

Impacts of noise pollution associated with the ULTRA Music Festival on fish

UM scientists, Drs. Berenshtein, Cartolano, Heuer, McDonald, Paris-Limouzy, and Grosell propose to conduct a series of controlled experiments in combination with field monitoring to quantify the impacts of noise pollution from the 2019 ULTRA Music Festival to take place in Virginia Key in March. The research team is committed to providing an objective report of their findings no later than 40 days after the concert and is committed to producing a peer-reviewed publication reporting the results of the study. Typically, the University of Miami requires that a portion of research grants awarded to scientists are allocated to institutional operating costs. However, in this unique case, the University of Miami has agreed to waive these costs in order to ensure maximal research value of the requested funding for this local issue. In the following, we outline experiments that will be performed prior to, during, and after the event.

I. Controlled experiments

The Gulf toadfish (*Opsanus beta*), a local and benthic species, will be used for these experiments for three primary reasons. First, toadfish play an important ecological role in the local environment as they are a common prey item for sentinel species such as dolphins. Second, toadfish vocalizations contribute to the local marine soundscape and they rely heavily on their hearing for reproduction, social interactions, and predatory avoidance. Third, toadfish have well-characterized responses to stress that our research team has studied extensively. The proposed experiments will utilize the very sensitive stress response of toadfish to determine the impacts of noise from the music festival by measuring fluctuations in stress hormones (cortisol and ACTH) found in blood.

Toadfish will be placed in holding tanks at the UM Experimental Hatchery immediately adjacent to the Virginia Beach Park weeks prior to the concert in March and blood will be sampled after a sufficient acclimation period to obtain baseline levels of stress hormones. These baseline levels are expected to be low and similar to those of wild fish. An additional set of fish will be held under identical conditions immediately before, during, and after the ULTRA Music Festival, and their blood will be sampled during peak intensity of the festival. Elevated stress hormone levels in samples from these fish will indicate stress in response to the event. Sampling one week after the festival will also allow us to determine if the stress response can recover after three continuous days of noise pollution. For these experiments, sound will be recorded adjacent to, and in the toadfish holding tanks in order to match stress levels to sound intensity.

II. Field monitoring

Underwater sound recording devices (hydrophones) will be also be deployed in two places to obtain before, during, and after soundscapes. First, recordings from Bear Cut directly in front of Virginia Beach Park will quantify and document the magnitude of noise pollution coming from the event. These recordings will be compared to baseline recordings collected before the festival to determine the level of noise pollution that wild fish endured. Additionally, we will compare these recordings to those obtained from toadfish experimental holding tanks to more broadly estimate stress induced in wild fish in Bear Cut during the event. Second, recordings in “Jimbo’s Lagoon”, located east of Virginia Beach Park and generally void of boat traffic, are intended to capture the natural sounds produced by Gulf toadfish and other marine organisms in this area before, during, and after the event. Studies on Gulf toadfish and other fish species have demonstrated reduced vocalizations in response to noise pollution and our field

monitoring will allow us to determine if the noise associated with ULTRA altered the natural marine soundscapes surrounding Virginia Key.

Sound in water and hearing by fish dictates detailed characterization of sound

The propagation of sound in water differs from that in air. Since air is compressible, land dwelling animals rely on pressure sensing diaphragms, like eardrums, for hearing. In contrast, water is much less compressible and sound results in particle (water) movement in addition to pressure gradients. Consequently, marine organisms both “hear” and “feel” noise in the water and rely on a range of specialized sensory systems to detect fluctuations in acceleration and velocity of their surrounding water to detect sound. Since fish detect mainly particle movement to “hear”, particle movement along with pressure gradients will be determined for pre-event and during event periods from both controlled experiments and field monitoring.

III. Budget

Drs McDonald, Paris-Limouzy, and Grosell are tenured professors at RSMAS and will be responsible for project completion and reporting. They offer their time and expertise at no cost to this project. In addition, existing relevant equipment for sound recording, cortisol analyses, as well as blood sampling is available for the present project. The majority of the requested funds will cover salaries for postdoctoral fellows Drs Berenshtein, Cartolano, and Heuer, who will perform the day-to-day observations before, during, and after the event, as well as the extensive sample and data analyses involved with the proposed work. In addition, a modest supply budget and funds for purchase of additional hydrophones and recorders is requested as detailed below.

| Item | Cost |
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| Salaries (2 months for each postdoctoral fellow) | \$31,793 |
| Hydrophones/recorders (4 at \$500 ea) | \$2,000 |
| Analytical cost of measuring ACTH and cortisol | \$ 1238 |
| General lab supplies (needles, syringes, sample tubes, liquid nitrogen, etc) | \$ 429 |
| Toadfish holding facilities | \$ 300 |
| Experimental fish | \$ 240 |
| Total | \$ 36,000 |