PARAMETRIC ALARMS PROTECTING MANATEES

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ABSTRACT
Manatees have difficulty detecting the dominant low frequency noise of approaching vessels in their shallow water habitats. Speed restrictions do not address the underlying acoustical causes for collisions. Ironically, this strategy can be counterproductive in tidal waters and exacerbate the problem. It makes vessels more detectable or repositionable for manatees while increasing their transit times, and thus the opportunities for collision. After more than a decade of slow speed zones, and millions of dollars spent on this project, manatee watercraft collisions and related injuries have reached record heights. Though manatees can detect the low frequency waterborne noise, they are well adapted for hearing higher frequencies which propagate effectively in the environment. This hearing sensitivity provides a sensory window through which to alert manatees of approaching vessels. Understanding their hearing abilities is critical to predicting their reaction to this form of disturbance. By understanding the hearing abilities of manatees, we can predict their reaction to this form of disturbance. This research was funded by the National Marine Mammal Foundation and the Manasota-Karoo National Estuarine Research Reserve.

MATERIALS AND METHODS
ACOUSTIC Buoys
To both audible and acoustically grid-shifted low frequency, bright yellow flotation buoys are fashioned. These buoys are instrumented with continuously monitored GPS (Global Positioning System) data loggers and a water level sensor. The data loggers were assembled using a combination of the US Navy’s AN/USQ-9A acoustic Doppler Current Profiler (ADCP) and a low frequency US Navy U/P-373 hydrophone suspended 1.5 m from the surface (Figure 2). USG P37 hydrophones are evaluated on a 6 month frequency range of 50 to 27 Hz at 1/3 octave bands. The Grid-Shifted data loggers were instrumented with buoy level sensors and a combination of 60 noisemaking buoys were deployed at varying distances, distances ranging from 100 to 150 m between 9 a.m. and 10 a.m. Each buoy level sensor was connected to a single-point pressure sensor on the bottom of the water column.

BACKGROUND
Manatees are adapted to hearing the dominant low frequency spectra from watercraft, water surface propagation characteristics and shallow-water transmission loss, in concert with the manatees’ unique auditory constraints, are underlying sensory causes for the collisions with boats and slow moving barges. Slow speed zones implemented to protect manatees do not address these underlying acoustical causes for collisions. Ironically, this strategy can be counterproductive in tidal waters and exacerbate the problem. It makes vessels more detectable or repositionable for manatees while increasing their transit times, and thus the opportunities for collision. After more than a decade of slow speed zones, and millions of dollars spent on this project, manatee watercraft collisions and related injuries have reached record heights. Though manatees can detect the low frequency waterborne noise, they are well adapted for hearing higher frequencies which propagate effectively in the environment. This hearing sensitivity provides a sensory window through which to alert manatees to approaching vessels. Understanding their hearing abilities is critical to predicting their reaction to this form of disturbance. By understanding the hearing abilities of manatees, we can predict their reaction to this form of disturbance. This research was funded by the National Marine Mammal Foundation and the Manasota-Karoo National Estuarine Research Reserve.

APPROACH
The purpose of the study is to evaluate the efficacy of an audible acoustic alarm for alerting manatees of approaching watercraft. The research has been documenting the behavior of wild manatees prior to, during, and after controlled boat approach trials. The experimental conditions are being tallied. (1) boat approaches without an audible alarm, (2) boat approaches using the same boat with an alarm, control observations are recorded prior to any boat approaches, or at least 30 minutes after any boat approach trials, are continuing this year in the Bahama River within the USFWS-Managed Island Wildlife Refuge (RI inhabitant), adjacent to the Bahama Kings Reef (5) and the Manatee Conservation Area (CMAA), Brevard County, Florida. The MIAWMO site is in a relatively isolated area, where public disturbances is not permitted. We predict the Manatee’s conditions controlled with two antidepressants and related acoustic variables are different from the behavior and behavioral variables, controlled with audible acoustic buoys, synchronized with video recorders document manatee behavior and the associated acoustic conditions, during control and experimental conditions.

PARAMETRIC ALARMS
A broad band, high directional, dual frequency parametric array was developed to reduce collision risks by alerting animals in the direct path of approaching vessels. The parametric transducer operates at a frequency of 12 kHz under the surface of the water for distances of up to 100 m. The manatee sensing is being practiced at very low energy levels, the device has been developed to exploit the manatee’s audible hearing abilities, therefore. The parametric transducer array (Figure 31a) was created to provide a high directional alarm with an effective range such that it would result in minimal drag on the smaller boats that the manatees. The 300 x 300 cm array transducer is a long-range, high frequency waveguide array to the manatees. The resulting parametric array which is a parametric element makes within their hearing range of 10 to 20 kHz. As shown in Figure 31b, the parametric array transducer generates very narrow 6.9 acoustic beam which directly alerts the animal. The result for such a directional device is to ensure that only individuals in the direct path of an approaching vessel is alerted. This requires that manatees are alerted only when they are not at risk of an ambient sound (the narrow beam and high frequencies also minimize any possible contributory noise impacts of multiple disturbance).

APPROACH BOATS
Two approach boats have been used for this study. The first is a 25 ft pontoon boat modified with an electric outboard engine, a bow with lowered observation platform, and in all 10 high frequency video cameras mounted on the bow (Figure 5). The boat serves as an approach and observation platform. It provides a stable forward sensory view of the direct boats. The manatees are present within the auditory range of the sound, the boats are not present or approach trials, at least 10 minutes directly ahead of the approach trials. The speed limit prior to the noise did not exceed 1 5 m/s.

CONCLUSION
Manatees do not react, and are unable to detect the sounds of approaching boats traveling at low speeds. The manatee’s low frequency hearing is not adapted to detect the measured shallow water and near source propagation parameters, neither these sounds are sufficient to provide the sounds against the ambient noise. The heard sounds would not provide the manatees with sufficient information to detect the boat sound.

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