ASSESSMENT OF BIGEYE TUNA
(*THUNNUS OBESUS*) IN THE
EASTERN PACIFIC OCEAN

January 1975 – December 2006
Outline

• Stock assessment
  – Overview of assessment model
  – Fishery data
  – Assumptions
  – Results of base case model
  – Projections
• Sensitivity analyses
• Summary and conclusions
• Discussion
Overview of assessment

- Age-structured, statistical, catch-at-length model (Stock Synthesis II).
- Same type of model as A-SCALA or MULTIFAN-CL
- Differences between SS2 and A-SCALA
Bigeye fishery definitions

- Early FLT (1)
- Early & Recent UNA (6, 7)
- Recent FLT (2-5)
- Discards (10-13)
- N Longline (8)
- S Longline (9)

FLT – Floating objects; UNA - Unassociated
Data - catch

Year -- Año

Fishery -- Pesquería 1
Disc -N FLT

Fishery -- Pesquería 2
S LL

Fishery -- Pesquería 3
Disc - S FLT

Fishery -- Pesquería 4
Disc – Eq FLT

Fishery -- Pesquería 5
N Offshore FLT

Fishery -- Pesquería 6
Early UNA

Fishery -- Pesquería 7
Recent UNA

Fishery -- Pesquería 8
N LL

Fishery -- Pesquería 9
Disc - coastal FLT

Fishery -- Pesquería 10

Fishery -- Pesquería 11

Fishery -- Pesquería 12

Tons -- Toneladas

Data - catch

Early FLT

S Offshore FLT

Equatorial FLT

Coastal FLT
Data - discards

![Graphs showing discards and retained fish](image)
Data - effort

Fishery -- Pesquería 1
Disc -N FLT

Fishery -- Pesquería 2
Disc - S FLT

Fishery -- Pesquería 3
Disc – Eq FLT

Fishery -- Pesquería 4
Disc – coastal FLT

Fishery -- Pesquería 5
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Fishery -- Pesquería 7
Recent UNA

Fishery -- Pesquería 8
N LL

Fishery -- Pesquería 9
S LL

Fishery -- Pesquería 10
Disc - N FLT

Fishery -- Pesquería 11
Disc – Eq FLT

Fishery -- Pesquería 12
Disc – coastal FLT

Thousands of days and hundreds of thousands of hooks
Miles de días y cientos de miles de anzuelos

Year -- Año
Data - CPUE

Year -- Año

Scaled CPUE -- CPUE escalado

Fishery -- Pesquería

Early FLT

N Offshore FLT

S Offshore FLT

Early UNA

Recent UNA

Disc – S FLT

Disc – Eq FLT

Disc – coastal FLT

N LL

S LL
Data - Length frequency data

Sexes combined whole catch lengths for fleet 3 (max=0.24)
Assumptions (base case) - movement

DATA

• Tagging records indicate little exchange of bigeye between E and W Pacific
• Results from conventional and archival tagging indicate regional fidelity for bigeye in EPO
• Different CPUE trends between EPO and WCP

ASSUMPTIONS

• Single stock of bigeye in EPO
• No net movement of fish between the eastern and western Pacific
• SA for EPO and Pacific wide are consistent
Assumptions (base case) - growth

- Von Bertalanffy – fixed parameters
Assumptions (base case) – M
Assumptions (base case) - cont.

- Age-specific maturity and fecundity indices
- No S-R relationship (steepness = 1)
Results (base case)

- Fit to the length frequency
- Fishing mortality
- Selectivity
- Recruitment
- Biomass
Fit to LF data – Pearson residuals

Combined sex whole catch Pearson residuals for fleet 9 (max=2.76)
Fit to CPUE data – Floating object

Fishery 2

Fishery 3

Fishery 5
Fit to CPUE data – Longline

**Fishery 8**

![Graph for Fishery 8]

**Fishery 9**

![Graph for Fishery 9]
Age-specific fishing mortality

Average total F - F total media

Age in quarters - Edad en trimestres

1975-1992

1993-2006
Size selectivity

Fleet 1: Early FLT
Fleet 2: S Offshore FLT
Fleet 3: Equatorial FLT
Fleet 4: Coastal FLT
Fleet 5: N Offshore FLT
Fleet 6: Early UNA
Fleet 7: Recent UNA
Fleet 8: N LL
Fleet 9: S LL
No-fishing plot

Spawning biomass (mt)

Year


No LL
No FO
No Dis

CIAT
IATTC
Average weight

![Graph showing the change in average weight from 1975 to 2010. The graph compares two lines: PS and LL. There are fluctuations in the mean weight over the years, with a notable drop around 2000.](image)

- **PS**
- **LL**

**Year**
- 1975
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010

**Mean weight (kg)**
- 80
- 70
- 60
- 50
- 40
- 30
- 20
- 10
- 0

CIAT IATTC
Retrospective analysis - biomass
Comparisons with A-SCALA

![Graph comparing biomass from SS2 2007, A-SCALA 2006, and A-SCALA 2007.](Image)

- **SS2 2007**
- **A-SCALA 2006**
- **A-SCALA 2007**

Summary biomass (tons)


- Values range from 0 to 700,000 tons.
Comparisons with A-SCALA assessments

- SS2 2007
- A-SCALA 2006
- A-SCALA 2007

Spawning biomass (tons)

Year

Graph showing changes in spawning biomass over years, with comparisons to A-SCALA assessments.
Comparisons with A-SCALA assessments

![Graph showing relative recruitment over years comparing SS2 2007 and A-SCALA 2007.](image)
Comparisons to reference points

- Spawning biomass depletion (SBR)
Spawning biomass ratio

Year


Spawning biomass ratio

SS2 2007
SBR comparison with A-SCALA

Year

- SS2 2007
- A-SCALA 2006
- A-SCALA 2007

Spawning biomass ratio

Time varying indicators

![Graphs of various indicators over time](image)
## AMSY-quantities

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### AMSY-quantities – by fishery

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Forward simulations

- Biomass
- Spawning biomass depletion
- Surface fishery catch
- Longline catch
Spawning biomass ratio

[Graph showing the spawning biomass ratio from 1980 to 2010]
Predicted catches – purse-seine

Surface fisheries

Tons

Year

Sensitivity analyses

1. Spawner-recruitment relationship (steepness = 0.75)

2. Growth
   - Growth estimated
   - Linf fixed (171.5 and 201.5)

3. Fitting to the initial equilibrium catch

4. Use of iterative reweighting of data

5. Time blocking of selectivity and catchability for southern longline fishery

6. Inclusion of new Japanese longline data
Stock-recruitment relationship
\( (h = 0.75) \)
Biomass

Summary biomass (tons)

- **basecase**
- **h = 0.75**

Year

Recruitment

Summary biomass (tons)

- basecase
- $h = 0.75$

Year

Spawner-recruitment curve
Use of CPUE time series for southern longline fishery only
Spawning biomass ratio

Year

Spawning biomass ratio

- basecase

- cpue 9
Model fit to CPUE data
Assumed value for the asymptotic length parameter of the VB growth curve
Growth curves

- Base case
- Growth estimated

Lmax = 201.5
Lmax = 171.5
SBR

Year

Spawning biomass ratio

Lmax = 171.5
Growth estimated
Lmax = 201.5
Fit to initial equilibrium catch
Spawning biomass ratio

![Graph showing the spawning biomass ratio over years, with two lines representing 'basecase' and 'init_catch'.]
Use of iterative reweighting
## Iterative reweighting

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</table>
Fit to CPUE data
Residual plot

Combined sex whole catch Pearson residuals for fleet 9 (max=10.23)
Use two time blocks for selectivity and catchability of the southern longline fishery
Fit to LF data – base case

Combined sex whole catch Pearson residuals for fleet 9 (max=2.76)
Spawning biomass ratio

![Graph showing spawning biomass ratio over time with different time blocks and scenarios.](image-url)
Fit to CPUE data

Without iterative reweighting

With iterative reweighting
Combined sex whole catch Pearson residuals for fleet 9 (max=2.74)
Inclusion of the new Japanese longline data
Biomass

Summary biomass (tons)

- basecase
- new JPN data

Year

Recruitment

- **basecase**
- Δ - new JPN data
SBR

Year

Spawning biomass ratio

- basecase
- new JPN data

## Comparisons between models

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Summary: Main results

• Both total and spawning biomass is estimated to have substantially declined since 2000
• Current biomass level is low compared to average unexploited conditions
• The current effort levels are too high to maintain the population at a level that will support AMSY
• Yields could be increased if more of the catch was taken in the longline fisheries
What is robust

- Fishing mortality levels are greater than that necessary to achieve the maximum sustainable yield
- Two exceptions: Lmax fixed and time blocks
• Results are more pessimistic with the inclusion of a stock-recruitment relationship
• Biomass trends are sensitive to the weighting of different datasets
• Recent estimates are uncertain and subject to retrospective bias
Conclusions

• Current spawning biomass is unlikely to remain at or above the level required to produce AMSY.
• In the most recent years the fishing mortality is greater than that required to produce AMSY.
• Under average recruitment, the stock is predicted to be below the level that would support AMSY unless fishing mortality levels are reduced further than the current restrictions.
### Comparisons between models

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