Eco-toxicogenomics

A Promising New Environmental Technology for Assessing Risk

The Problem

Toxic substances affect different species in different ways, making it difficult to predict which organisms will be most at risk from contaminants released to the environment.

How and why do species differ in their sensitivity to toxic substances such as lead or mercury? What pathway does a contaminant take to affect plants, wildlife and humans? If environmental decision makers and managers were forewarned about potential impacts of environmental toxics on individual species and ecosystems, they could target resources and actions to better prevent and treat contamination. As yet, environmental scientists have not been able to provide this kind of early warning system.

Seeking Solutions through S&T

Sensitivity to toxic substances can vary greatly from species to species depending on genetic make-up. Toxicogenomics is the study of how an organism's genetic information responds to toxins. Eco-toxicogenomics applies this science to the study of ecosystems, using a representative organism as a means of understanding the effects of environmental toxins on the ecosystem as a whole.

Environment Canada researchers are investigating the potential of eco-toxicogenomics as a tool to assess how environmental toxins affect aquatic systems, terrestrial systems and wildlife. Researchers with different areas of specialization are working together to build the expertise needed to apply eco-toxicogenomics to current and emerging environmental issues, for example:

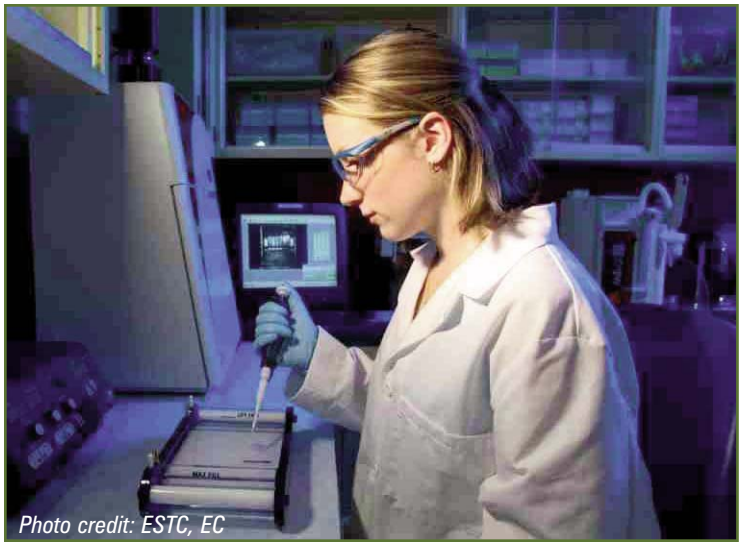
- developing new molecular-based screening methods to assess and predict the toxic effects of contaminants, as defined by the *Canadian Environmental Protection Act (1999)*, on aquatic ecosystems;
- testing effects of pulp and paper mill effluents on rainbow trout and other fish;
- testing and monitoring the eco-toxicological impacts of genetically modified crops on aquatic ecosystems; and
- determining the response of soil microbial communities to hydrocarbon contamination and the biological remediation of contaminated sites.

With colleagues from McMaster University, Environment Canada scientists are measuring the response of gulls, at the genetic level, to exposure to toxic substances. They have shown that birds living near active steel mills show more genetic mutation than those living in either urban or rural settings. Their research continues at two sites where gull populations exhibit different loadings of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) to determine which site is associated with gene mutation. Both PAHs and PCBs are identified as toxic substances under the *Canadian Environmental Protection Act (1999)*.

Transforming Knowledge into Action

Who can use these results?

Scientists expect eco-toxicogenomics will strengthen environmental risk assessment by providing a new generation of tools for toxicity screening. With these they will be able to predict genetic susceptibilities to particular stressors and identify which chemicals or groups of chemicals present the greater risk to human health or the ecosystem. Eco-toxicogenomic methods can be used to examine specific genetic toxicity and help identify unanticipated toxicity pathways. With this knowledge, environmental scientists can customize test designs and test methods, optimizing them for given chemicals, making for a targeted, faster, less costly risk-assessment process.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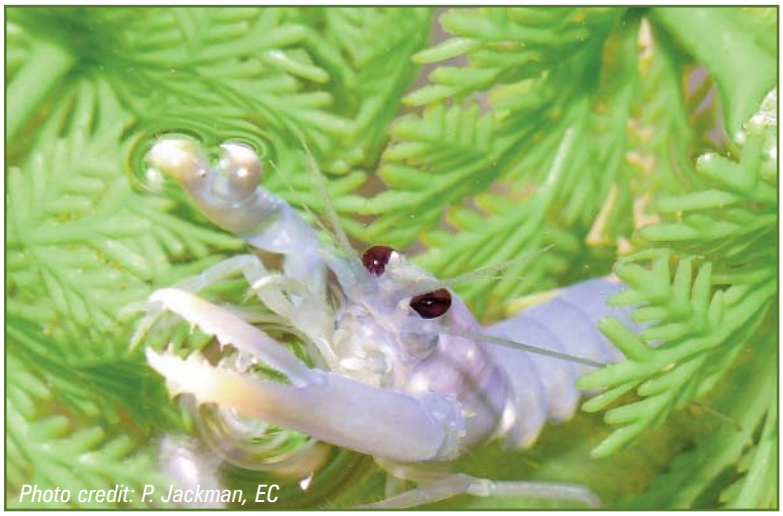
EC scientists are working with colleagues in other government agencies, universities and the international scientific community to address the challenge of developing and applying this new environmental technology: for example, developing standardized methods for obtaining and validating data, and esta-blishing systems for managing the sheer volume of data generated from genomic-based research.

Benefits to Canadians

Results from this research may act as part of an early warning system, alerting scientists to the first signs of threats to plant and animal species, while providing the information needed to help officials make appropriate conservation and regulatory decisions. Earlier prediction leads to better preventative strategies to protect Canadians.

Cataloguing, analysis and interpretation of data from eco-toxicogenomics research can provide a clearer picture of an ecosystem's response and susceptibility to chemically induced diseases and to contaminants — providing a more effective and efficient evaluation of toxic substances and their impacts on the ecosystem and, potentially, on the health of Canadians.

More effective monitoring tools based on eco-toxicogenomics could mean earlier detection of chemical and biological threats to wildlife, leading to better protection of endangered and commercially important wildlife populations, and bringing economic and environmental benefits to future generations of Canadians.



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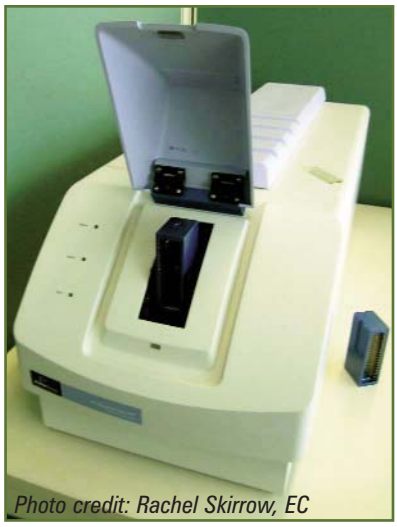
Genomics information may lead to development of molecular indicators called "biomarkers of effect" that could allow scientists to identify potentially sensitive species and populations.

EC's Toxic Substances Management Policy presents a precautionary and preventive approach to deal with substances that enter the environment and could harm the environment and/or human health. It provides a framework for making science-based decisions on the effective management of toxic substances.

EC scientists are applying eco-toxicogenomics to create effective tools to assess the risk and persistence of potentially toxic substances in the environment that may present a risk to ecosystems and human health. The development of new standardized test methods will help scientists predict certain toxic effects with greater speed and sensitivity, using fewer live specimens than traditional toxicity testing methods.



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For more information:

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