

The Need for Whole-ecosystem Experiments

Scott Higgins

As research scientists at the IISD-ELA, people often ask us: Why do you need to conduct your experiments on a whole lake? Why not just use test tubes and aquariums in the lab? These are great questions.

Environmental scientists are focussed on how humans impact the environments around us, and what this means to the world's biodiversity and ecosystem services that we depend on (e.g., clean water, clean air, arable soils for agriculture, etc.). At a global scale, human impacts are reaching the point where the earth may be entering a new geologic period called the "Anthropocene." The term "Anthropocene" has been proposed as the period where human activities have had a major and measurable global impact on the earth's ecosystems. There are a great number of ways human activities can impact our ecosystems, and it is the job of environmental scientists to try and understand the causes, consequences, and perhaps most importantly, potential solutions. That information can then be related to the public and to policy-makers. Scientists use many approaches to understand these impacts including long-term monitoring, laboratory experiments, complex computer models and ecosystem experiments. Each has its drawbacks and limitations, but all are useful and have unique strengths.

Whole-ecosystem experiments are especially useful because they take into account the vast complexity of interactions between the natural environment and the large numbers of species present in most ecosystems. Experiments done in the laboratory are very useful, but often do not scale well to the ecosystem level because they frequently include only one or a few species that one might find in nature. Environmental monitoring and observational studies lack adequate scientific controls and may be affected by many external factors (invasive species, nutrient inputs, climate change, etc.), making the effects of any single factor very difficult to isolate. There is a great saying in science: "correlation does not equal causation." Essentially, this means that controlled experiments are essential to determine causation and prove the effect of



any potential driver. As noted, laboratory experiments, which do have controls, are often not appropriate for understanding impacts to ecosystems. In whole-ecosystem experiments, like the ones we do at the IISD-ELA, we can manipulate one potential driver (e.g., a nutrient, a species of fish, a pollutant or contaminant) in one lake, while using nearby un-manipulated lakes as controls. In this way, we can determine the effect of the potential driver while accounting for the large number of potential interactions that occur in natural ecosystems. A good example is a recent experiment that examined how synthetic hormones from birth control pills, which are not currently treated for at municipal water treatment plants, impact food webs. The results showed that while Lake Trout (the top predator in the ecosystem) were not directly affected by the hormone, their population declined by 20-40 per cent because populations of their main prey, fathead minnows, collapsed because the hormone affected their ability to reproduce.

Whole-ecosystem experiments are not the only way to do environmental science; they can't answer every question and they are not appropriate in all circumstances. But, they are a very useful tool in the tool box; helping to provide a better understanding of our impact on the world around us and on which we depend, and hopefully assist us in making evidence based decisions. I am very proud that the Canadian public and scientists from around the world rallied to save one of the world's only facilities capable of conducting whole-ecosystem research on fresh waters, proud that the provinces of Ontario and Manitoba showed incredible leadership to fund its core mandate for the next five years, proud that the International Institute for Sustainable Development (IISD) undertook the risks and challenges of operating the ELA, and proud that one of the world's pre-eminent research stations on fresh water remains right here in Canada.

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