

Temporal characterization of Humpback whale (*Megaptera novaeangliae*) song in Tongan waters

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Background

- Cetacean- Humpback whales is a species of baleen whale.
- Migratory species.
- IUCN Red listing for Oceania humpback whales; Status- Endangered.



Introduction

- Individuals in the same sub-population share similar song.

- They change each year.

- Songs can last for up to 30 minutes or more

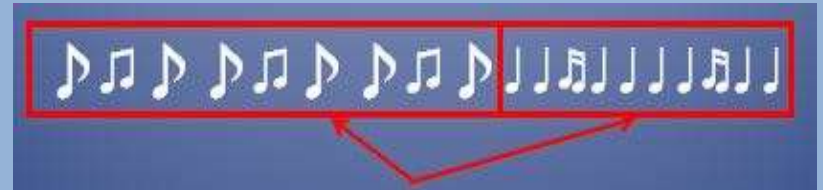
- Song structure



- Series of individual sounds or units



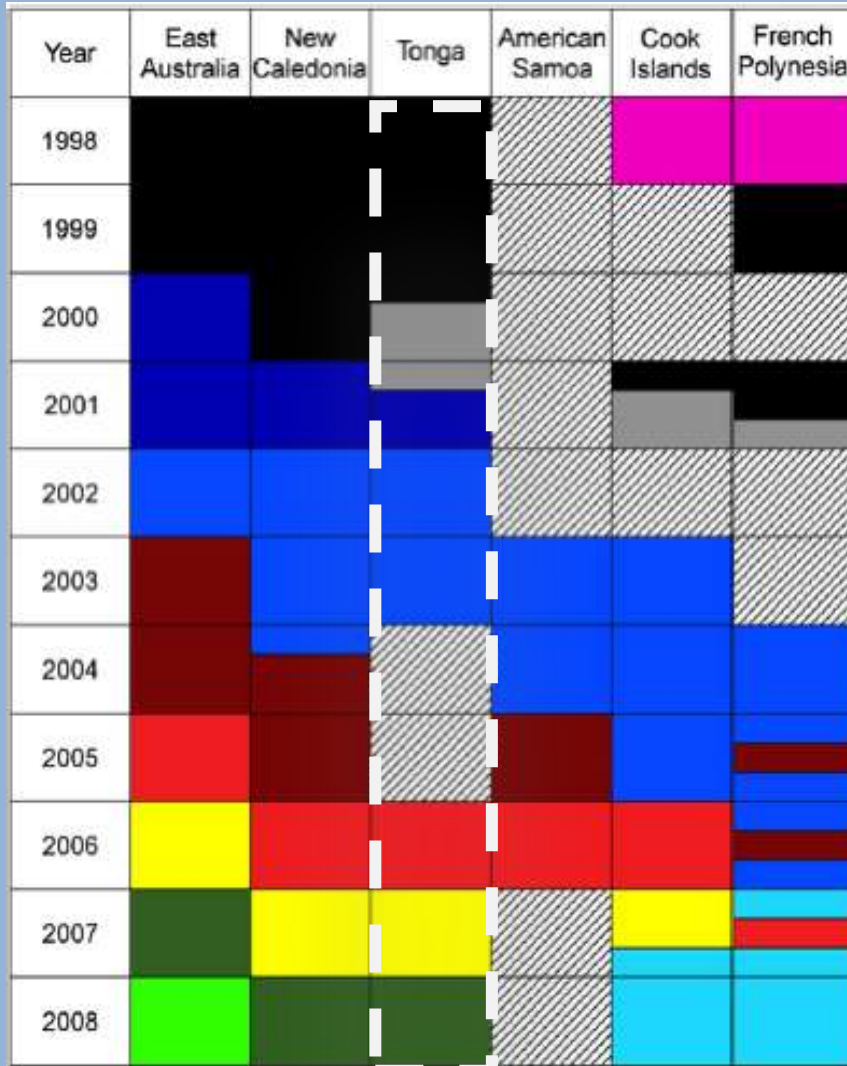
- Repeating sequence of units=phrase



- Series of repeated phrases=theme

- Series of repeated themes=song

- Song types



Garland et al. 2011

Song types identified from

1998 to 2008. Populations

are listed from west to

east across the region.

Each color represents a

distinct song type.

- **Study Objective:** Characterize the song structure of Tongan Humpback whale song during 2013 migration period.

Study site



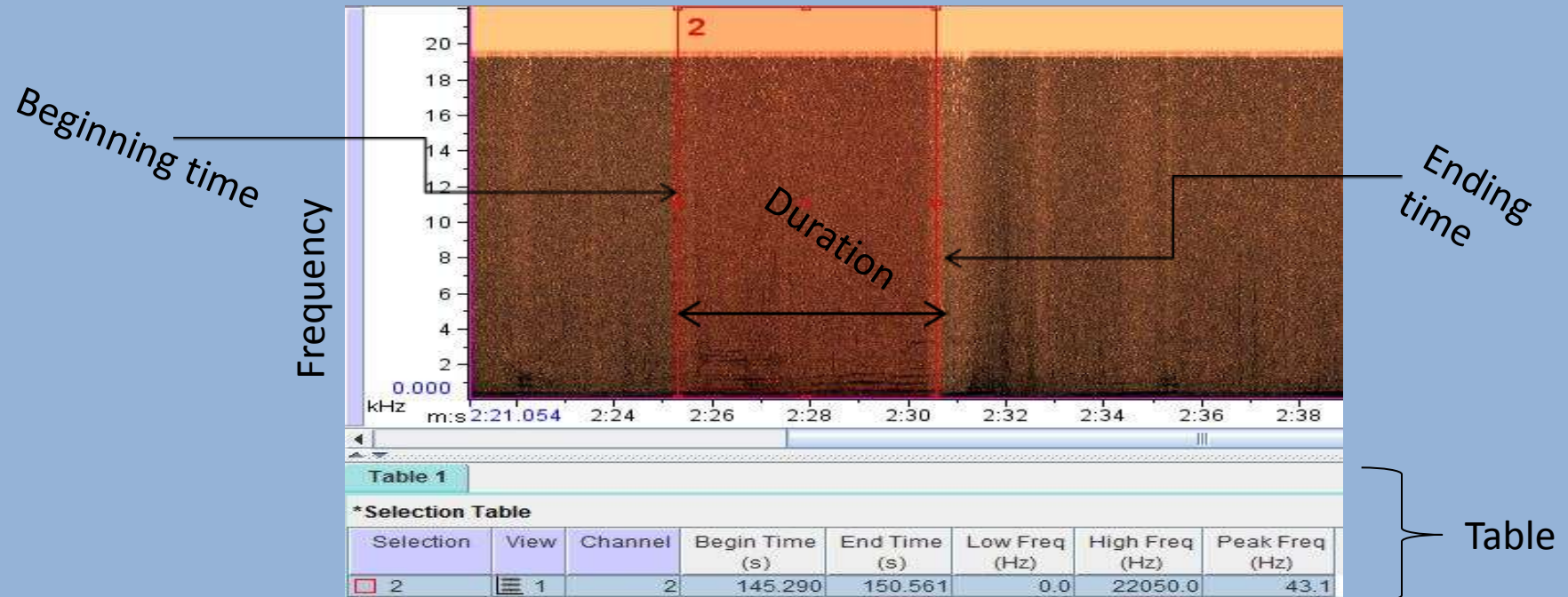
Methodology

- Data collection: 7-8 hours per day, 20 days, Aug-Oct, 2013.
- High Tech HTI-96-MN hydrophone
- Audio Micro track II digital recorder
- GPS
- Weather conditions Bureau Sea State (BSS)



Cont.

- Data Analysis
 - Raven Pro 1.4 (Cornell Lab Ornithology)
 - Spectrogram



- Beginning and ending time (s), Duration (s), Low, High and Peak Freq. (Hz).
- Individual distinctive sounds were classified according to the changing of the Peak Frequency.
- Statistical Analysis
 - R software

Results

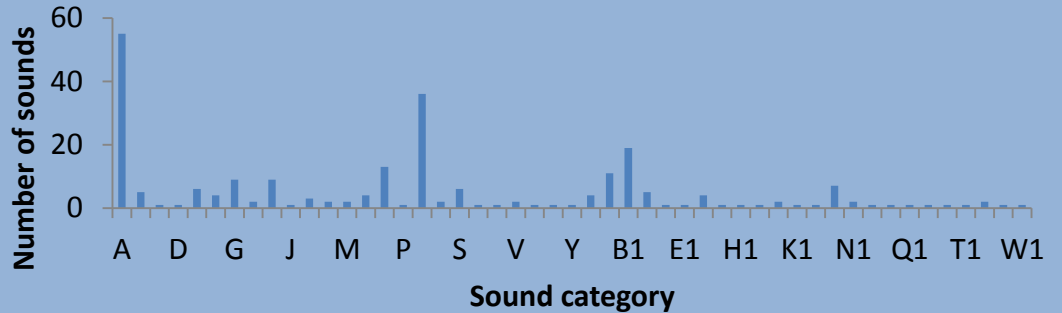
Overall summary

Tracks	20
Sound Types	71
Total # of sounds	3172
Highest Peak freq. (Hz)	3273
Lowest Peak freq. (Hz)	21.5

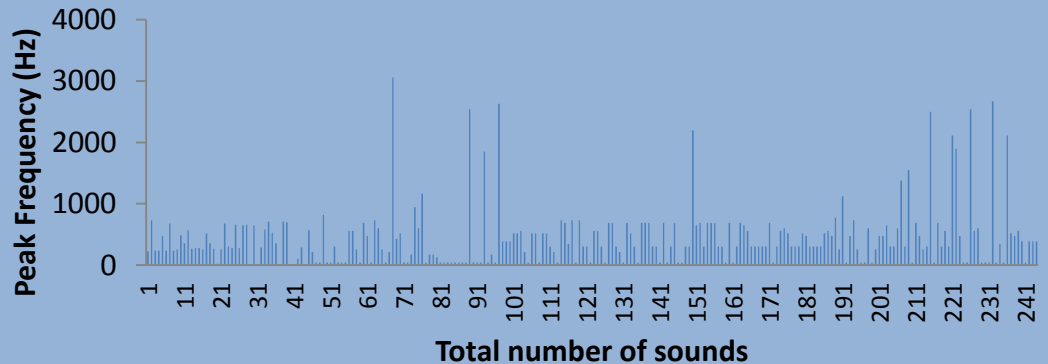
Song 1

Sound Types	Number of Sounds	Peak Freq. (Hz)
A	55	43.1
B	5	646
C	1	818.3
D	1	226.1
E	6	732.1
F	4	236.9
G	9	473.7
W1	1	2670.1

Sound Types versus no. of sounds



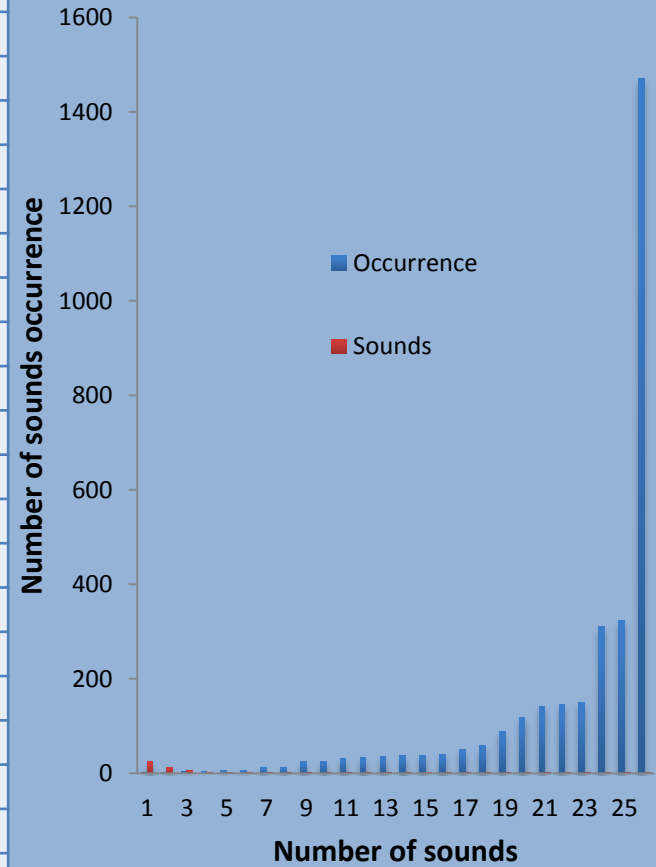
No. of Sounds versus Peak Freq. (Hz)



Cont.

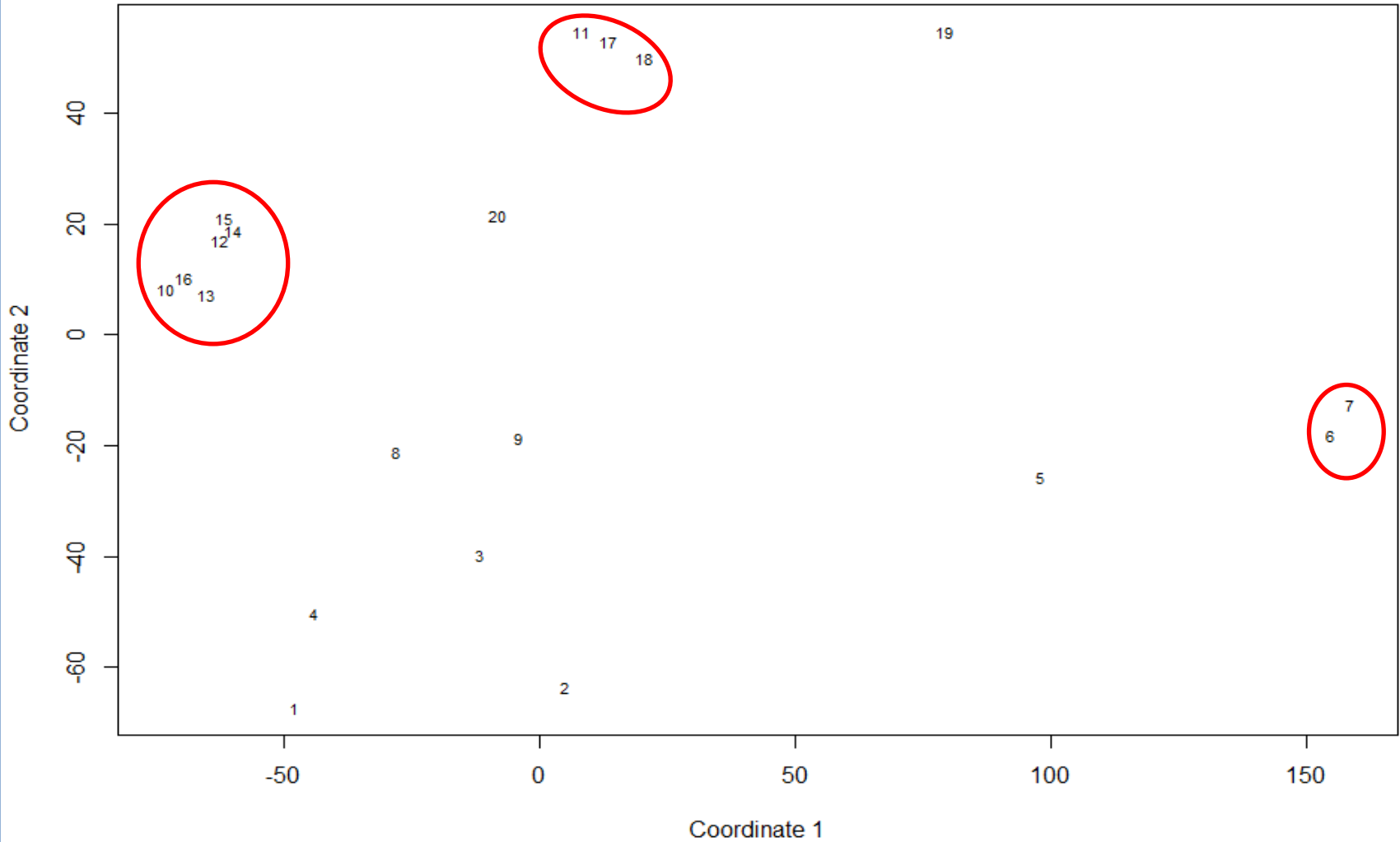
Count (occurrence)	Frequency (#_of_sounds)	Sounds
1	26	D,J,T,U,W,X,D1,H1,K1,L1,O1,S1,T1,V1,W1,X1,Y1,A2,B2,C2,D2,G2,K2,L2,N2,O2,
2	13	H,L,M,R,V,Y,G1,J1,Q1,R1,F2,P2,R2
3	5	K,U1,I2,M2,S2
4	2	Z1,Q2
6	2	S,J2
7	2	C,F
12	1	N
13	1	P1
24	1	H2
26	1	E
32	1	C1
34	1	B1
36	1	E1
37	1	B
38	2	O,E2
40	1	G
50	1	F1
58	1	A1
89	1	Z
119	1	I1
142	1	I
145	1	M1
149	1	P
310	1	Q
324	1	N1
1471	1	A

Sounds versus Occurrence



Cont.

Metric Multidimensional scaling of humpback whale sound samples



Discussion

- High variability in number and occurrence of sounds within humpback whale song tracks
- Song structure:
 - Individual sounds described
 - Patterns of individual sounds (phrases) characterized
 - Method for identifying similar sound tracks achieved. Further work will outline themes.
- Field work – 2014 migration period. Additional data – 2012 collected. Together these datasets will provide a comprehensive review of Tongan humpback whale song.

Cont.

- Applications:
 - Regional and national song structure ---> population structure
 - Management implications for whale watching industry and mining exploration in the Tongan EEZ
 - Implements the 2013-2017 Pacific Islands whale and dolphin action plan (SPREP and CMS) as well as Tonga's National Biodiversity and Strategic Action Plan

Thank You and Malo 'Aupito

