(I_{md}) - min(I_{md}))) + 0.1$$
$$I'_{lg} = (((I_{lg} - min(I_{lg})) * 0.9)/(max(I_{lg}) - min(I_{lg}))) + 0.1$$

$$I'_{sm} = \frac{1}{3}\sum_{y-2}^{y} I'_{sm}$$
$$I'_{md} = \frac{1}{3}\sum_{y-2}^{y} I'_{md}$$
$$I'_{lg} = \frac{1}{3}\sum_{y-2}^{y} I'_{lg}$$

$$I_{tot} = I'_{sm} + I'_{md} + I'_{lg}$$

$F_{0.1}$ is calculated based on a yield-per-recruit analysis from *fishmethods* (Nelson, 2019) that follows the modified Thompson-Bell algorithm, where:

$$Z_a = M_a + PR_a * F_a$$
$$N_{a+1} = N_a * e^{-Z_a}$$
$$\bar{N}_a = (1 - e^{-Z_a}) * \frac{N_a}{Z_a}$$
$$\bar{N}_{a+} = \frac{N_{a+}}{Z_{a+}}$$
$$C_a = (N_a - N_{a+1}) * \frac{PR_a * F_a}{Z_a}$$
$$Y_a = \bar{W}_a C_a = PR_a * \bar{F}_a B_a$$

where the ages *a* for each management area are as defined in the 2015 VPA (**Table A4**),

Y_a, C_a, N_a, B_a = Yield, Catch numbers, population Numbers and population Biomass at age, respectively,

W_a = Weight at age is from the 2015 VPA for the west and 2017 VPA for the east (**Table A4**),

F_a = Fishing mortality at age, is the product of PR_a and F,

M_a = Natural mortality at age scaled to the Lorenzen function (Walter *et al.,* 2018) (**Table A4**),

Z_a= Total mortality at age (F_a+M_a),

$PR^E_{1:10}$ or $PR^W_{1:16}$, the partial recruitment vectors applied to fishing mortality (F) to obtain F-at-age, are calculated from the East or West MP indicators, as follows, upon each application of the MP:

$$PR^{E/W}_{1:10/16} = \left\{ \frac{I'_{sm}}{\overline{I_{tot}}_{1:4}} \quad \frac{I'_{md}}{\overline{I_{tot}}_{5:6}} \quad \frac{I'_{lg}}{\overline{I_{tot}}_{7:10/16}} \right\}$$

The $F_{0.1}$ estimate is based on the yield-per-recruit calculation for F ranging from 0 to 10 in increments of 0.01. The last age is a plus group and the oldest age in the plus group is 35. If an estimate of $F_{0.1}$ can't be calculated because of missing index values or a failure of the yield-per-recruit calculation, a default value of 0.2 is assumed.

The next step involves estimating the current spawning stock biomass for each stock or region. The stock or region specific biomass is based on the value of an index assumed to reference either the biomass of the stock or the biomass of fish in a region and is scaled by the change in stock to the component indices relative to a reference period (2016 to 2021) as follows:

$$I'_{md\_cur} = \frac{1}{3}\sum_{y-2}^{y} I'_{md}$$

$$I'_{lg\_cur} = \frac{1}{3}\sum_{y-2}^{y} I'_{lg}$$

$$I_{total\_current} = I'_{md\_cur} + I'_{lg\_cur}$$

$$I'_{md\_ref} = \frac{1}{6}\sum_{2016}^{2021} I'_{md}$$

$$I'_{lg\_ref} = \frac{1}{6}\sum_{2016}^{2021} I'_{lg}$$

$$I_{total\_ref} = I'_{md\_ref} + I'_{lg\_ref}$$

$$B = \left(\frac{1}{6}\sum_{2016}^{2021} I_{bm}\right) * \frac{I_{total\_current}}{I_{total\_ref}}$$

where MED_LAR_SUV and CAN_SWNS were chosen as I_{bm} for the East and West, respectively (**Table A3**).

In each case the year 'y' is one year prior than the year for which the TAC is set.

A TAC proposal for the East and West area during the phase-in period is calculated as follows:

$$pTAC_{y+1} = \{\alpha * F_{0.1} * \frac{B}{q},\ I_{tot} > 0\ \ \alpha * 0.2 * \frac{B}{q}, I_{tot} = 0$$

Similarly, the TAC proposal following the phase-in period is:

$$pTAC_{y+1} = \{\beta * F_{0.1} * \frac{B}{q},\ I_{tot} > 0\ \ \beta * 0.2 * \frac{B}{q}, I_{tot} = 0$$

where the α and β values (**Table A5**) and q = 1.875E-7 were used in performance tuning. This value comes from the catchability estimated in the 2015 VPA.

The TAC proposal during the phase-in period is modified in order to minimize variability as follows:

$$TAC_{y+1} = TAC_y * exp^{\left(log\left(\frac{pTAC_{y+1}}{TAC_y}\right)*0.1\right)}$$

and TAC_{y+1} is constrained to be $>= 0.9 * TAC_y$ and $<= 1.2 * TAC_y$. If TAC_{y+1} was less than $0.9 * TAC_y$, then $TAC_{y+1} = 0.9 * TAC_y$; if TAC_{y+1} was greater than $1.2 * TAC_y$, then $TAC_{y+1} = 1.2 * TAC_y$.

The TAC after the phase-in period is constrained so that if $pTAC_{y+1}$ was $<= 0.7 * TAC_y$ or $>= 1.2 * TAC_y$, then the TAC was set to the maximum $1.2 * TAC_y$, or minimum $0.7 * TAC_y$. The 0.7 value will need to be modified to 0.65 if the Commission chooses a 3-yr length management cycle with PGK=60%.

Table A3. List of indicators used by the FO CMP for each age class for the East and West TAC calculations. Index (*) was used for biomass of stock or region, I_{bm}.

Item	*Age range*	*Formula*	*East indicators*	*West indicators*
Young fish	1-4	I_{sm}	FR_AER_SUV2	US_RR_66_144
Middle aged fish	5-6	I_{md}	JPN_LL_NEAtl2	CAN_SWNS*
Older fish	East: 7-10+ West: 7-16+	I_{lg}	MED_LAR_SUV*	MEXUS_GOM_PLL

Table A4. Values for weight at age (a), W_a, and natural mortality at age, M_a, for each stock used in the "*Fishmethods*" yield-per-recruit analysis.

	East			*West*	
Age (a)	W_a	M_a	*Age (a)*	W_a	M_a
1	3.0	0.40	1	3.1	0.40
2	10.0	0.33	2	9.8	0.33
3	19.0	0.27	3	15.1	0.27
4	35.0	0.23	4	19.9	0.23
5	50.0	0.20	5	43.3	0.20
6	69.0	0.18	6	60.5	0.18
7	90.0	0.16	7	89.9	0.16
8	113.0	0.14	8	111.6	0.14
9	138.0	0.13	9	144.8	0.13
10+	205.0	0.12	10	174.0	0.12
			11	201.1	0.12
			12	225.5	0.11
			13	247.7	0.11
			14	264.0	0.11
			15	283.5	0.11
			16+	340.0	0.11

Table A5. α and β tuning parameter values for the performance tuning.

CMP				*East*		*West*	
name	*PGK*	*Cycle*	*Stability*	*α*	*β*	*α*	*β*
F260	60	2	+20/-30	0.5	0.6	1.25	0.62
F360	60	3	+20/-35	0.5	0.61	1.25	0.62
F265	65	2	+20/-30	0.5	0.54375	1.25	0.58
F365	65	3	+20/-30	0.5	0.555	1.25	0.577
F270	70	2	+20/-30	0.5	0.4875	1.25	0.53
F370	70	3	+20/-30	0.5	0.5	1.25	0.535

Annex 2

Schedule for Management Procedure implementation

2 Year Cycle

	2022	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*
SCRS check ECs		X	X	X	X	X	X
SCRS runs MP	X		X		X		X
Commission endorses and implements TAC based on MP	X		X		X		X
TAC in effect		X	X	X	X	X	X
SCRS MP review						X	X
Status Check/Assessment					X		
Commission assesses SCRS review and next steps							X

3 Year Cycle

	2022	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*
SCRS check ECs		X	X	X	X	X	X
SCRS runs MP	X			X			X
Commission endorses and implements TAC based on MP	X			X			X
TAC in effect		X	X	X	X	X	X
SCRS MP review						X	X
Status Check/Assessment					X		
Commission assesses SCRS review and next steps							X