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#### INTRODUCTION

In the late 1990s, scientists with the National Oceanic and Atmospheric Administration (NOAA) Auke Bay Laboratory (ABL) in Juneau, Alaska, published several studies on the effects of aqueous fractions of weathered crude oil upon salmon and herring eggs and larvae during exposure to water flowing through columns containing oiled-gravel. The investigators interpreted the results of these experiments as evidence of toxicological effects from exposure to 1 µg/L or lower of dissolved total polycyclic aromatic hydrocarbons (TPAH) (Heintz *et al.* 1995, 1999; Carls *et al.* 1997, 1999). They also concluded that oil toxicity increased with weathering. Their work has been quoted by other authors as representing a "new paradigm" in the evaluation of toxicity of PAH to fish early life stages (Rice *et al.* 2001; Peterson *et al.* 2003), demonstrating that weathered oil is more toxic and that fish embryos are more sensitive to oil than previously thought. Carl and McCaloy (2009) stated that this work "unambiguously demonstrates the dissolved PAHs from weathered crude oil severely impact fish embryos at low µg/L concentrations." Although later studies

We have reviewed all available information pertaining to the toxicity studies of Heintz *et al.* (1995, 1999), and Carls *et al.* (1997, 1999, 2003, 2005) as well as related studies. This review included original chemistry data in the public Exxon Valdez

observations and video information concerning the experiments (Dunberg 1998; Sebastian 2010) obtained under the Freedom of Information Act (FOIA). Based on our review, we find that the evidence produced by these studies does not support the conclusion that weathered oil is toxic at low µg/L TPAH concentrations or that oil toxicity increases with weathering. In addition, this review found evidence that these experimental studies were compromised by uncontrolled variables including variation in concentration and composition of exposure media, failure to demonstrate causality, presence of particulate (non-dissolved) oil, microbial activity in the gravel columns, microbial infections, and variation in brood sources that would have limited the conclusions that could be drawn from the studies.

#### OVERVIEW OF THE OILED-GRAVEL COLUMN EXPERIMENTS

A series of experiments using unfiltered water upwelling through oiled gravel columns to provide an exposure medium were begun at the NOAA Auke Bay Laboratory in Alaska in 1992 to simulate exposure of early life stages of Pacific herring (*Clupea pallasii*) and pink salmon (*Oncorhynchus gorbuscha*) to dissolved petroleum constituents in water that had passed through oiled shoreline gravel (Marty *et al.*