Data Use in the Assessment of Striped Marlin in the North Pacific

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Stock Assessment Process

**DATA and INPUT**
1. Fishery-dependent data
2. Fishery-independent surveys
3. Life history information

**Population Dynamics** (statistical models)

- **Reference Points and Stock Status**
- **Projection**
- **Stock Trajectory** (Biomass, fishing intensity, recruitment)

**Habitat and environmental information** improves and informs
Overview of integrated assessment model

Stock synthesis Version 3.20b:
1) a data sub-component that use of a variety of fishery dependent and independent information (catch, abundance trend, age/size data, biological samples),

2) a statistical sub-component that quantifies the fit of model predictions to the data using a negative log-likelihood (NLL) function,

3) a population sub-component that simulates the numbers and biomass-at-age of the population using fixed and estimated model processes.
Stock Synthesis Data

- Retained catch
- CPUE and survey abundance
- % Discard
- Mean body weight
- Tag-recapture

- Age composition
  - Within length range
- Size composition
  - By biomass or numbers
  - Within gender
  - Weight bins or length bins
- Mean length-at-age
# Stock Synthesis Structure

<table>
<thead>
<tr>
<th>AREA</th>
<th>FLEET / SURVEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-specific movement between areas</td>
<td>Length-, age-, gender selectivity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NUMBERS-AT-AGE</th>
<th>CATCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohorts: gender, birth season, growth pattern; Distributed among areas</td>
<td>F to match observed catch; Catch partitioned into retained and discarded, with discard mortality</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RECRUITMENT</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected recruitment is a function of total female spawning biomass; Optional environmental input; Apportioned among cohorts;</td>
<td>Can have prior/penalty; Time-vary as time blocks, random annual deviations, or a function of input environmental data</td>
</tr>
</tbody>
</table>
Data and input for striped marlin

• **Life history information**
  • Stock structure
  • Growth
  • Maturity and reproduction
  • Natural morality

• **Fishery-dependent data**
  • Catch data (commercial and recreational)
  • Abundance index from catch-and-effort data (logbooks or observers)
  • Size information sampled from the catch
Impacts of alternative life history information on assessment

alternative natural mortality

alternative growth curves

Age 1+ biomass

Age 1+ biomass

Base case
High M
Low M

Base case
Larger_fish
Smaller_fish
Stock structure

- New genetic studies have been completed since 2007 assessment, indicating that there are at least two distinct genetic populations in the North Pacific.

- The following boundaries are defined by the two Pacific Ocean Regional Fisheries Organizations, ISC and IATTC.

![Map showing WCNPO and EPO regions](image-url)
Growth, maturity, and weight-at-length

- The study by Skillman and Yong (1976) took a quantitative approach by fitting a von Bertalanffy growth equation to the length frequency data collected from the Hawaii longline fleet during 1960-1970.

- The first hardpart based age & growth study was conducted by Melo-Barrera et al. (2003) based on sampling the recreational troll fishery off Mexico.

- No age 0-1 samples and could not corroborate the determination of the first true annulus in their dorsal spine sections using otolith-based age estimates.

- Kopf from southwest Pacific Ocean

Growth based on otoliths studies from a maximum of age 6 fish (Sun et al. 2011)
Growth, maturity, and weight-at-length

Port sampling from offshore longline, gillnet, and harpoon fisheries off Taiwan waters during 2004-2010.

(Sun et al. 2011)
Growth, maturity, and weight-at-length

- Two spawning grounds were identified in the WCNPO.
- We rely on the biological samples from western side of WCNPO.
Growth, maturity, and weight-at-length

• Growth studies are best conducted when large sample sizes are available that encompass a broad size range of fish collected including age 0 fish and a broad spatial scale.

• Reproductive studies are best conducted when large sample sizes are available that encompass a broad size range of fish collected throughout the spawning season and within spawning grounds by various fishing gears.
Natural mortality

- Estimates are based on indirect methods which are referred to analyses conducted based on estimates of maximum age, life history correlates, and evolutionary-ecology theory.

- Not estimated from direct methods which are referred to analyses using the actual data (e.g. tagging data)
  - Concerns with tagging analysis including representative sampling, non-reporting of tags, tag shedding, and tag induced mortality (either initial or long-term)
Available fishery-dependent data
Catch data

- Total removal from the fisheries including discards provided by the ISC members.
- Majority of catch are from Japan. (US account for about 11% since 1990)
Abundance index from catch-and-effort data

- Catch and effort data were compiled by fishery and used to develop standardized annual indices of relative abundance.
- We rely on the ISC member to provide estimates of abundance indices.

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<tr>
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<th>Taiwan LL</th>
<th>Hawaii LL</th>
<th>Japan coastal driftnet</th>
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<tbody>
<tr>
<td>Data resolution</td>
<td>Aggregated monthly, 5X5 degree</td>
<td>Aggregated monthly, 5X5 degree</td>
<td>Operational, 1X1 degree</td>
<td>Operational</td>
</tr>
<tr>
<td>(time-area strata)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Raised catch and effort data</td>
<td>Raised catch and effort data</td>
<td>Observer</td>
<td>logbook</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td>Spatial coverage</td>
<td>WCNPO</td>
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<td>Hawaii waters</td>
<td>Japan coastal waters</td>
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Abundance index from catch-and-effort data

- Hawaii always provides thorough analyses using the finest resolution data.
- Details will be given in the following talk (stay tune).

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Size information sampled from the catch

- Size frequency data were compiled by year, season, and fishery (spatial).
- We rely on the ISC member to provide size data.

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<th>What is measurement precision?</th>
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<td>nearest 1 cm</td>
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<td>landing ports by samplers or onboard measure by crew</td>
<td>onboard measure by crew</td>
<td>onboard measure by observer</td>
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<td>Sample from every 3rd fish</td>
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Size distribution by fishery

- Striped marlin grow rapidly during first year.
- Age 0 fish is around 120 cm caught by JPN_DWLL1 and HW_LL.
Size distribution by Hawaii LL

- There is seasonal pattern in Hawaii_LL size.
- Age 0 fish recruit to the HW fishery in season 4 and 1.
- Age 0 fish recruit to the JPN fishery in season 1-3.
- It appears that the timing of peak recruitment varies regionally.
Highly migratory stock assessment

Features: rely on the international collaboration in terms of data and biological information

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<th>Things we could NOT control and improve</th>
<th>Things we could control and improve</th>
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<tr>
<td>Fishery-dependent data</td>
<td>Fishery data from other countries</td>
<td>Bring best available data (corrected catch, discard estimate, spatial and temporal data analysis etc.)</td>
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<td>Life history information</td>
<td></td>
<td>Representative biological sampling and collaboration</td>
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Data and biosamples are the key

- Representative biological sampling of
  1. sampling design
  2. broad size range of fish
  3. broad temporal and spatial scale
  4. large sample sizes
  5. various fishing gears

- Tagging studies
- Age and growth studies
- Reproductive studies
- Genetic studies

by Michael Musyl
Improvement and need of data for highly migratory species

Biosampling

• **Ageing:**
  - Production ageing on regular basis to account for regional and temporal variation of growth.
  - Ageing error could be included in the assessment.

• **Reproductive studies:**
  - Sample fish throughout year in spawning grounds.
  - Consider regional variation of reproduction.

• **International tagging research:**
  - Understand migration and other key parameters

Oceanography data