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Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish

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Significance

The 2010 *Deepwater Horizon* (MC252) disaster in the northern Gulf of Mexico released more than 4 million barrels of crude oil. Oil rose from the ocean floor to the surface where many large pelagic fish spawn. Here we describe the impacts of field-collected oil samples on the rapidly developing embryos of warm-water predators, including bluefin and yellowfin tunas and an amberjack. For each species, environmentally relevant MC252 oil exposures caused serious defects in heart development. Moreover, abnormalities in cardiac function were highly consistent, indicating a broadly conserved developmental crude oil cardiotoxicity. Losses of early life stages were therefore likely for Gulf populations of tunas, amberjack, swordfish, billfish, and other large predators that spawned in oiled surface habitats.

Abstract

The *Deepwater Horizon* disaster released more than 636 million L of crude oil into the northern Gulf of Mexico. The spill oiled upper surface water spawning habitats for many commercially and ecologically important pelagic fish species. Consequently, the developing spawn (embryos and larvae) of tunas, swordfish, and other large predators were potentially exposed to crude oil-derived polycyclic aromatic hydrocarbons (PAHs). Fish embryos are generally very sensitive to PAH-induced cardiotoxicity, and adverse changes in heart physiology and morphology can cause both acute and delayed mortality. Cardiac function is particularly important for fast-swimming pelagic predators with high aerobic demand. Offspring for these species develop rapidly at relatively high temperatures, and their vulnerability to crude oil toxicity is unknown. We assessed the impacts of field-collected *Deepwater Horizon* (MC252) oil samples on embryos of three pelagic fish: bluefin tuna, yellowfin tuna, and an amberjack. We show that environmentally realistic exposures (1–15 μg/L total PAH) cause specific dose-dependent defects in cardiac function in all three species, with circulatory disruption culminating in pericardial edema and other secondary malformations. Each species displayed an irregular atrial arrhythmia following oil exposure, indicating a highly conserved response to oil toxicity. A considerable portion of Gulf water samples collected during the spill had PAH concentrations exceeding toxicity thresholds observed here, indicating the potential for losses of pelagic fish larvae. Vulnerability assessments in other ocean habitats, including the Arctic, should focus on the developing heart of resident fish species as an exceptionally sensitive and consistent indicator of crude oil impacts.

oil spill damage assessment heart development embryology

Footnotes

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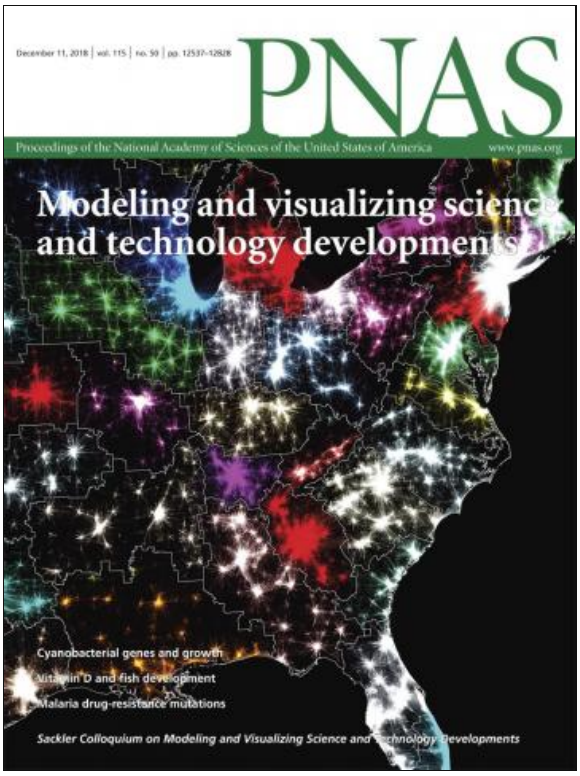

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