Detecting Blue Whale Calls By Extending a Speech Processing Algorithm: A Proof-of-Concept

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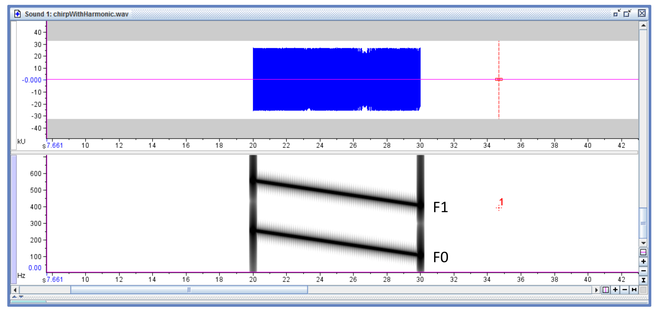
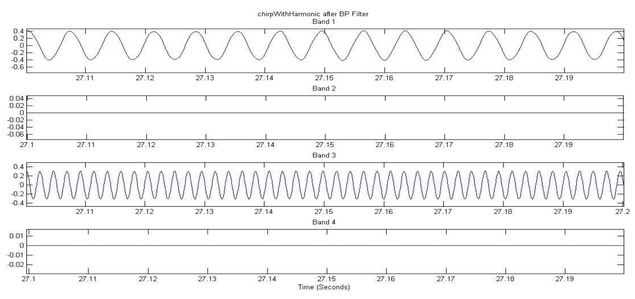
Demo using speech signal processing algorithm



This synthetic signal is the sum of two chirps, labelled F0 and F1.

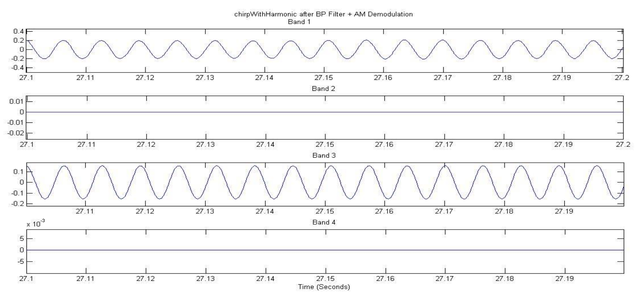
Band-pass filter into sub-bands



A filter bank decomposes the signal into sub-bands. Note that each band has a different amplitude scale. Zooming in on a small time window, we see that F1 does not correlate well with F0--because they are in different frequency bands. However, what if we were to treat each band as an AM "channel"?

AM-demodulation per band transforms each component to the "base band".

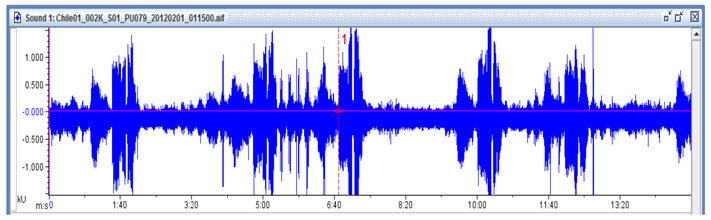
(It's as if each "base-band" signal got into its band by AM-modulating that band's carrier frequency.)



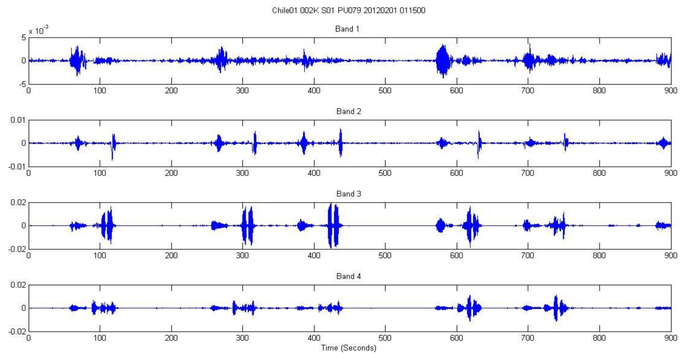
After band-pass filtering and AM-demodulation per channel, the "base-band" of F1 now correlates well with the "base-band" of F0. Even if the signal is degraded by multi-path, there should still be correlation between the "base-band" components (i.e. after band-pass filtering and AM-demodulation).

This approach was inspired by a speech signal processing technique, where each "formant" of a vowel is modeled as an AM/FM-modulated waveform. What's new *here* is to ***use this speech signal processing trick to improve detection***. So, the detection algorithm can take advantage of an inherent attribute of the bioacoustic signal--the fact that its "base-band" components are correlated in time.

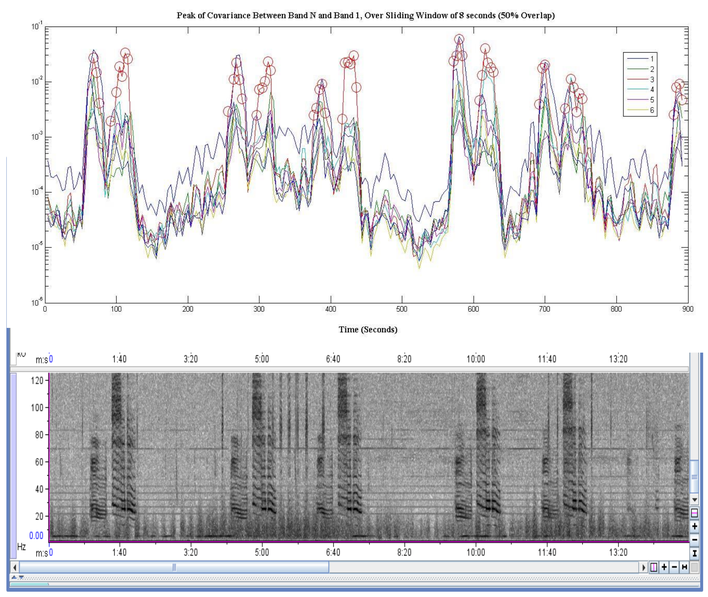
Blue Whale calls with broadband noise



Band-pass Filter followed by AM-demodulation per band

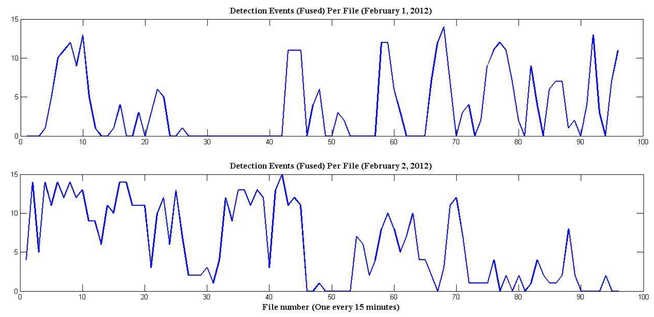


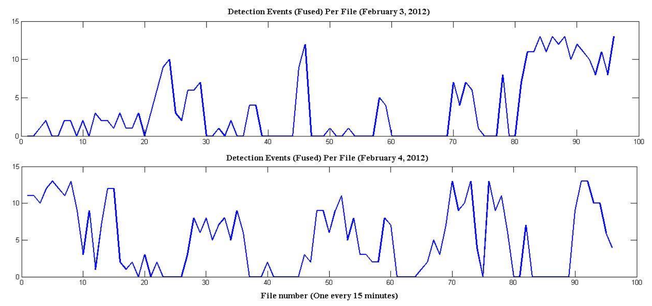
Apply Detection Rule, based upon Covariance Between Bands N and Band 1



The detection algorithm detects the whale calls but not the broadband noise. The algorithm looks for a specific pattern of covariance across the bands. For this signal, band 3 is well-correlated to band 1 AND the other bands are NOT as well-correlated to band 1. So, we look for this pattern. Occurrences of the pattern are circled red.

Detection Events Over Four Days





Detection Events are "fused", meaning they are counted here only if they are separated by more than 2 consecutive intervals (i.e. more than 8 seconds apart).

ACKNOWLEDGEMENTS:
Thanks to Dr. Laela Sayigh for providing the whale recordings, which were acquired in collaboration with the Melimoyu Ecosystem Research Institute in February of 2012