

SOUND, STRESS, AND SEAHORSES: THE CONSEQUENCES OF A NOISY ENVIRONMENT ON ANIMAL WELFARE

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In the design of aquaculture systems, aquaculturists may be overlooking effects of chronic ambient noise exposure from circulation pumps on fish health, growth, and welfare. We examined primary, secondary, and tertiary stress responses to this stimulus in the lined seahorse, *Hippocampus erectus*, as a model ornamental fish species.

Thirty-two seahorses were weighed, measured, and then housed individually in either loud (123.92 ± 0.96 dB re: $1 \mu\text{Pa}$ at mid-level, 143.77 ± 0.51 dB at bottom) or quiet (107.91 ± 0.91 dB at mid-level, 118.41 ± 0.51 dB at bottom) tanks for one month. One-hour weekly behavioral observations were scored and tested with repeated measures ANOVAs. At the end of the trial, animals were euthanized, weighed and measured again. Blood was collected and processed for leukocyte count and differential, PCV, blood glucose, and plasma cortisol (using enzyme immunoassay). Organs were weighed to obtain hepatosomatic and gonadosomatic indices. MANOVAs were employed to compare measures among treatments, sex, and trials.

Animals housed in loud tanks declined in overall morphological indices more precipitously so than in quiet tanks (Wilks' Lambda $p=0.018$); these differences were especially apparent in weight change (-2.2 ± 0.3 vs. -1.4 ± 0.3 g, $p=0.039$) and change in Fulton condition factor (-0.045 ± 0.009 vs. -0.002 ± 0.013 , $p=0.005$). Overall, the leukocyte differential was marginally different between treatments (Wilks' Lambda $p=0.108$); driven by marginal lymphocytopenia (59 ± 5 vs. $71 \pm 3\%$, $p = 0.072$) and significant heterophilia (36 ± 5 vs. $23 \pm 4\%$, $p = 0.039$). Plasma cortisol was significantly higher among animals in loud tanks (7547 vs. 5816 pg/mL median concentration, Wilks' Lambda $p=0.026$). Other measures were unremarkable. Physiological results suggest that ambient noise represents a chronic stressor to seahorses.

Behaviorally, animals in loud tanks made more adjustments (69 ± 18 vs. 27 ± 7 , $p < 0.01$) on holdfasts in the first week, but habituated thereafter. This was coupled with marginally less time spent holding on to holdfasts in the first week ($59 \pm 7\%$ vs. $77 \pm 6\%$, $p < 0.1$). By week 4, the pathological and concomitant distress behaviors of piping and clicking (respectively) developed among animals in loud tanks (piping: 106.9 ± 96.5 vs. 3.1 ± 1.1 , $p < 0.05$; clicking: 6.2 ± 3.2 vs. 1.1 ± 0.4 , $p < 0.025$). Yawning reflects general inactivity and its increased occurrence among animals in quiet tanks (12.5 ± 1.2 vs. 7.8 ± 0.8 , $p < 0.01$) is consistent with less activity observed in this group. Other behavioral results were unremarkable.

In light of these results, aquarists and aquaculturists are advised to incorporate soundproofing modifications during design and set-up of facilities to improve fish health, growth, and welfare in culture.