Towards a Tropical Tuna Buoy-derived Abundance Index (TT-BAI)


LA JOLLA, 05/25/2016
INTRODUCTION

- Conventional fishery-independent surveys are not practicable for highly migratory widely distributed tuna stocks;
- CPUE is the standard abundance index used to guide the assessment of tuna stocks;
- PS-CPUE data are notoriously problematic;
- Catchability (q) is rarely constant and depends on a number of different components;
- Fishing efficiency and dynamics of the fleet are evolving very rapidly due to the fast technological development and the sharp increase of the use of FADs.
INTRODUCTION

CPUE ~ q x Biomasa

- competitors
- oceanography
- Type and size of preys
- Habitat disponibility
- Specie
- Maturity
- Habitat preference
- Vessels characteristics
- Catsat
- Echo-sounder
- Bird radar
- Sonar
- DFADs
- Depth of the set
- Day
- Time
- Location
- Size
- Age
INTRODUCTION

- One of the most important technological developments: satellite linked echo-sounder buoys.

- rapidly spread between all the purse seine fleets worldwide since mid-2000’s.
- causing rapid changes in the fishing strategy and fleet behavior
- potential of being a privileged observation platform to evaluate abundances of tunas and accompanying species using catch-independent data.
CPUE \sim q \times \text{Biomasa}
TT-BAI

INTRODUCTION

\[ \text{BAI} \sim \lambda \times \text{Biomasa} \]

- competitors
- oceanography
- Type and size of preys
- Habitat disponibility
- size
- specie
- maturity
- age
- Habitat preference
- location
- time
- echo-sounder
- day
TT-BAI
OBJECTIVE

• Initial examination of some of the features of the information potentially available from satellite tracking echo-sounder buoys used and provided by the Spanish TT PS and associated fleet to ultimately develop a “fishery semi-independent” abundance index.
• **1 month**: March 2011 (AO & PO) & October 2011 (IO)
• **38 vessels / 11,705 buoys / 4,196 with echo-sounder**
• **> 1,200,000 records [position] /568,000 echo-sounder records**
### MATERIAL & METHODS

#### 3 types of buoys

<table>
<thead>
<tr>
<th></th>
<th>Brand A</th>
<th>Brand B</th>
<th>Brand C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating frequency (kHz)</td>
<td>50</td>
<td>190.5</td>
<td>120</td>
</tr>
<tr>
<td>Range (m)</td>
<td>150</td>
<td>115</td>
<td>100</td>
</tr>
<tr>
<td>Number of layers</td>
<td>50</td>
<td>10</td>
<td>-----</td>
</tr>
<tr>
<td>Energy source</td>
<td>Solar panels</td>
<td>Battery</td>
<td>Solar panels</td>
</tr>
</tbody>
</table>
## MATERIAL & METHODS

<table>
<thead>
<tr>
<th></th>
<th>BRAND A</th>
<th></th>
<th>BRAND B</th>
<th></th>
<th>BRAND C</th>
<th></th>
<th>ALL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>EPO</td>
<td>All</td>
<td>EPO</td>
<td>All</td>
<td>EPO</td>
<td>All</td>
<td>EPO</td>
</tr>
<tr>
<td>Vessels</td>
<td>-</td>
<td>-</td>
<td>38</td>
<td>17</td>
<td>31</td>
<td>14</td>
<td>38</td>
<td>17</td>
</tr>
<tr>
<td>Buoys</td>
<td>1,634</td>
<td>186</td>
<td>5,522</td>
<td>1,339</td>
<td>4,549</td>
<td>475</td>
<td>11,705</td>
<td>2,000</td>
</tr>
<tr>
<td>Buoys with echo-sounder</td>
<td>1,634</td>
<td>186</td>
<td>2,271</td>
<td>558</td>
<td>291</td>
<td>0</td>
<td>4,196</td>
<td>744</td>
</tr>
<tr>
<td>% Buoys with echo-sounder</td>
<td>100</td>
<td>100</td>
<td>41.1</td>
<td>41.7</td>
<td>6.4</td>
<td>0</td>
<td>35.8</td>
<td>37%</td>
</tr>
<tr>
<td>Number of records</td>
<td>575,966</td>
<td>66,701</td>
<td>262,361</td>
<td>77,342</td>
<td>459,915</td>
<td>58,485</td>
<td>1,298,242</td>
<td>202,528</td>
</tr>
<tr>
<td>Acoustic records</td>
<td>486,109</td>
<td>56,864</td>
<td>28,528</td>
<td>10,409</td>
<td>53,368</td>
<td>0</td>
<td>568,005</td>
<td>67,273</td>
</tr>
<tr>
<td>Daily acoustic records</td>
<td>38,799</td>
<td>4,909</td>
<td>17,902</td>
<td>6,806</td>
<td>7,825</td>
<td>0</td>
<td>64,526</td>
<td>11,715</td>
</tr>
<tr>
<td>Daily positive records</td>
<td>23,443</td>
<td>3,683</td>
<td>14,247</td>
<td>5,638</td>
<td>6,792</td>
<td>-</td>
<td>44,482</td>
<td>9,321</td>
</tr>
<tr>
<td>% positives</td>
<td>60%</td>
<td>75%</td>
<td>80%</td>
<td>83%</td>
<td>87%</td>
<td>-</td>
<td>69%</td>
<td>80%</td>
</tr>
</tbody>
</table>
• Ways to integrate buoy information into a catch-independent abundance index for tropical tuna, including

  – **filtering** for acoustic data reductions and exclusions
  – identify **factors that should be considered** in the analysis, either because they may affect the assumption that the acoustic records are proportional to tropical tuna abundance or may influence the coefficient of proportionality (φ).
RESULTS

BAI = Buoy-derived Abundance Index

\[ BAI_t = \varphi \cdot B_t \]

- standardization of nominal measurements of the echo-sounders using a Generalized Linear Mixed Modelling approach.
- Delta method, estimating the predicted abundances as the result of two processes:
  
  i. the probability of encounter tropical tuna in the acoustic observations (proportion of positives) and,
  
  ii. the mean relative abundance given that a positive observation has been realized.
TT-BAI
RESULTS

SKJ

BET

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IATTC catch data
Considerations for the exclusion of records

- Time after deployment (or fishing event) [<5 days]
- Vertical range of the buoy [<25 m – non target spp]
- Time of the day [sunrise?]
- Bottom depth [<200 m]
- Speed of the buoy [>3 kn]
Variables to be considered in the standardization apart from year, month, area:

– Soak time
– Buoy type
– Depth of the acoustic layers
– Bearing and speed
– Density of FADs
– Environmental variables
– Species composition underneath the FAD
• Work in progress;
• Very valuable information to build “Fishery Independent” Biomass Index for use in the stock assessment
• But also to investigate the effect of dFADs on Tuna populations and ecosystem;
• Long term project which will use acoustic discrimination of species/sizes;
• Collaborative project between scientist and vessel owners.