Tagging Hawaiian Humpback Whales: Assessing Approach Methods to Gather Social Sounds and Expand Ethogram Data

Ann Zoidis[1,2], Maren Anderson[1], Kate Lomac-MacNair[1], Kerri Seger[3], Andrew Day[1], and Thomas F. Norris[4]
[1]Cetos Research Organization, Bar Harbor ME/Oakland CA,[2]Tetra Tech, Oakland, CA, [3]Univ. of New Hampshire, Durham, NH, [4]Bio-Waves, Inc., Encinitas, CA

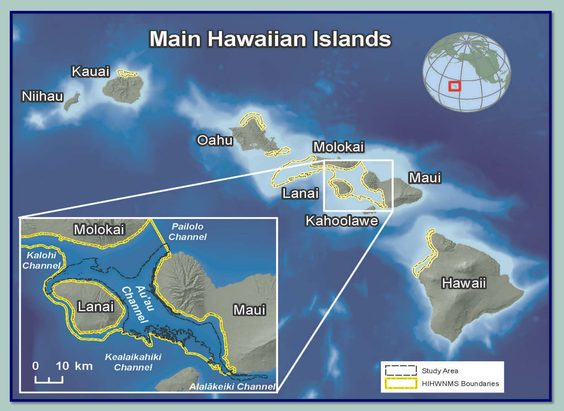


OBJECTIVES

1) Develop and test data-logger tagging methods (Burgess 2000) with our prototype GPS tag in combination with underwater videography and B-probe acoustic tags
2) Build on previous tagging methods performed and outlined by Stimpert et al. (2012)
3) Expand knowledge of humpback whale social calls in mother/calf pairs.

ABSTRACT

Since 2003, we have collected an audio-visual dataset on Hawaiian humpback whale (*Megaptera novaeangliae*) behaviors and social sounds using underwater videography and have established successful snorkeling protocol for in-water approaches. A primary goal was to develop an underwater ethogram for humpback whales in the Hawaiian Island breeding grounds to improve our understanding of their sub-surface behavior and associated calls, particularly for mother-calf pairs. In 2015, we incorporated acoustic tags to complement underwater videography to expand available data sources for the ethogram. We combined the tagging approach protocols of Stimpert et al. (2012) with our previously successful approach strategies for both vessel and in-water snorkeling. We attached 6 tags; 1 on a mother, 3 on calves, and 2 on competitive pod adults (1 with a mother/calf pair). When a tagging approach is successful, behavior data are acquired and social sound data can be collected that not only contributes to knowledge about the social sounds produced by a tagged whale and its proximate conspecifics, but also expands the efforts of a current internationally- collaborative cataloguing effort to document the variation of social sound repertoires across all humpback whale subpopulations. From just a single tag in Maui deployed Feb 17, 2015, on a mother with her calf that stayed on for 4hr7m, 27 different types of social calls were recorded: one of which is unique to Maui as compared to Mexico (24 in common), Alaska (8 in common), and Australia (21 in common). Tagging data are scarce, so raising the odds of a successful tagging event is critical for expanding datasets and increasing their statistical power when trying to measure social call variation later.

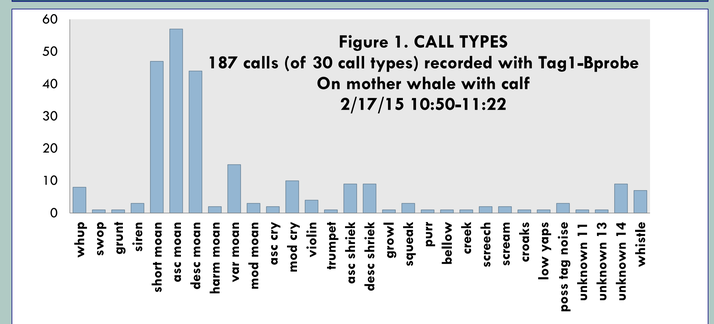


RESULTS

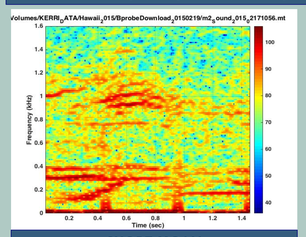
From Feb 16 – 23, 2015 we successfully attached 6 tags: 1 on a mother, 3 on calves, and 2 on adults of competitive pods (one with a mother/calf pair). Of the 6 deployed tags we retrieved four; 1 was lost and 1was destroyed (Table 1). Our experimental mini-GPS watch tag was deployed in 4 of 6 successful tag attachments.

For Feb 17 Tag1-Bprobe on a mother from 10:50 -11:22 (32 minutes):

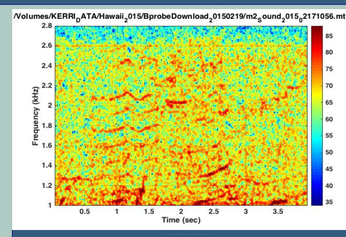
- 187 calls of 30 call types were detected (Fig. 1)
- 24 of these types are common with the Los Cabos breeding ground; 8 are common with the Alaska feeding ground, and 21 are common with the eastern Australian migration route.
- Call type unique to Hawaii ("unknown 14").
- Call rates varied across 5-min segments (3.4, 20, 6.2, 3.8, 1, and 5 calls/min, sequentially). Average rate = 5.8 calls/min.



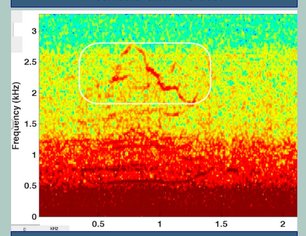
CALL TYPES (in order of appearance)
descending shriek (9), ascending shriek (9), modulated moan (3), unknown 14 (9), variable moan (15), ascending moan (57), siren (3), descending moan (44), screech (2), grunt (1), short moan (47), harmonic moan (2), low yap (1), growl (1), creek (1), violin (4), "possible tag noise" (3), unknown 13 (1) bellow (1), whistle (7), whup (8), modulated cry (10), unknown 14 (4), croak (1), swop (1), purr (1), trumpet (1), unknown 11 (1),ascending cry (2)



SHORT MOAN
A "short moan" between 0.8 and 1.2 kHz recorded at 11:00:01 on Feb 17th in Maui. The "short moan" has also been recorded in Australia and Mexico.



VIOLIN
A "violin" with several tones between 1.2 and 2.6 kHz at 11:01:13 on Feb 17th in Maui. The "violin" has also been recorded in Alaska and Mexico. Spectrogram truncated to eliminate more intense song units below 1.2 kHz.



UNKNOWN 14
A sample of the unknown 14 call type recorded at 10:53.16 AM on February 17th in Maui

Figure 2. CALL TYPES by %

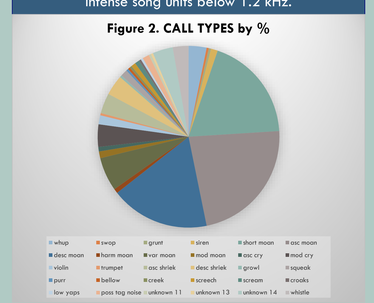


Table 1. Summary of Tag Deployments

Date	Tag Type	Total Tag Duration (h:mm)	Duration Usable Data (h:mm)	Tag Retrieved (Y/N)	Whale
17-Feb	B-probe (no GPS mini-tag)	5:00	4:10	Yes	Mother
17-Feb	B-Probe (with GPS mini-tag)	5:26	4:24	Yes	Mother
18-Feb	GPS mini tag	4:02	0:00	No (destroyed)	Calf
20-Feb	B-probe (no GPS mini-tag)	4:10	0:00	Yes	Adult (Comp group)
23-Feb	GPS mini tag	0:02 (attempt 1) 1:08 (attempt 2)	0:08	Yes	Calf
26-Feb	GPS mini tag	3:22	0:00	No (lost)	Adult (Comp group)

ACOUSTIC ANALYSES

- ✧ Acoustic data from Bprobe .mt files exported and loaded as spectrograms using the Ulysses GUI from custom MATLAB software (written by Drs. Aaron Thode and Jit Sarkar)
- ✧ 30-second spectrograms saved as PNG image files and vocalizations visually color-coding by type.
- ✧ Vocalization color-coding that followed an oscillating pattern were defined as song units and discarded from further analyses.
- ✧ Remaining sounds that were not masked by flow noise or other vocalizations were annotated in Ulysses and named using the international working social call catalogue discussed in Seger (2017).
- ✧ 11 parameters automatically calculated: min freq, max freq, noise SE dB, noise RMS dB, noise peak PSD dB, signal SE dB, signal RMS dB, signal peak PSD dB, SNR RMS and SNR RMS dB; and 5 parameters measured by hand: "Hz separation" (bandwidth between harmonics), number of inflections, "6 dB slope" (slope call portion at least 6 dB above background noise), number of harmonics, and number of pulses in trains.

DISCUSSION & CONCLUSIONS

- ✧ The unknown 14 call type is unique to Hawaii insomuch that they have not yet been discovered in data from the social sound working group researchers in Mexican, Alaskan, Ecuadorian, nor Australian waters (Seger, 2017; Javier Ona, pers. comm.)
- ✧ Humpback whale cue rates are not stereotyped, meaning they would not be good candidates for cue rate-based density estimation.
- ✧ The presence of a calf in the tagged group likely contributes to the variety of call types used in a short period of time, unlike in competitive groups (which use fewer call types less often). This supports observations in Mexico (Seger, 2017).

METHODS & TAGGING APPROACH

- ✧ 30 minute observation period used to assess baseline behavior of pod prior to tagging.
- ✧ B-probe data-logger acoustic suction-cup tag deployed on mothers and escorts.
- ✧ Prototype 'mini' GPS archival tag with suction-cup and Garmin 'Forerunner' watch deployed on mother and calves.
- ✧ Tested and documented various approach methods attempted to determine best approach for resting mother/calf pairs. Divers in water with tagged ani

Approach Technique:

- Slow approach methods used on resting mother/calf pairs or mother/calf/escort groups yielded most reliable attachments.
- Approaches on traveling mother/calf pairs or mother/calf/escort groups rarely resulted in successful tag attachment. Evasive maneuvering, breath-holding and increased speed were observed in these pairs/groups.
- Any speed approach on competitive groups (comp pods) usually resulted in successful tag attachments, regardless of boat speed.

Tag Attachment:

Once animal was in range of tagging pole, the scientist tagging reached over side of boat with one arm towards animal. Once the suction cup had made contact with the whale, the tagger pulled 180° opposite to the tagging direction (90° in towards animal, and 90° in the opposite direction of tagging) in order to release the tag from the PVC holder on the end of the tagging pole.

ACKNOWLEDGEMENTS

All research was conducted under permit #14353. This study would not have been possible without the support and involvement of Dr. Aaron Thode and Brooke Hawkins at Scripps Institute of Oceanography. We would like to thank the following people for their project and field support: Terry McCabe, Dave Steckler, Mari Smultea, Athena Corcoran Tadd, and Charlie Bishop. All work was completed with private funding.