Mysticete acoustics

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SIO 133: Marine Mammal Biology
Why make sounds?

- Finding food
- Sensing the environment
- Navigation
- Mate attraction
- Mate guarding
- Communicating with conspecifics / social interactions: territorial defense, conflict resolution, parent-offspring interactions

song
How do whales make sounds?

Respiratory tract in red
Digestive tract in blue

Schematic laryngeal region

Sound produced by moving Air from the lungs via the Trachea (Tr) into the Laryngeal sac (L)

Reidenberg and Laitman 2007
Communication: overview

Sender → Signal → Receiver

How?
- Visual (e.g. bright feathers), chemical (e.g. pheromones), electroreception (e.g. sharks), acoustic – works at a distance, even underwater

Why?
- Trying to influence behavior (current or future)
Behavioral Aspects of Baleen Whale

Sound Production

Song
- produced by males
- optimized for detection at distance
- not compatible with foraging
- geographically distinct
  – associated with mating (?)

Contact Calls
- produced by both sexes
- can be intermixed with foraging
- little geographic variation

More Complex Calls
- potential for more information content
What is a song?

- Series of repeated sounds (music?)
- Efficient information exchange
- Sender and Receiver agree on meaning?
- Unit → Phrase → Theme → Song

Modified from Payne and McVay (1971)
Humpback Whale - *Megaptera novaeanglia*

Complex songs: 10-15 min sequences
Evolution of Humpback Whale songs

From Payne (2000)

Songs are
Changed
During each
Annual cycle

Gradual change
over time (mostly)

From Payne (2000)
Evolution of humpback whale songs

- Geographic variation

From Noad et al. 2001

From Helweg et al. 1998
Baleen Whale

Blue Whale - *Balaenoptera musculus*

![Image of a blue whale](image)

- **Time (seconds):** 0 to 15
- **Frequency (Hz):** 0 to 150

- **Graph:** Time vs. Frequency

- **X-axis:** Time (seconds)
- **Y-axis:** Frequency (Hz)
Blue whales - California

90,000 B calls/yr. == 68,000 song,  22,000 single calls

Songs: patterned sequences made by males only

42,000 D calls/yr.

Counter-calls: occur among individuals of both sexes
Calling Seasonality

B Call

D Call Pattern more comparable to Sighting rates
Blue whale songs worldwide

From McDonald et al. (2006)
Biogeography of blue whale song

From McDonald et al. (2006)
Long Term Changes in Blue Whale Song

A

Frequency (Hz)

0 20 40 60

B

measure point

pre-whaling

post-whaling

FREQUENCY (Hz)

YEAR


44 48 52 56 60 64

R1

R2

120
Blue Whale Song in Australia

- Seasonal changes
- Long-term trend

Gavrilov et al. 2012
Song of Fin Whale – *Balaenoptera physalus*

Gulf of California July 2006

Sound plays 5x rate

Frequency (Hz)

Time (seconds)
Song of Fin whale – *Balaenoptera physalus*

Doublet - SOCAL

Triplet – Gulf of CA
Song of Fin whale – *Balaenoptera physalus*

20 Hz calls, song

Doublet - SOCAL

Long = 1/2 sec, Intense = 186 dB, Repetitive
Fin Song seasonal & long-term trends

From: Oleson et al. 2014, J. Buccowich 2015, Sirovic et al. 2015

Southern California
- Seasonally variable 2001-2004
- Long-term trend 2007-2012
- Small presence of Gulf of CA in the summer/fall

Graphs showing median fin whale song IPL data with markers for long doublet, short doublet, long triplet, and short triplet.

Data sources:
- Oleson et al. 2014
- J. Buccowich 2015
- Sirovic et al. 2015
Fin Whale 20 Hz Call Tracking – Source Level

- Short Doublet
- Meandering Track
- High Source Level
  ~190 dB re µPa

Near San Clemente Is
Nov 2007
Fin whale call types

Širović et al. (2012)

40 Hz calls

20 Hz calls
Fin Whale 40 Hz Call Tracking – Source Level

- Two animals – contact call
- Converging Tracks
- V High Source Level
  \(~200 \text{ dB re } \mu\text{Pa}\)
Minke whale (*B. acutorostrata*)

- Boings in the Pacific
  - Hawaii
  - San Diego

- Thump trains in the Atlantic

From Rankin and Barlow (2005)
Gray Whale - *Eschrichtius robustus*
Gray Whale Calls

M1 – Pulsed

M3 - Moan

Guazzo et al. in prep