European Commission

Science for Environment Policy

Increasing ocean acidification affects larval barramundi's response to underwater sound cues so they are potentially attracted to the wrong type of habitat

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Source: Rossi, T., Pistevos, J., Connell, S. and Nagelkerken, I. (2018). On the wrong track: ocean acidification attracts larval fish to irrelevant environmental cues. *Scientific Reports*, 8(1).

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Since the industrial revolution, the ocean has absorbed increased levels of carbon dioxide, leading to the ocean's pH becoming more acidic. Effects of these pH changes on marine and estuarine biota is the focus of much research effort worldwide and the authors of this study focus on the larval habitat-choice process of a commercially important tropical marine fish species, *Lates calcarifer,* barramundi.

Populations of fish stock in the ocean rely on the successful movement of larvae to a suitable adult habitat; however, ocean acidification negatively affects the behaviour of marine animals towards the physical and chemical cues (for example the sight and smell) of suitable habitats. It has been shown that many larval fish can use sound cues — in addition to physical or chemical ones — to guide them to favourable habitats. This study investigated whether larval fish raised under elevated carbon dioxide levels of the near-future climate would still be attracted to sound cues of suitable tropical estuarine adult habitat, or whether they would be attracted instead to unfamiliar sound cues of temperate rocky reefs or artificial white noise. Disruption of behaviour adapted to help fish find suitable habitats and thrive could disrupt population replenishment of barramundi — as well as other economically important fish species — if animals fail to adapt to more acidic oceans of the future.

In choice experiments, the researchers recorded the response of the larval stage of barramundi towards a soundscape of a temperate reef located outside of its distribution range, and towards artificially generated white noise as a proxy for irrelevant anthropogenic sounds (those originating from human activity), as well as to its optimum estuarine habitat soundscape. The larvae used in the experiments were all obtained from the same hatchery in Adelaide, with two batches: one supplied as eggs; and the other at nine days post hatching (dph). Behavioural responses of the larvae were recorded on each day from 16 dph to 21 dph.

Prior to being placed in the choice chambers, the larval barramundi were raised either under present-day carbon dioxide levels in saline water tanks, or under elevated CO_2 levels, to represent future effects of ocean acidification, between 1 368 and 1 541 microatmospheres (µatm – measures of atmospheric pressure). Some of the larvae from the egg batch were exposed to CO_2 from two dph whereas the larvae of the nine dph batch were exposed to CO_2 from 10 dph. Prior studies have shown four days of exposure to higher levels of CO_2 is enough to trigger behavioural changes in fish.

Individual larva were placed into one of eight lanes of a choice chamber (four control and four elevated CO_2 per trial) and left to acclimatise for two minutes with the active sound playing throughout, before being released. At the end of each side of the chamber was a speaker: one as a silent control, the other playing the active sound. Twenty larvae raised from eggs were released per day, half from the raised CO_2 group and half from the unaffected group. The sound cues of white noise and a mangrove estuarine soundscape were tested on this batch. Thirty-two larvae were released from the 9 dph batch per day — again, half from each of the CO_2 conditions. The sound cue tested on these larvae was of a temperate rocky reef (an unsuitable habitat). The movement of the larvae was filmed from above and tracking software was used to track the larvae's movements within the two sides of the chamber for seven minutes. Statistical analysis was used to detect significant deviation from a random choice response and the percentage of time spent close to the speaker broadcasting sounds.

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Increasing ocean acidification affects larval barramundi's response to underwater sound cues so they are potentially attracted to the wrong type of habitat *(continued)*

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The researchers found that larval barramundi raised in projected end-of-century elevated CO_2 conditions for estuarine environments not only showed avoidance of the soundscape of its natural estuarine settlement habitat, but also significant attraction towards the temperate rocky reef soundscape and white noise — that is, towards sounds that are ecologically irrelevant which are ignored by larvae raised in current lower levels of oceanic acidification.

The barramundi is a tropical Asian species of fish; the findings are relevant to European policymakers, however, as a similar study with a temperate species, stickleback *(Gasterosteus aculeatus),* noted a similar effect[1]. The researchers note that the results of this study are consistent with the only other study investigating the effects of ocean acidification on relevant and non-relevant cues which used olfactory (smell) habitat cues; the researchers suggest that this indicates a common mechanism underlying the reversal in typical behavioural response to sound and olfactory cues. They also posit that elevated CO_2 concentration causes a reversal in the functioning of the sensory GABA-A receptors in the brain of the larvae, from inhibitor to activator, which has been shown, in several previous studies, to alter multiple sensory behaviours in various species of fish.

This study also highlights the potential of ocean acidification to attract larval fish to white noise or artificial sound in the water, which the researchers suggest might lead to them being attracted to boat noise and other auditory pollution in the future. As the EU Marine Strategy Framework Directive states that noise pollution should be kept to levels that do not adversely affect the marine environment, there may be need for further research, in light of the fact that ocean acidification is likely to magnify the detrimental effects of marine noise pollution in the future.

1. Lai, F., Jutfelt, F. and Nilsson, G. (2015). Altered neurotransmitter function in CO_2-exposed stickleback (*Gasterosteus aculeatus*): a temperate model species for ocean acidification research. *Conservation Physiology*, 3(1), p.cov018.