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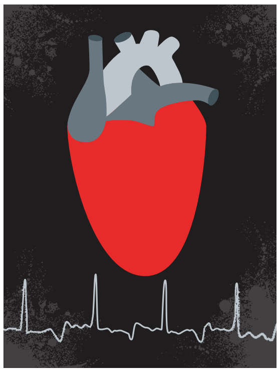
Salmon versus dilbit: it's a matter of the heart

ECOTOXICOLOGY



When it comes to the rush for 'black gold', the oil sands of the Western Canada Sedimentary Basin are one of the largest crude oil reserves in the world. Most of this oil is found in the form of bitumen, which when diluted is known as dilbit – for diluted bitumen – ready for transport via a transcontinental pipeline network for refinement. Proposals are currently underway to expand the existing pipeline network into the Pacific Northwest of North America, potentially taking it through critical freshwater habitats and the migratory routes of economically important fish, such as the Pacific salmon. Although spills from pipelines in the aquatic environment are rare, it is hard to decontaminate pollution when they occur. In addition, dilbit contains a mixture of chemicals, such as metals, naphthenic acids (NAs) and polycyclic aromatic hydrocarbons (PAHs), that are known to be toxic to fish. Low doses of PAHs in particular have been shown to impair swimming ability and cardiac function in fish, which can have long-term implications for migratory species, such as salmon. These fish rely heavily on their highly performing cardiovascular system to power their exertions as they migrate out to sea as juveniles and return to their native freshwater stream as adults.

Sarah Alderman, a postdoctoral fellow at University of Guelph, Canada, and her colleagues set out to identify the potential risks of accidental exposure of Pacific salmon to dilbit and the possible impact on their ability to migrate. Working with sockeye salmon (*Oncorhynchus nerka*), the team exposed juvenile fish to sub-lethal and environmentally relevant concentrations (of a few parts per billion) of dissolved contaminants from dilbit for 1 and 4 weeks. To test the hypothesis that exposure to low doses of dilbit impairs the migratory ability of salmon by inducing cardiotoxicity, the authors conducted swim performance tests on the exposed fish to assess their swimming ability. This was then followed by an examination of the heart tissue, to look for changes that may impair the fish's ability to sustain the high levels of exercise that are required during migration. In addition, Alderman and colleagues conducted an analysis of the fish's liver tissue, to determine whether chemical detoxification pathways were affected by the exposure.

The team was able to demonstrate, for the first time, that exposure to low and environmentally relevant levels of dilbit impairs the cardiovascular system, and that this effect is dependent on both the dose and the length of the exposure. While low doses of dilbit had no effect on swimming performance, higher doses induced heart remodelling and did impair swimming, thus affecting the migratory capacity of the exposed fish. In addition, the authors noted that all doses of dilbit induced an increase in cellular detoxification pathways in the liver, increasing the risk of producing secondary cellular compounds that may induce toxicity if the exposure to crude oil occurs for an extended period of time.

While previous studies have shown that crude oil components do affect heart shape and induce changes in the structure of the heart muscle when exposure occurs at the embryo life stage, the current study is the first to show that these effects also occur in juvenile fish and may be an indicator of dilbit or crude oil exposure. Therefore, in the case of salmon versus dilbit, it appears that it is all a matter of the heart.

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