The CCSBT MP process (nice idea but how do you get it adopted and implemented?)

Too many to mention (but some are in the room): the member scientists and indepedent panel of the CCSBT SC

October 18, 2013

Talk outline

The CCSBT MP process (nice idea but how do you get it adopted and implemented?)

Too many to mention (but some are in the room): the member scientists and indepedent panel of the CCSBT SC

- Getting OM structure defined & agreed
- Uncertainty:
  - (i) **Quantitative**: things we believe we can either estimate or define *a priori*
  - (ii) **Qualitative**: scenarios we think are likely, possibly even ranked, but not able to probabilistically decide between
- What data do we want to be part of an MP?
- Targets, operational constraints and performance measures
- From many to two: iterative deselection and adaption
- Two become one: what to do when it's close *and* tense...
- Actual adopted MP specs and performance
- Lessons learned and future MP and OM development

CCSBT Operating Model

- Previously more than one assessment model and different data interpretations
- Part of previous MSE work (prior to over-catch) single OM structure developed
- Important to set the base for the MSE here - already too many options later on; get this agreed first...

OM structure

- Seasonal, non-spatial age/length structured model
- Data:
  1. Catch biomass and composition (age/length)
  2. CPUE (Japanese long-line fleet from 1969 onwards)
  3. Mark-recapture data (from large-scale tagging in 1990s)
  4. Fishery independent aerial survey of juvenile SBT
- Key parameters estimated directly:
  1. Unfished SSB
  2. Recruitment deviates
  3. Natural mortality (ages 4 and 30+, specified func. form)
  4. Selectivity (time-varying) for each fishery

Quantitative uncertainties: the "grid"

- Key parameters/options where may not have convincing information in data *but* can explore quantitative options:
  1. Steepness (h): strong but one-way trip decline in CPUE...
  2. $M_{0,10}$: no direct data but vital to define shape of M_a
  3. ω: non-linearity of biomass-to-CPUE relationship
  4. CPUE series: spatial weighting options for core series
  5. q age-range: ages over which LL CPUE q calculated
  6. Sample size: initial effective sample sizes
- With grid elements have pre-defined priors *but* option of resampling based on objective function

Quantitative uncertainties: the "grid"

- For MSE work grid option table (reference set of OMs):

	Levels	CumulN	Values	Prior	Weighting
h	5	5	0.55, 0.64, 0.93, 0.82, 0.9	uniform	obj. fun.
M_0	4	20	0.3, 0.35, 0.4, 0.45	uniform	obj. fun.
M_{10}	3	60	0.07, 0.1, 0.14	uniform	obj. fun.
ω	1	60	1	NA	NA
CPUE	2	120	w.5, w.8	uniform	prior
q age-range	2	240	4-18, 8-12	0.67, 0.33	prior
Sample size	1	240	SQRT	NA	NA

- From 240 grid permutations sample of 2000 generated

Reference set OM SSB & recruitment

- SSB (top, 1e+6t) and recruitment (bottom, millions) median & 80% CI

Qualitative uncertainties: robustness trials

- Location for alternative OM settings/future scenarios
- For SBT main issues:
  1. Over-catch scenarios (magnitude, CPUE impact)
  2. CPUE and survey variability
  3. Tag mixing
  4. Non-linearity in biomass-to-CPUE
  5. Alternative CPUE series (model/data)
  6. Catchability changes (past/future) given LL changes
- Core set of plausible robustness trials chosen

Uncertainty overall

- Recruitment stochasticity ($\sigma_R = 0.6$) - projections
- Observation/process error in CPUE/survey - projections
- Catch composition - projections
- No direct inclusion of parametric uncertainty (grid only)
- Theory (hope) is robustness tests cover plausible range
- No implementation error assumed in projections

What data can candidate MPs use?

- Previous catch, CPUE, aerial survey, LL age composition
- Have to use *at least* CPUE **and** aerial survey
- Median and 80%CI for aerial survey (top) and LL CPUE (bottom):

Targets & Operational Constraints

- SSB rebuilding target: $p(SSB_{y^{\text{targ}}} > 0.2SSB_0) = p^{\text{targ}}$
- Target year: y^{targ} either 2035 or 2040
- Target probability: p^{targ} 0.6, 0.7 and 0.9
- Control variable: global TAC (for fixed national allocation)
- Frequency: every 2 or 3 years
- Implementation lag: zero or one year
- Minimum TAC change: 100t
- Maximum TAC change: 3000t/5000t

Midpoint observation

- Lots of switches and options $\equiv$ **unhelpful**
- If possible quickly explore what matters, what doesn't
- Target level, year & probability alias
- Virtually no difference between 2 and 3 years (long-lived)
- Give clear and early advice to Commissioners:
  1. Avoid specifics until OM and robustness trials defined
  2. Plan for and expect multiple iterations
  3. Remove quasi-identitical scenarios
- Makes understanding what matters easier & faster
- Increases likelihood of acceptance later on...

Performance measures

The CCSBT MP process (nice idea but how do you get it adopted and implemented?)

Too many to mention (but some are in the room): the member scientists and indepedent panel of the CCSBT SC

- Focus of (interim) MP: rebuild SSB to 20% SSB_0
- Base criteria: MP "tuned" to targets on reference set OMs
- Tuned MP then run on all relevant robustness trials
- Key SSB performance measures:
  1. $p(SSB_{\text{fut}} < SSB_{\text{min}})$: future declines
  2. $p(SSB_{2022/2025} > 0.2SSB_0)$: half-way point
  3. $\mathbb{E}(SSB_{\text{fut}}/SSB_{2011})$: rebuilding factor
- Key catch performance measures:
  1. Average future catch (range of years)
  2. Average annual variation (AAV)
  3. Max. TAC decrease
  4. $p(C_t \uparrow \mid C_{t-\tau} \downarrow)$: down-then-up catch trajectories
- Create 47,000 figures & tables...

Design & initial selection process

- Member scientists invited to design candidate MPs
- Base criteria: hit targets on reference set of OMs
- Range of candidate MPs:
  1. Purely empirical with different HCRs
  2. Model-based (production, relative abundance)
  3. Fuzzy logic even made an appearance
- Core group of CCSBT SC met at technical workshop

From many to two

- Workshop chose two MPs to go to CCSBT SC in 2010
- Both clearly performed best of suite of candidates
- MP_1:
  1. Model-based (recruit-adult relative abundance model)
  2. CPUE target-driven
  3. Recruitment limit-type behaviour
- MP_2:
  1. Empirical (using CPUE and aerial survey)
  2. CPUE trend-driven
  3. Recruitment target-type behaviour

CCSBT 2010

- Performance of MP_1 and MP_2 scrutinised in detail
- MP_1 summary:
  1. lower initial TACs; higher average TACs
  2. less catch and SSB variability
  3. better on pessimistic robustness trials
- MP_2 summary:
  1. higher initial TACs; lower average TACs
  2. more variability in catch and SSB
  3. better on catchability change trials
- Hard to choose...
- Individual and average MP go to Commission
- Commission can't decide, wants more options and work...

CCSBT 2011

- Minor tweaks but MP_1 and MP_2 back again...
- CCSBT OM reconditioned with latest data (more positive)
- Target probability agreed: 0.7; TACs every 3 years
- Still in play: 2035 or 2040; 3000t or 5000t; lag or no lag
- **Issue No. 1**: one MP can't tune to likely settings
- **Issue No. 2**: issues around "ownership" of MP
- Tuning issue means average off the table...

Two become one (fast)

- Looks like no agreement probable with *status quo*
- 3 days before end of meeting "fusion" MP coded
- Introduced to SC for discussion
- SC: if it tunes on problem scenarios we go for it (it did)
- Every available laptop confiscated
- Fusion MP (originally MP_3) tuned, robustness trials run
- Good performance balance relative to original MPs
- SC recommends MP_3 to Commission for consideration

2011 Commission outcomes

- The "Bali Procedure" adopted by CCSBT Commission:
  1. Target year: 2035
  2. Maximum TAC change: 3000t
  3. 1 year implementation lag (except for 2012)
- Initial TAC increase limited to 1000t (new TAC 10,449t)
- TAC locked for 2012/2013
- 2014 TAC min. of 12,449t or level from MP (2015-2017)

Specifications of CCSBT MP

- Key data: LL CPUE & aerial survey
- RE model for juvenile (R_y), adult (B_y) biomass:

$$
\begin{aligned}
B_y &= R_y + g_{y-1} B_{y-1}, \\
R_y &= \exp\left(\mu_R + \epsilon_y^R\right), \\
g_y &= \exp\left(\mu_g + \epsilon_y^g\right), \\
\epsilon_y^\bullet &\sim N\left(-\sigma_\bullet^2/2, \sigma_\bullet^2\right).
\end{aligned}
$$

- Aerial survey: $I_{y-1}^{AS} \sim R_y$
- LL CPUE: $I_y^{CPUE} \sim B_y$

Specifications of CCSBT MP

- Mini-assessment central to MP:

Specifications of CCSBT MP

- HCR is an average of two candidate TACs:

$$TAC^1_{y+1} = TAC_y \times \begin{cases} 1 - k_1|\lambda|^\gamma & \text{for} \quad \lambda < 0 \\ 1 + k_2\lambda & \text{for} \quad \lambda \geq 0 \end{cases}$$

- Above λ is the slope in the regression of ln B_y against year (from years $y - \tau_B + 1$ to year y)
- k_1 and k_2 "gain" parameters; $\gamma \geq 1$ action asymmetry

Specifications of CCSBT MP

- Second candidate TAC:

$$TAC^2_{y+1} = 0.5 \times \left(TAC_y + C^{\text{targ}}_y \Delta^R_y \right),$$

$$C^{\text{targ}}_y = \begin{cases} \delta \left[\frac{B_y}{B^*} \right]^{1-\varepsilon_b} & \text{for} \quad B_y \geq B^* \\ \delta \left[\frac{B_y}{B^*} \right]^{1+\varepsilon_b} & \text{for} \quad B_y < B^* \end{cases},$$

$$\Delta^R_y = \begin{cases} \left[\frac{\bar{R}}{\mathcal{R}} \right]^{1-\varepsilon_r} & \text{for} \quad \bar{R} \geq \mathcal{R} \\ \left[\frac{\bar{R}}{\mathcal{R}} \right]^{1+\varepsilon_r} & \text{for} \quad \bar{R} < \mathcal{R} \end{cases}$$

Specifications of CCSBT MP

- δ "target" catch (tuning parameter)
- B^*: "target" CPUE (mean CPUE obs. @ 20% SSB_0)
- $\bar{R}$ average recent juvenile biomass:

$$\bar{R} = \frac{1}{\tau_R} \sum_{i=y-\tau_R+1}^{y} R_i,$$

- $\mathcal{R}$: "limit" level; mean survey 1993-2011
- $\varepsilon^{\bullet} \in [0, 1]$ action asymmetry

Specifications of CCSBT MP

The CCSBT MP process (nice idea but how do you get it adopted and implemented?)

Too many to mention (but some are in the room): the member scientists and indepedent panel of the CCSBT SC

- Overall: $TAC_{y+1} = 0.5 \times \left(TAC^1_{y+1} + TAC^2_{y+1} \right)$
- Control parameters:

Parameter	BP
δ	30,750
k_1	1.5
k_2	3
γ	1
τ_B	7
B^*	1.2
ε_b	0.25
ε_r	0.75
τ_r	5

Bali Procedure performance

- Detailed summary for key robustness tests:

Bali Procedure performance

The CCSBT MP process (nice idea but how do you get it adopted and implemented?)

Too many to mention (but some are in the room): the member scientists and indepedent panel of the CCSBT SC

- Performance summary:

Scenario	$p(SSB_{2035} > 0.2SSB_0)$	$\mathbb{E}\left(\frac{SSB_{2022}}{SSB_{2011}}\right)$	$\mathbb{E}(C_{2012-2022})$	$p(C \uparrow\downarrow)$
Ref. 3000t	0.7	2.76	15,200	0.49
Ref. 5000t	0.7	2.65	15,600	0.71
Robustness trials				
lowR, 3000t	0.66	2.32	13,200	0.83
Upq, 3000t	0.45	2.58	15,300	0.5
STWin, 3000t	0.34	2.39	12,872	0.81
Omega75, 3000t	0.48	2.74	13,304	0.74

Bali Procedure performance

- "Worm" plot (reference OM):

Lessons learned (technical)

- Tuning is **essential** - main point of reference set OMs
- Crucial comparability baseline between candidate MPs
- "Entry level" test: no tuning, no further...
- Use pessimistic robustness tests to rule out riskier MPs
- Detailed robustness performance for final "decisions"

Lessons learned (general)

- Going to take a number of years; plan accordingly
- Agree and codify "exceptional circumstances"
- Clear guidance to Commissioners right from start
- Minimise options given to Commissioners
- Encourage full collaborative developement
- For CCSBT "Olympic" approach led to stalemate
- Get "member ownership" off the table early

Future OM & MP work

- Develop spatial OMs (use tagging/e-tagging data)
- Include close-kin genetics into OM (adult abundance)
- Adopted MP is *interim* (get to limit level)
- MP in place is good but not a recovery guarantee:
  1. Keep exploring cost-effective monitoring
  2. Future development of adjusted/alternative MPs
  3. Time does not stand still post implementation...

Acknowledgements

- Over many years member scientists, Commissioners and indepedent panel of the CCSBT SC