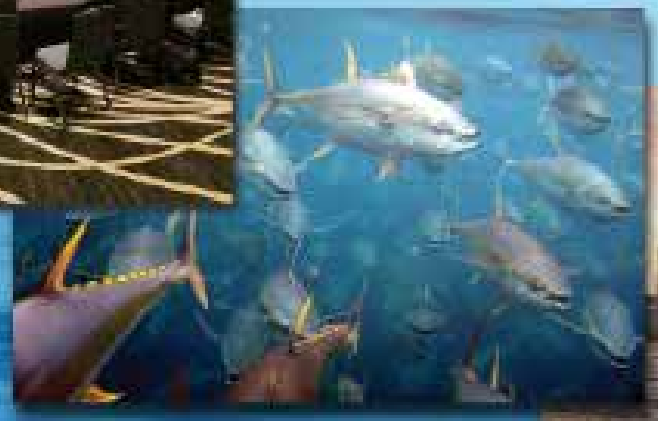

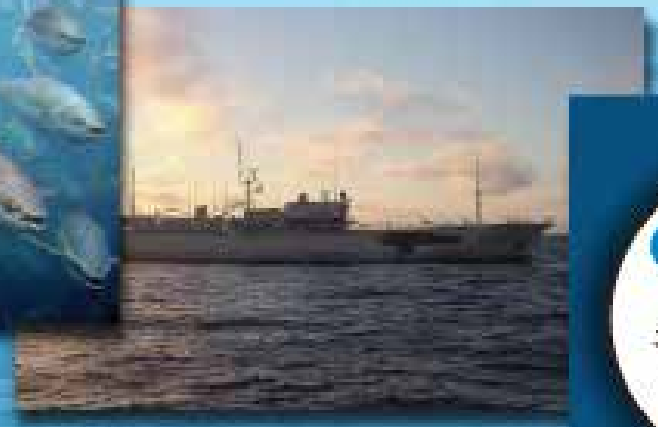

Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

CIAT
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Stock assessment approach at the IATTC

Mark N. Maunder

Outline

- Assessment approach
- Model assumptions
- Data
- Data weighting
- Diagnostics
- Management output
- Major issues

Assessment approach: previous EPO tropical tuna assessments

- **BET 2019**
  - https://www.iattc.org/GetAttachment/1eb798ce-29b8-49c9-8473-14d68638afb5/SAC-11-06_Bigeye-tuna-benchmark-assessment-2019.pdf
- **YFT 2019**
  - https://www.iattc.org/GetAttachment/1996b7a3-25aa-443d-9bcc-eee859137394/SAC-11-07_Yellowfin-tuna-benchmark-assessment-2019.pdf
- **SKJ 2021**
  - https://www.iattc.org/GetAttachment/0acfc999-fbcd-4b07-9e8d-fc5f85fd88e8/SAC-13-07_Skipjack-tuna-interim-assessment-2022.pdf

Focusing on YFT and BET

Assessment approach

- SS3: statistical sex (not SKJ) and age-structured stock assessment fit to length composition data (and other data)
- Quarter as year
- Areas as fleets
- Data
  - Catch
  - Index of abundance
  - Length composition
  - Limited conditional age at length
- Risk analysis using an ensemble of models

Model assumptions

Dimension	YFT	BET	SKJ
Start Year	1984 (spatial information limited)	1979 (or 2000 to avoid R regime shift)	2006 (eliminates the early 2000's where the longline abundance index was highly variable)
Ages	0 - 29+ quarters	0 - 39+ quarters	0 - 20+ quarters
Length bins	2 to 220+ cm by 2 cm	2 to 220+ cm by 2 cm	2 to 120+ cm by 1 cm
Sex	Yes	Yes	No

Likelihood	YFT	BET	SKJ
Catch	Lognormal SD = 0.01	Lognormal SD = 0.01	Lognormal SD = 0.01
Index	Lognormal	Lognormal	Lognormal
Length composition	Multinomial	Multinomial	Multinomial
Age	(Multinomial conditioned on length)	(Multinomial conditioned on length)	NA

Fisheries

- Determined by clustering length composition (and CPUE BET) data independent (or a compromise BET) of gear type
- Purse seine
  - Set type: OBJ, UNA, DEL
  - Area
  - Quarter (OBJ YFT)
  - Discard
- Longline
  - Area
  - Quarter (YFT)
  - Catch record: number, weight
- Pole and line (YFT)

Parameters

Parameter	YFT	BET	SKJ
Stock-Recruitment	Beverton-Holt fixed steepness = (0.7, 0.8, 0.9, and 1.0)	Beverton-Holt fixed steepness = (0.7, 0.8, 0.9, and 1.0)	Beverton-Holt fixed steepness = 1
Recruitment variation	Quarterly, lognormal, sd fixed at 1.0, penalized likelihood, bias adjustment ramp	Quarterly, lognormal, sd fixed at 0.6, penalized likelihood, bias adjustment ramp, (recruitment regime parameter)	Quarterly, lognormal, sd fixed at 0.6, penalized likelihood, bias adjustment ramp
Spawning biomass	Proportion of mature females, batch fecundity, fraction of females spawning per day, by age (from length)	Proportion mature at length converted into age-at-maturity	Proportion mature and batch fecundity
Initial conditions	Initial recruitment regime, parameter, initial fishing mortality, deviates for the youngest 16 quarterly age classes	Initial recruitment regime, parameter, two initial fishing mortalities, deviates for the youngest 16 quarterly age classes	Initial recruitment regime, parameter, initial fishing mortality, deviates for the youngest 10 age classes

Parameters

Parameter	YFT	BET	SKJ
Growth	Richards fixed parameters from previous assessment, (estimated)	Richards, fixed based on otolith and tagging, (estimated)	Growth cessation model, fixed based on tagging, Linf and L1 (2 quarters) assumed
Variation of length-at-age	Normal, coefficient of variation of 7.5%	Normal, sd assumed proportional to mean length, sd0 estimated and sd40 fixed (estimated)	Normal, linear relationship between CV and length, fixed at arbitrary values
Length-weight	Allometric Fixed (Wild 1986)	Allometric Fixed, Nakamura and Uchiyama (1966)	Allometric Fixed, (Hennemuth, 1959)
Natural mortality	Age and sex specific, female M increases after the fish mature, fixed based on age-specific proportions of females, maturity at age, and M of Hampton (2000), (estimated)	Age and sex specific, female M increases after the fish mature, fixed based on age-specific proportions of females, maturity at age, and M of Hampton (2000), (estimated)	Fixed at Hampton (2000) with linear interpolation between the mid points of the length classes

Parameters

Parameter	YFT	BET	SKJ
Selectivity	Double normal (asymptotic/dome), spline, estimated/shared/fixed, index time in variant, (time block)	Double normal (asymptotic/dome), spline, estimated/shared, index time in variant	Spline, estimated
Catchability	Estimated, (density dependent), (time block)	Estimated, time block	Estimated

Data

- Catch, assumed known without error
  - Purse-seine: Best Scientific Estimate (BSE) includes IATTC port sampling for species composition
  - Longline: from data submitted to IATTC
- Index of abundance
  - Longline (BET)/Dolphin associated (YFT)/OBJ and NOA (SKJ)
    - Spatio-temporal model
    - Logit and log link functions for the linear predictors of encounter probability and positive catch rate
    - Whole stock (core area)
    - 1 x 1 x month x vessel
    - BET: split at 1994/1995
    - Length comps weighted by CPUE
    - Separate selectivity
  - Other
    - Echo sounder buoy index (SKJ)
    - OBJ (uses info from buoys) and NOA not useful (vessels do both types of sets)

Data

- Length composition
  - Longline
    - Index: Calculated by spatio-temporal model using Japanese data, weighted by CPUE, 10-cm intervals, from 20 cm to 190 cm
    - Fishery raw length frequencies weighted by catch 2-cm intervals from 20 cm to 198 cm
    - Input sample sizes are computed as the total number of fish sampled divided by 100
  - Purse seine
    - Calculated by the substitution algorithm
    - 1-cm length interval
    - Sample size is number of wells sampled
- Age
  - Counts of daily increments on otoliths
  - Integrated into some, but not all, reference models to estimate the growth curve inside the assessment model
  - Age conditioned on length

Data

- Tagging
  - Limited amount of data
  - Limited spatial distribution of releases
  - Mixing is an issue
  - New spatio-temporal model

Data weighting

- Index
  - BET early: index is the sum of the CV estimated by VAST and a constant estimated by the assessment model;
  - BET late, YFT: index is fixed at the sum of the CV estimated by VAST and a constant that scales the mean CV in 1995-2014 to be 0.15 (0.2 SKJ), (catch curve)
- LF
  - Francis (2011) approach (not SKJ)
  - YFT and SKJ: some down weighted
  - (BET: down weight length comps)

Diagnostics

- Residual analysis
- Age-structured production model
- R0 likelihood component profile
- Retrospective analysis
- .....

Management output

- Fmult = F_{MSY}/F_{cur}
- Kobe plot S_{cur}/S_{MSY} and F_{cur}/F_{MSY}
- Fishery impact plots
- Risk analysis

Major identified issues

- YFT
  - Spatial/stock structure
  - Oversensitivity to the inclusion of new data from the longline index of abundance (e contraction of both the spatial extent and the fishing effort of the Japanese longline fishery)
  - Inconsistencies between the longline and dolphin associated purse seine indices
  - Misfit to length-composition data for the fishery that is assumed to have asymptotic selectivity
- BET
  - Recruitment regime shift when the OBJ fishery expanded
  - Poor fits to the longline length comps when assuming an asymptotic selectivity
  - Stock-structure (EPO-WCPO)
  - Contraction of the longline fleet used for the index of abundance and length compositions
- SKJ
  - Using longline as an index of abundance
  - Why the large skipjack are not seen in the purse-seine fishery: dome-shaped selectivity, high fishing mortality, high natural mortality for old fish, or a rapid decline in growth rates for older fish
  - Reference points
  - Stock structure
  - Tagging analysis
- General
  - Model weighting