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Computer-aided detection of non-stereotyped bowhead whale calls in the presence of seismic airgun signals

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In 2007 thirty-five autonomous recording packages were deployed over a 150 mile swath in the Beaufort Sea to monitor the annual migration of the bowhead whale (*Balaena mysticetus*) population during seismic exploration activities. Over 1350 days worth of acoustic data were gathered, generating a need for computer-aided assistance in detecting calls. Bowhead whales produce over ten types of frequency modulated calls, and the frequency range, duration, and fine structure of individual calls vary considerably even within each call type, creating difficulties when using simple matched-filtering or spectrogram correlation. Numerous airgun signals also display frequency-modulated structure, complicating the challenge. In this presentation a three-stage process is presented for detecting arbitrary bowhead whale calls in the presence of seismic airgun signals, implemented in JAVA and MATLAB, with components extracted from the industry-supported PAMGUARD software package. The first stage runs several "energy-based" detectors simultaneously across multiple frequency bands to capture events, and a second stage analyzes the timing of these detections to remove regular periodic sequences, such as those expected from airguns. The final stage attempts to trace contours on spectrograms. Both genetic algorithms and direct optimization are used to optimize the program's 21 input parameters. [Work supported by Shell Exploration and Production Company].