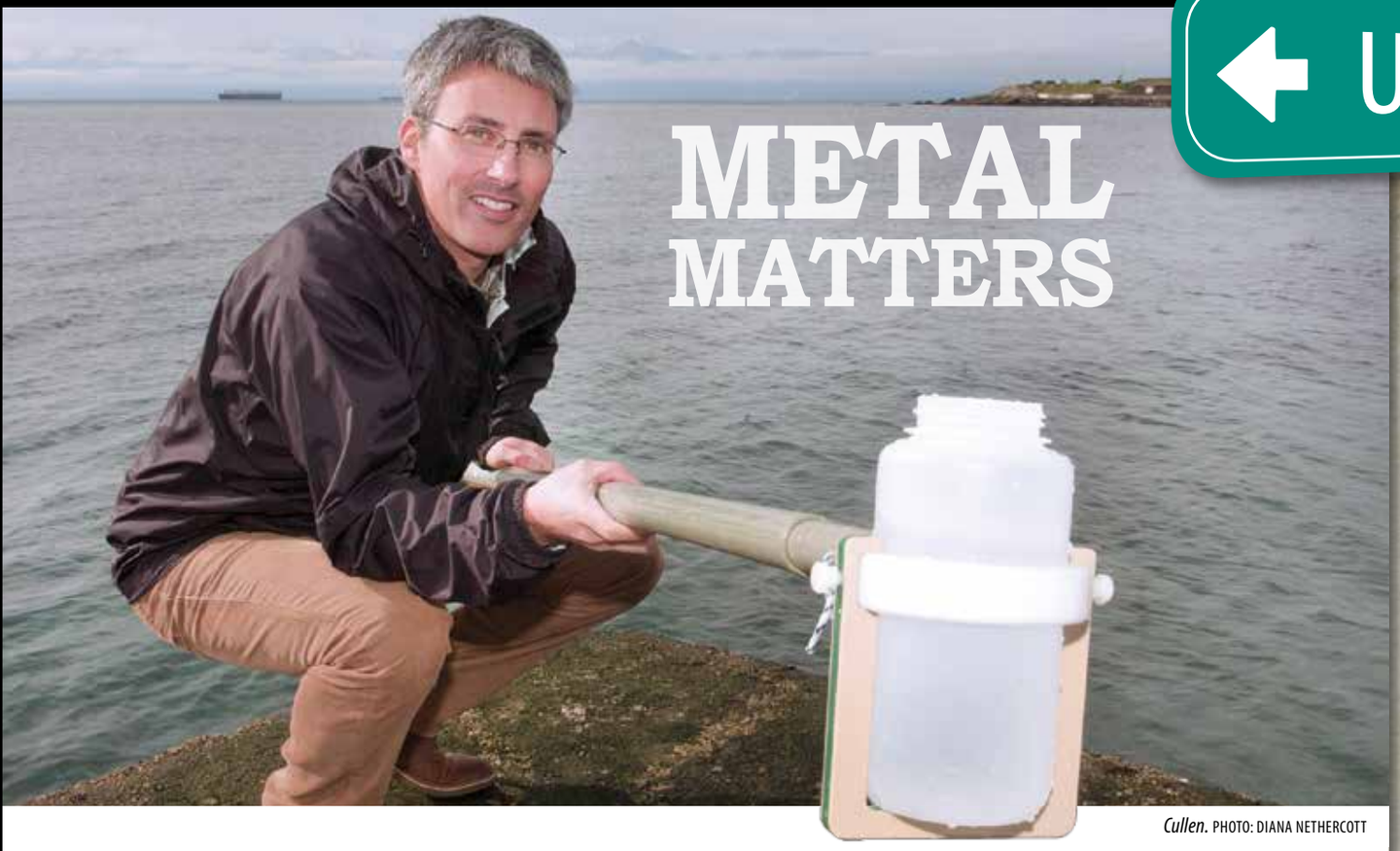

METAL MATTERS

Cullen. PHOTO: DIANA NETHERCOTT

Tiny metal particles in the ocean are helping us answer some big environmental questions

Hanging off the bow of a 61-foot sailboat in the middle of the Indian Ocean in the roiling wake of a massive ocean freighter may not sound very scientific. But for University of Victoria researcher Jay Cullen, it was all in a day's work.

Cullen was scooping up water samples churned up by the passing freighter. He was part of a project trying to find out whether unrelenting traffic in one of the world's busiest shipping lanes is affecting the chemistry and biology of the ocean surface.

As a chemical oceanographer, Cullen studies the fate of trace elements, especially metals, in the marine environment and how they influence ecosystems and critical ocean processes. "I'm interested in how metals are added to the ocean, what they do once they're there, and how they're removed from the ocean over time," he says.

He's especially interested in "bioactive" trace metals, such as iron, which are vitally important to the growth of algae at the base of the marine food chain.

"Trace metal concentrations influence which organisms grow and how much they grow," he says. "Salmon stocks, for example, might be affected by how much or how little iron there is in seawater."

The trace metal-algae connection is also critical to understanding climate change. One of the main ways that carbon dioxide—the most worrisome greenhouse gas—is removed from the atmosphere is through the growth of marine algae.

"Climate change is linked to ocean productivity, and these metals help control that," says Cullen. "Understanding these processes will tell us to what degree the ocean can mitigate the impact of human greenhouse gas production."

Although there are trace metals in every drop of seawater, we can't see them. Their concentrations can be so incredibly small—equivalent to about 100 grains of sugar dissolved in an Olympic-sized swimming pool—that researchers must use special "clean" techniques for collecting and measuring them.

"We go to great lengths not to contaminate our samples, which can be challenging when you're floating on a massive iron research ship," he says. "It's kind of a dirty secret of trace element chemists that we use a lot of plastic. It would be very difficult to do our jobs without it."

Most of Cullen's field work takes place in the Arctic Ocean and the North Pacific. In the Arctic, his main focus is the disappearing sea ice and how trace metal concentrations are being affected.

"We think the ice is an important transport mechanism for iron from the land into the middle of the ocean," he says. "It suggests that an ice-free Arctic Ocean during the summer might be an iron-limited Arctic Ocean. And that's going to affect productivity, although we don't yet know how."

In the North Pacific, where Cullen works closely with Fisheries and Oceans Canada, long-term measurements have revealed large swaths of iron-deficient ocean. "There are plenty of other nutrients available, but the algae aren't able to use them because they don't have the iron to grow," says Cullen.

Ongoing studies of trace metals will help us understand how our activities are affecting the environment now and what might happen in the future, says Cullen. "Our impact will be mitigated or maybe amplified—we're not sure—by how the ocean responds to a changing climate."

UVic knowledge

EDGEWISE

Examples of trace elements are iron, copper, zinc and lead. All living things, from humans to marine algae, need very small amounts of these elements for normal growth and health. Trace elements occur naturally in the environment at very low levels, but high levels can be disruptive and even toxic.

Human activity—everything from mining and the burning of fossil fuels, to wastewater and a wide range of consumer products—has significantly increased trace element concentrations in the environment over time.

In 2015, Cullen and some of his students will join an international GEOTRACES expedition to the Arctic, as part of global survey of trace elements in the world's oceans. The Canadian ship, which will leave from Quebec City, will join research ships from other countries that will be working in the Arctic Ocean at the same time.

Hands-on experience is crucial to Cullen in his teaching. He's experienced the thrill of discovery first-hand, and he wants the same for his students. "Research is often perceived as a pretty dry kind of enterprise. It's anything but. That motivation to learn what you don't know, or what no one knows yet—that's what I try to pass on to my students."

Meet Jay Cullen at *bit.ly/uvic-cullen*