

## **Land use and protection matter when it comes to streams**

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Canada is a country covered by vast networks of water. Rivers, streams, lakes and wetlands span thousands of kilometers, connecting the different parts of our landscapes. As water moves through these systems, it carries with it traces of the places it has been. But these traces come from more than the river beds and lake bottoms the water moved through; they also come from the landscape surrounding the waterways. When rain falls from the sky onto the landscape, it creeps slowly into the soil or around the rocks it lands on. Some of that water is then absorbed and used by vegetation, some of it may go toward recharging stocks of underground water, and some of it is likely to continue on toward nearby freshwater systems, carrying with it whatever it picks up along its route. This means that rain that lands in an agricultural field and moves toward surrounding rivers, streams, lakes or wetlands may carry traces of that field. Depending on how that field is managed, you would expect to find different traces: more or less fertilizer and pesticides, more or less sediments. In a different context, such as a landscape covered by forest, the rain that moves toward waterways would again carry different sediments, different traces.

In my PhD research, I sought to find out what happens to a stream when you protect the land surrounding it. Is the water found in such a stream different from the water found in a stream that is not surrounded by protected land? What about all the other ways humans interact with streams beyond the fact that they can provide us with clean water? After all, streams are a great place to recreate. In the area surrounding streams - the riparian zone – we can go for peaceful walks or find delicious wild foods like elderberries, blueberries and Labrador tea. This area is also a place that can store carbon in vegetation and soil, preventing greenhouse gases from further heating the air. On top of all that, streams and their riparian zones provide habitat to numerous species that we share land and freshwater systems with, and care about. I wanted to know how protection affects streams because most protected areas were not created with streams in mind. Yet, protecting a stream and the land that surrounds it could have an important effect on that stream. I wondered if there are the differences between streams that are surrounded by protected and unprotected land? I wanted to know about this because when land isn't protected it tends to be converted into land dedicated to the production of material goods, and I wanted to find out what would happen to our protected streams if they did undergo such changes.

In Canada, some common ways we convert land is to change what was once a forest to an area with agriculture, or to harvest forests for timber. So, I sought out to measure differences between streams surrounded by protected forests, unprotected forest, timber harvesting, and agriculture. I care about this because I love streams. I grew up playing in them and wish for future generations to be able to do so as well. They are the veins of our rivers and lakes, and keeping them healthy is as important to me as keeping myself healthy. In addition to that, I know that we humans are those who make the decisions about whether or not to give land a formal protection status, and to maintain that status through time. We are also those who decide how to manage land when we don't protect it. Will we grow delicious food on our land? Will we harvest the trees found on it to build beautiful houses or make paper? How will we practice those activities? Research suggests that when we make these decisions about land use management, there are implications then for the ways we are able to interact with the landscape and benefit from it. To be able to make informed decisions about land use management and protection we need to understand the implications associated with our actions, but little information exists concerning the effects of protection on streams. My project seeks to shed light on the implications of protecting land or using it in different ways for streams and their riparian zones. Freshwater ecosystems, although expansive in Canada, are vastly understudied. I seek to improve our understanding of them because I care deeply about them and want to ensure that all Canadians continue to have sustainable and equitable access to clean freshwater systems now and in the future.

I figured the best way to answer my questions would be to visit several streams and collect information, or in other words, data. As an ecologist, which is a type of scientist interested in the environment, this is something I have been trained to do. Using a geographic information system –a computer tool that allows you to map data and ask questions about it - I located 28 comparable, but different streams. These included streams surrounded by: protected forests, unprotected forests, unprotected forests with recent timber harvesting, and unprotected areas with agriculture. These streams were found in Quebec, between the Mont-Tremblant Park and the Monts-Valin Park. At each of them I spent a day or two gathering information about what scientists call “ecosystem services”. Ecosystem services are essentially the different ways that humans benefit from nature. Specifically, I was interested in the provision of clean water, wild foods, carbon storage, recreational trails, habitat quality and biodiversity. I collected water and insects, I counted the elderberry, blueberry, Labrador tea, raspberry and wintergreen plants that I saw, I identified and measured trees, and I looked for indicators of habitat that diverse species are able to live in. Then, I spent months in the laboratory analyzing these samples and months at the computer figuring out what they meant. I wanted to know what all this information could tell us about how protection and land use affect the ecosystem services provided by streams and their riparian zones, as well as biodiversity.

It turns out that land use has an important effect on stream and riparian zone ecosystem services and biodiversity. Clean water provision, carbon storage, habitat quality, and tree diversity were significantly higher in and around streams surrounded by intact forest- protected or not. Surprisingly though, recreational trails, wild foods, and aquatic biodiversity did not significantly differ between the four different watershed types I visited. This tells us a few important things. It tells us that protection matters for streams and riparian zone ecosystem services and biodiversity, but only because it is a way to prevent land use from changing. The thing is, research shows us that when we don't protect land, in the long run, we tend change it, to develop it. So streams surrounded by unprotected forests, which are currently doing a better job than those embedded in production landscapes at securing the provision of clean water, carbon storage, habitat quality and tree diversity, are always at risk of losing their ability to be strong providers of these services. The data also tells us that streams that are surrounded by forestry and agriculture still provide numerous benefits and support biodiversity. Landscapes with agriculture and forestry do much more than just produce food and wood. By thinking of them in this way and paying attention to the diverse ecosystem services they rely on and support, we can make management decisions that maintain or improve their sustainability and multifunctionality. Most importantly, this project shows that it is important to think carefully about the implications of land use management and protection around streams and their riparian zones. This is especially true in Canada, where we have such vast freshwater networks.

Now that this information is available, my hope is that people seeking to make decisions about land use management and protection will think about streams and their riparian zones when they do. They will think about the numerous different ways that streams contribute to our well-being and biodiversity. They will think about what it means to maintain the forest surrounding a stream or protect it, as opposed to developing it for agriculture or timber harvesting. When they do develop land for agriculture or forestry, they will consider management approaches that sustain biodiversity and other ecosystem services at the same time. Information is the power to make better decisions, and I hope that this information sheds light on a piece of the complex puzzle we must solve to foster more sustainable and equitable land management and protection decisions for freshwater ecosystems.