PROJECT ID:
601

Chronic Toxicity and Bioaccumulation Evaluation of Multiple PFAS for Benthic and Pelagic Species Relevant to Marine Ecological Risk Assessment

A Sailor carries a tank of AFFF down a ladder during a fire drill. AFFF is highly effective yet contains polyfluoroalkyl substances. (Photo Credit: MCS 2nd Class Nathan K. Serpico)

OBJECTIVE

The objective of this study is to produce acute and chronic toxicity and bioaccumulation data for 10 priority polyfluoroalkyl substances (PFAS).

PROBLEM STATEMENT

PFAS are a group of thousands of chemicals that have become widespread and persistent at Department of Defense (DoD) sites primarily due to their use in aqueous film-forming foam (AFFF) although it can be found worldwide at sites not influenced by DoD facilities. Currently, there are robust data sets that suggest two of these compounds, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), are detrimental to human health, resulting in significant regulatory and public concern. In addition, both PFOS and PFOA have been shown to be chronically toxic to aquatic organisms and bioaccumulate in aquatic systems, resulting in concerns over the environmental risk posed by these compounds. However, there is a lack of data regarding these chemicals' effects on marine species.

DESCRIPTION

In the first task, the team will use PFAS-spiked marine water and sediment to conduct water toxicity tests for two critical pelagic marine species, the opossum shrimp (*Americamysis bahia*) and topsmelt fish (*Atherinops affinis*)

and will report toxicity values such as lowest observed effect concentration (LOEC) and median lethal (LC50) or median effect (EC50) concentrations. If during this testing, no adverse effects are observed at concentrations well above (i.e., 100 times higher) detected concentrations of individual PFAS at AFFF-impacted sites, then species will be retested using a reduced concentration series to verify the no observed effect concentration (NOEC), and all test concentrations will be verified by a DoD-certified analytical laboratory (Eurofins). This testing will also sample tissue of exposed animals to develop water-to-tissue uptake factors.

Next, sediment testing will be conducted for a marine polychaete (*Nephtys caecoides*). Based on the project team's initial data, chronic toxicity effect thresholds for many PFAS in sediment are expected to be higher than the levels observed at AFFF sites, indicating that direct toxicity to sediment species is unlikely to drive risks at these sites. However, AFFF concentrations at these sites may still pose risks to aquatic-dependent wildlife, due to uptake of PFAS into tissues of benthic invertebrates. The team will test concentrations that are at the high end of the observed range at affected sites for all 10 PFAS, and will also test two PFAS mixtures with concentrations within ranges that have been observed at Navy sites to provide sediment-to-tissue uptake values, which would indicate a risk to other aquatic life.

Throughout the project, the team will provide data to the end user community (regulators, risk assessors, site managers) via a variety of methods including publication of at least two peer-reviewed manuscripts, at relevant Navy working group meetings, and through an advisory panel created as part of the project that includes Navy RPMs as well as scientists from the U.S. Environmental Protection Agency and the California State Water Board.

RETURN ON INVESTMENT

This project is primarily focused on filling data gaps (rather than replacing a current technology) and, as such, it will provide a variety of intangible benefits. For example, without concrete data on multiple PFAS, especially for marine species, regulators are likely to set overly protective, unattainable PFAS thresholds based solely on PFOS toxicity data and/or primarily freshwater organisms. This could result in overly stringent management burdens at PFAS-impacted sites adjacent to marine systems. Providing specific PFAS ecotoxicity effects and uptake data will lead to more scientifically defensible and cost-effective return on investment calculations for the Navy and its regulatory stakeholders. Given the high cost to remove PFAS from environmental matrices, more reasonable, scientifically-backed thresholds for PFAS will likely greatly reduce the financial burden of the Navy's management of these impacted sites.

NAVY BENEFITS

Filling critical data gaps will enable managers of Navy sites contaminated with PFAS to move forward with ecological risk assessments within the site investigation process using sound, scientifically supported information

TRANSITION DESCRIPTION

At least two articles will be published in peer-reviewed literature, providing context within the ecological risk assessment framework so that these data are immediately available and relevant to Navy sites undergoing remedial investigations and permitting processes for discharge compliance. A short paper discussing best practices for PFAS testing will be provided for both marine aquatic and sediment matrices in the event that other PFAS need to be evaluated. A final report incorporating all the toxicity values and uptake values will also be produced, and results will be disseminated at relevant conferences, webinars and the Navy emergent chemical and sediment working groups.

CONTACT

For more specific information about this project, contact the Principal Investigator at 619-553-3304.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development, demonstration and validation (6.4) program, sponsored by the Chief of Naval Operations, Energy and Environmental Readiness Division (OPNAV N45) and managed by the Naval Facilities Engineering Systems Command (NAVFAC) out of the Engineering and Expeditionary Warfare Center (EXWC) in Port Hueneme, CA.

The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness and lethality. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.navfac.navy.mil/nesdi or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or kenneth.c.kaempffe.civ@us.navy.mil.