Humpback whale, *Megaptera novaeangliae*, song during the breeding season in Tribugá’s Gulf, Colombian Pacific

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Breeding grounds serve as windows to help researchers understand social dynamics and conspecific communication.

Among the mating strategies utilized by Humpback whales is song.

**Breeding grounds**
- Bermuda (Payne & Payne, 1985); Western and Eastern South Atlantic Ocean (Darling & Sousa-Lima, 2005); Eastern Australia (Noad et al., 2000); Tongan Islands (Eriksen et al., 2005); Hawaii (Payne et al., 1983); North Pacific (Cerchio et al., 2001); Southeastern Pacific (Oviedo et al., 2008);

**Feeding grounds**
- Western Antarctic peninsula (Stimpert et al., 2012); Balleny Islands, north of Antarctica (Garland et al., 2013); Western Georges Bank (Gulf of Maine) (Clark & Clapham, 2004)

**Migration routes**
- Eastern North Pacific (Norris et al., 1999)
Units = short, uninterrupted sounds (Payne & McVay, 1971)

Multiple units are grouped together into a phrase (Payne & McVay, 1971)

Continuous repetitions of phrases are termed themes (Payne & McVay, 1971)

A song is made up of multiple themes (Payne & McVay, 1971; Payne et al., 1983)

- Songs range in length from 8 to 35 minutes (Payne & Payne, 1985)

Sequences of songs are termed song sessions, and can endure for several hours (Payne & McVay, 1971)
Migrate north from feeding grounds near Antarctica to breeding grounds along the west coast of South America (Stevick et al., 2004)


To date, there has been no published research describing Humpback whale vocalizations in Colombian waters

- It is crucial to study stocks in all breeding areas to understand song structure, function, and transmission
Research Objectives

-To document song on the Colombian breeding grounds
  - Describe themes and phrases
  - Track changes within individual songs and throughout the season
-To compare Colombian song with song on other breeding grounds
-To increase the awareness of tourists, whale watching operators, fishermen, and local communities regarding the conservation of Colombia’s Humpback whales, as a part of efforts by Macuáticos
Study Area

Tribugá’s Gulf

Coquí
June 7th – September 13th 2013
- 3 trips/week alternating to the north and south of the town of Coquí
- Eight-meter fiberglass boat with 40 horsepower outboard motor

When singers were detected visually or audibly, a single SQ26-08 hydrophone was deployed, with 10m cable attached to a Zoom H1 digital recorder (Cetacean Research Technology)

Recordings began only when song was clear and one dominant whale was audible
**Results: 2013**

### Overall Theme Analysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Total # of recordings</td>
<td>6</td>
</tr>
<tr>
<td>analysed</td>
<td></td>
</tr>
<tr>
<td>Total duration of song</td>
<td>Approx. 4 hours, 30 minutes</td>
</tr>
<tr>
<td>analysed</td>
<td></td>
</tr>
<tr>
<td>Total number of different themes</td>
<td>3</td>
</tr>
<tr>
<td>Number of songs per recording (Range)</td>
<td>0-7</td>
</tr>
<tr>
<td>Approx. total duration of Theme 1</td>
<td>Approx. 3 hours, 4 minutes</td>
</tr>
<tr>
<td>Approx. total duration of Theme 2</td>
<td>Approx. 54.5 minutes</td>
</tr>
<tr>
<td>Approx. total duration of Theme 3</td>
<td>Approx. 37.5 minutes</td>
</tr>
</tbody>
</table>

### Individual Theme Analysis

<table>
<thead>
<tr>
<th>Date</th>
<th>Theme Order</th>
<th>Total # of Complete Songs Recorded (Individual Whale)</th>
<th>Approx. Duration of Theme 1</th>
<th>Approx. Duration of Theme 2</th>
<th>Approx. Duration of Theme 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2, 2013</td>
<td>1-2-3</td>
<td>3</td>
<td>21.5 minutes</td>
<td>5.5 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>August 9, 2013</td>
<td>1-2-3</td>
<td>7</td>
<td>1 hour 3 minutes</td>
<td>28 minutes</td>
<td>13.5 minutes</td>
</tr>
<tr>
<td>August 12, 2013</td>
<td>1-2-3</td>
<td>2</td>
<td>29 minutes</td>
<td>3 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>September 9, 2013</td>
<td>1</td>
<td>1 theme only</td>
<td>12 minutes</td>
<td>0 minutes</td>
<td>0 minutes</td>
</tr>
<tr>
<td>September 9, 2013</td>
<td>1-2-3</td>
<td>2</td>
<td>22.5 minutes</td>
<td>7 minutes</td>
<td>3.5 minutes</td>
</tr>
<tr>
<td>September 13, 2013</td>
<td>1-2-3</td>
<td>4</td>
<td>36 minutes</td>
<td>11 minutes</td>
<td>10.5 minutes</td>
</tr>
<tr>
<td>Theme Name</td>
<td>Description</td>
<td>Spectrogram</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Theme 1: AB AB AB AB AA</td>
<td>Repeated slight variations of phrase 'AB AB AB AB AA'. The sub phrase 'AB' was repeated between 4 and 17 times. The sub phrase 'AA' occasionally consisted of a single 'A' or a triple 'AAA'.</td>
<td><img src="image" alt="Spectrogram 1" /></td>
<td></td>
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<tr>
<td>Theme 2: BI F</td>
<td>Repetitions of a units 'BI' and 'F'. Phrase variations consisted of multiple &quot;BI&quot; units or 'F' units in a row.</td>
<td><img src="image" alt="Spectrogram 2" /></td>
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<tr>
<td>Theme 3: SS SS SS SS</td>
<td>Repeated phrases of a long tonal upsweep unit followed by a short tonal upsweep unit, sometimes with a downsweep unit in the pattern. S unit heard during theme transitions.</td>
<td><img src="image" alt="Spectrogram 3" /></td>
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</tbody>
</table>
No pattern to shifting ‘AA’ sub phrase

Consistant use of ‘AA’ in both August and September recordings

Use of ‘AAA’, ‘AA’, and ‘A’ in other recordings in both August and September

‘AB’ sub phrase repeated most often between 5 and 7 times, but
as many as 17 times

No patterns to differing repetitions of ‘AB’ subphrase
Variation within a song
  o 8-12-13: Second time Theme 2 is heard, phrase structure is the same but unit Bl is sometimes replaced by unit H, and unit F is slightly audibly different
  o Bl unit sometimes has elements of B unit

Variation between recordings
  o 3 Bl units heard before Theme 3 in all August recordings
  o Double/triple F and Bl units repeated throughout theme in September recordings
Considerable between song variation

- Mid-August and September:
  - short harmonic SS unit followed by an S unit repeated before Theme 1
- One early August recording contains only a few phrase repetitions each time Theme 3 is heard

Little within song variation

- Phrase “SS long/upsweep and SS short/upsweep repeated twice and followed by a 10 second pause with X unit audible, and then repeated again
Gabon and Brazil (Western and Eastern South Atlantic Ocean) (Darling & Sousa-Lima, 2005)

- Theme 5 ABABABCC similar in structure to ABABABAA from Theme 1

Tonga (Jenkins et al., 1995)

- Subphrase 4 from Eastern Australia similar harmonic structure to unit SS downsweep from Theme 3
Hawaii (Au et al., 2006)

- Unit E₂ similar to SS long, upsweep unit from Theme 3
- Unit H similar to unit A from Theme 1
Fishing, whale watching, and other types of tourism a major part of livelihood

Safe practices for both people AND animals

Song is a tool to educate the communities about the importance of conservation, and to advocate for stricter guidelines for safe practices

Long-term results will also contribute to our understanding of the function of song
Acknowledgements

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Communities of Coquí, Joví, Termales, and Nuquí
Dr. Jim Darling


Recordings were made on 11 days, totaling 18 recording sessions between 7/23 and 9/16

11 recordings identified as analyzable, totaling 4:45:40 of song