Characterizing the soundscape of the western edge of the Gulf Stream off the coast of Cape Hatteras, NC

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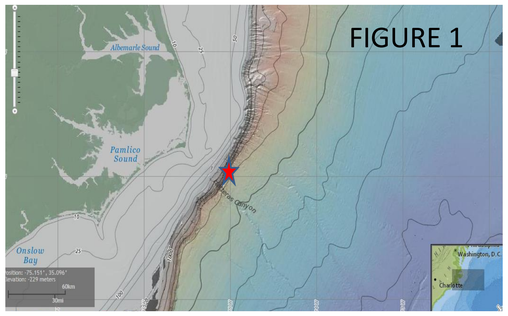
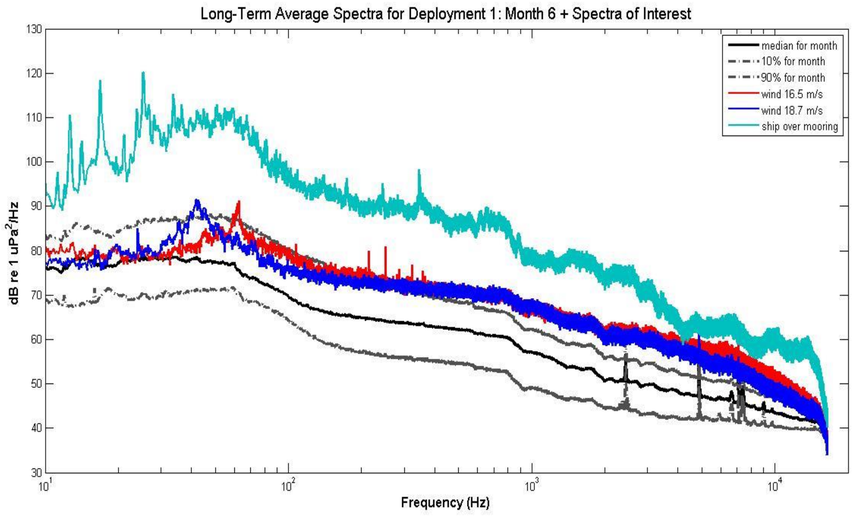


FIGURE 1

The North Carolina Renewable Ocean Energy Program (NCROEP) has been exploring the prospect of sustainably harnessing Gulf Stream energy off the coast of Cape Hatteras, North Carolina, USA. Characterizing the soundscape in this region is one of the environmental and ecological assessment goals of our program. Here, we present results of a 16-month soundscape characterization--including statistics of the spectra, the temporal patterns of marine mammal whistles, and an acoustic propagation model.

We deployed a hydrophone from late January 2015 to late April 2016, on a mooring at at 35°6’ N, 75°5’ W at a depth of 230m. The Multi Electronique Aural-M2 hydrophone was configured to sample at 32,768 samples/second, recording for 5 minutes out of every half-hour.

FIGURE 2

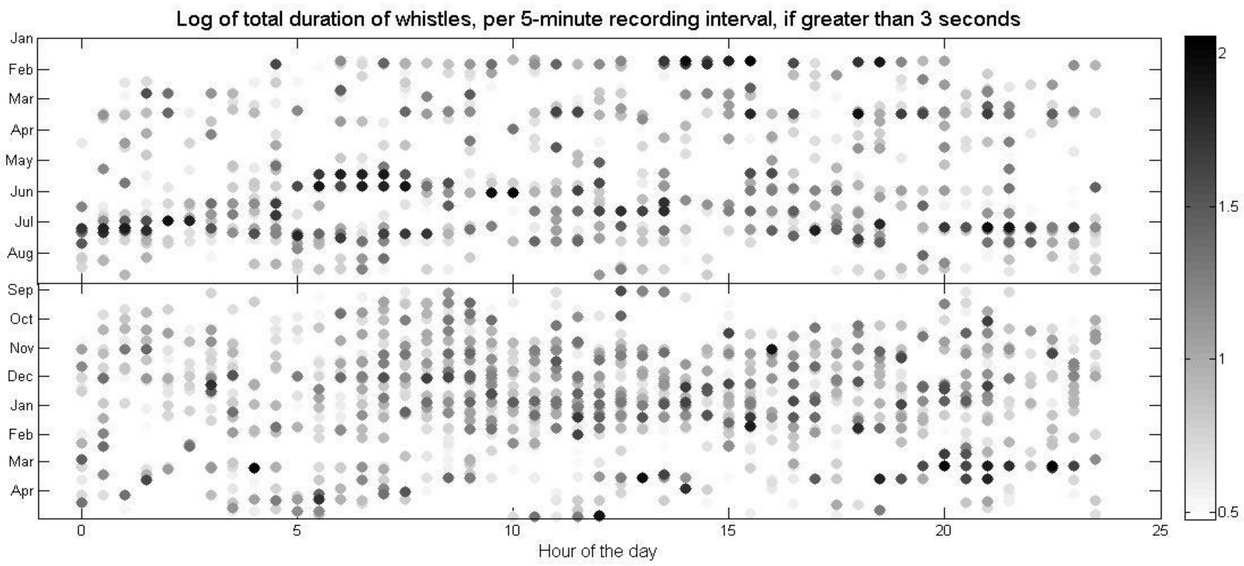


In Figure 2, Long-Term Average Spectra (LTAS) were calculated for each 5-minute recording interval, using an analysis window of 8 seconds. This figure shows statistics for an ensemble of LTAS for a representative month, July 2015. Statistics include the median (black), and 10- and 90-percentiles (gray).

Figure 2 also shows the LTAS for specific recording intervals when the winds were strong at the surface (red, blue) and when our research vessel was underway directly over the mooring (turquoise). **It appears that such loud ship noise is a relatively rare event at this location.** *Note that actual sound levels are based upon factory calibration levels, not field calibration*.

Previous studies have shown that many species of marine mammals inhabit the waters off North Carolina. Our recordings do include many marine mammal vocalizations—high-frequency clicks and whistles as well as a variety of low-frequency vocalizations. For example, Figure 3 shows the temporal pattern of whistling in the frequency range 2 kHz – 16 kHz for both deployments. In this figure, each 5-minute recording interval is color-coded based upon the log of the total duration of whistling (in seconds) during that interval. Recording intervals are included in this plot if there was more than 3 seconds of whistling during the interval. Marine mammal whistles were detected using Silbido. At an SNR threshold of 10 dB, Silbido’s false alarm rates are estimated to be very low—less than 10%. There were some false alarms due to 12kHz echosounders, and these were removed in post-processing.

FIGURE 3



ACKNOWLEDGMENTS:
This project was funded by the North Carolina Renewable Ocean Energy Program. We also acknowledge the support of Dr. Robert Todd of WHOI for his glider data, a transect of the western half of the Gulf Stream near our mooring, acquired in January of 2016.

FIGURE 4

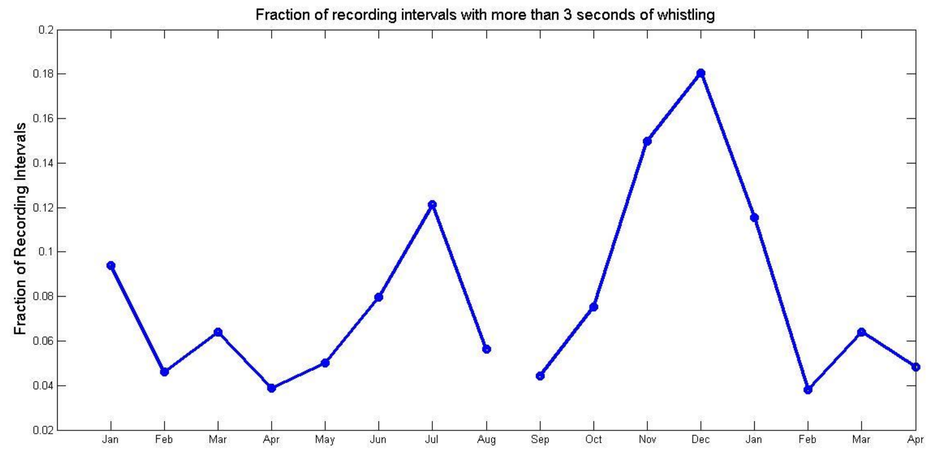


Figure 4 summarizes the data in Figure 3, showing the fraction of recording intervals per month (for both deployments) having more than 3 seconds of whistling.

FIGURE 5a

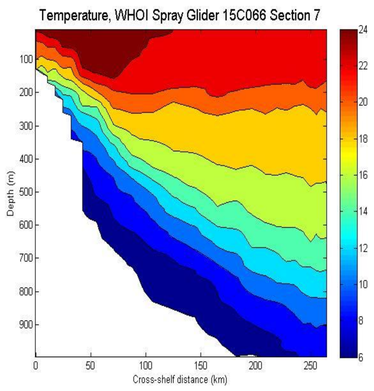


FIGURE 5c

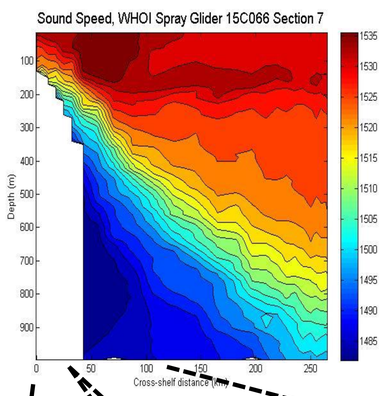
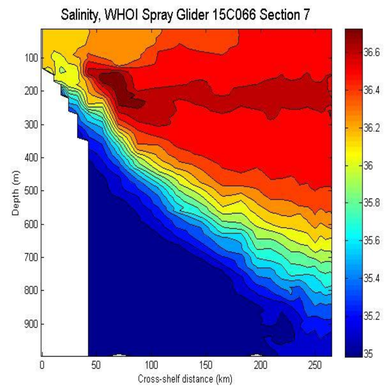
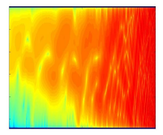


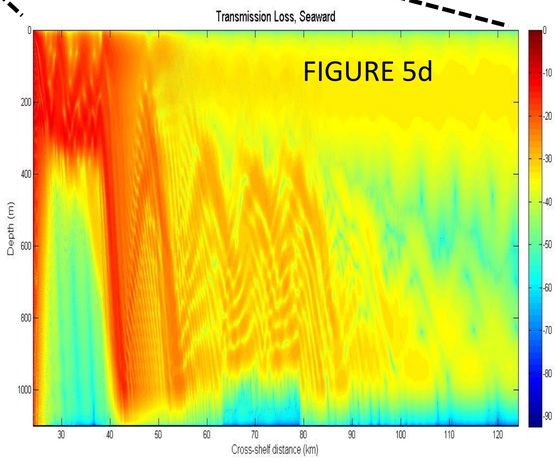
FIGURE 5b





Transmission Loss, Shoreward

FIGURE 5d



Using temperature (Figure 5a) and salinity (Figure 5b) from a nearby glider transect, we derived sound speed profiles (Figure 5c). Using RAM, we then derived transmission loss as a function of range and depth (Figure 5d). With a sound source of 75 Hz at a depth of 200m (30m above our mooring), sound propagating seaward is confined to two channels, where the transmission loss at a range of 100km is only about 40dB.

CONCLUSIONS:

Previous studies have shown that many species of marine mammals inhabit the waters off North Carolina. In fact, we recorded marine mammals whistling every month, with peak activity in July and December. Anthropogenic noise is also present, but rarely loud, as suggested by a statistical analysis of the spectra. This may not be the case if a new anthropogenic noise source is introduced. There is some risk that a constant, low-frequency source of noise at this location could potentially impact marine mammals for a great distance, as suggested by a propagation model. Further research would be needed to quantify this risk.