

Characterizing Traffic on The Charles River with Sound

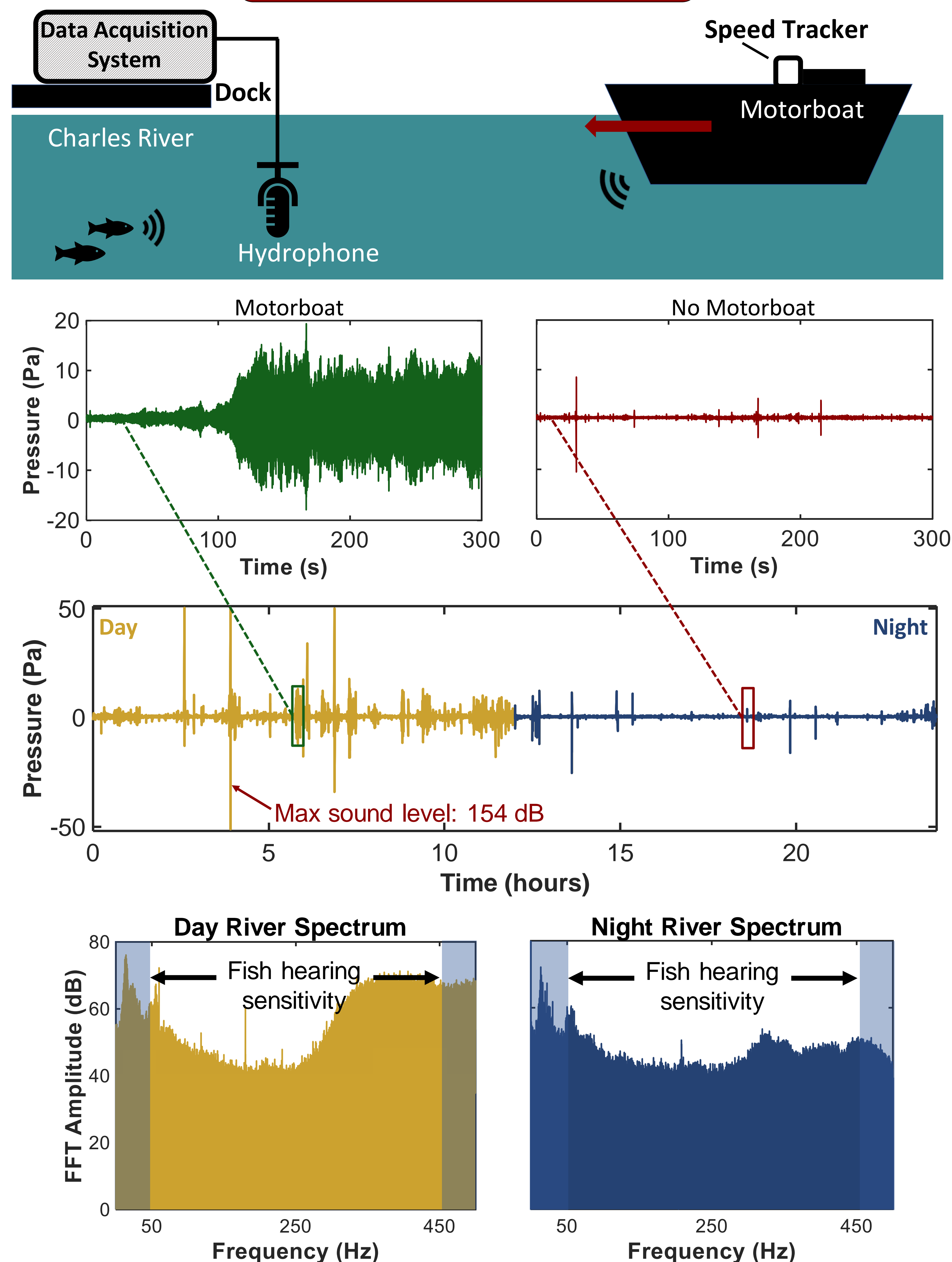
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2.671 Measurement and Instrumentation

Abstract

In order to test the feasibility of a single hydrophone monitoring system for anthropogenic sounds, ambient sound levels of the Charles River over a week and specific acoustical signals of motorboats driving past the hydrophone at varying speeds were recorded and examined. Averages of recordings taken during the day (7am-7pm) and night (7pm-7am), were compared and showed a significant difference in ambient noise while also indicating that noise levels were below fish-harming thresholds. Cross-correlations between specific motorboat signals and ambient data, as well as analysis of Doppler shifts in spectrograms of motorboat speed tests suggest extracting traffic data via hydrophone implementation is possible. These results show that a single hydrophone may be used as a simple, low-cost, and versatile data collection tool.

Experimental Setup



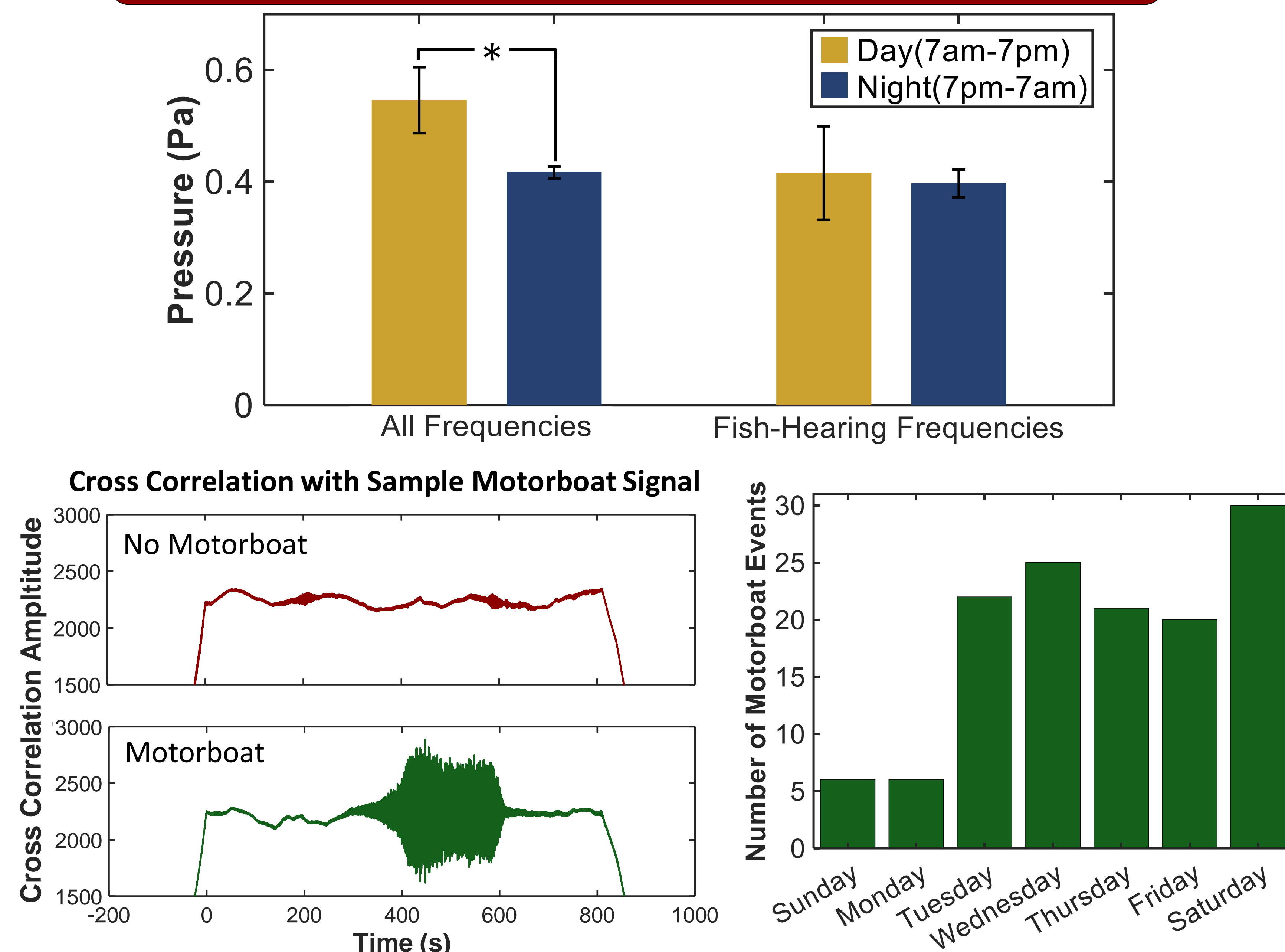
Acknowledgements and References

I would like to thank Professor Hughey and Professor Peacock for all of their help through the project. I would also like to thank Stewart Craig and Hannah Agate, the dockmasters at the MIT Sailing Pavilion, for allowing me to use their facilities for experimentation. Finally, I'd like to thank my phone for collecting GPS data and which due to an unfortunate accident is now at the bottom of the Charles River.

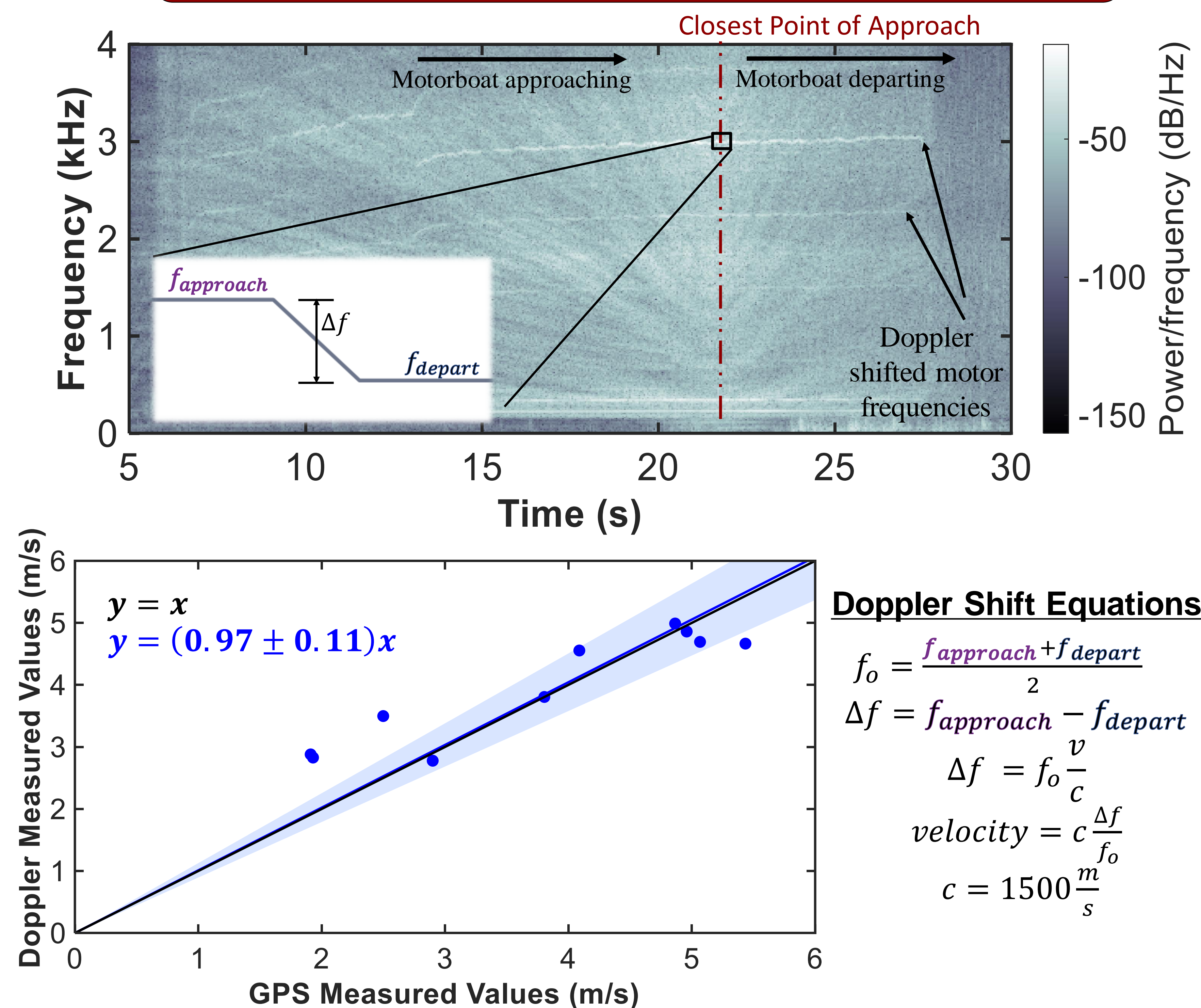
[1] https://www.pngitem.com/middle/ixJRbRh_drawn-yacht-speed-boat-boat-coloring-page-hd/. [Accessed: 22-Nov-2021].

[2] Popper, A. N., and Hawkins, A. D., 2019, "An Overview of Fish Bioacoustics and the Impacts of Anthropogenic Sounds on Fishes," J. Fish Biol., **94**(5), pp. 692–713.

Ambient Noise Measurements



Determination of Motorboat Speed



Doppler Shift Equations

$$f_o = \frac{f_{approach} + f_{depart}}{2}$$
$$\Delta f = f_{approach} - f_{depart}$$
$$\Delta f = f_o \frac{v}{c}$$
$$velocity = c \frac{\Delta f}{f_o}$$
$$c = 1500 \frac{m}{s}$$

Conclusion

- Although there is a difference between day and night ambient sound levels within all frequencies, there is no difference within fish hearing frequencies.
- Maximum sound levels during motorboat events reached 154 dB, above the 150 dB threshold for fish-harming sound levels [2]. The Charles River may not be a safe environment for fish close to motorboats.
- Measurements from a low-cost one-hydrophone setup can be used to reasonably obtain nearby river characteristics such as noise levels, boat traffic measurements, and speed of motorboats.