ROYAL ONTARIO MUSEUM

GREEN BELT

Possibility grows here.

BIODIVERSITY IN A CHANGING CLIMATE

The effects of extreme weather on species in the Greater Golden Horseshoe

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Go to the produce section of your grocery store and you'll find the fruits of biodiversity.

Biodiversity, loosely defined as the variety of life in a given ecosystem, is the reason we have mangos, apples, blueberries and bananas. These commonplace fruits were all born and bred from unassuming plants found in ecosystems around the world. Their existence to this day relies on a host of other life forms—pollinators, predatory insects, fungi—without which, our grocery store shelves would be much emptier.

Worryingly, scientific evidence suggests that biodiversity is in decline across the globe, and that one of the drivers of this phenomenon is climate change. As some regions become hotter and drier, and others wetter, species lose their ecological niches. One biological response to this is migration; species move into new territories where weather is more suitable. But this can have unexpected consequences for the environment and, more pointedly, you.

The Ontario Greenbelt is at the heart of Canada's most biodiverse region; the Carolinian Forest zone, stretching into the Mixed Forest zone to the north. This region is home to an incredible diversity of plant and animal life, including 78 endangered species. Climate change is already affecting biodiversity in the region, and it is important that scientists and government agencies understand what is going on in order to create and implement effective conservation strategies.

ROM natural history collections have been used to examine changes in distribution of native Ontario plants and animals. Distribution changes and climate data can help us see how species are affected by climate change. What we've learnt is that some species will migrate, whereas others cannot. Those that cannot migrate may disappear from certain areas.

As the world gets warmer, species are moving in response to where, when and how they can survive. In Ontario, this generally means moving north as new territory becomes habitable and old habitats become more hostile. Ecosystem health relies on many species all being in sync with one another. When the climate changes, species are more likely to fall out of sync and the ecosystem can begin to fail or change.

When species move, their absence is felt by other organisms that relied on them. Conversely, when species emerge into new ecosystems, they can threaten the balance of what was already there. Some species cannot adapt or move quickly enough as the climate changes and for these, which include many invertebrates, plants and fungi, extirpation—the disappearance of a species from a specific area—is likely..

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IMPACTS

Distributional changes of Northern black widow and Black purse-web spiders

Two Ontario species that seem to be adjusting well to climate change are the Northern black widow spider (*Latrodectus variolus*) and the Black purse-web spider (*Sphodros niger*). In fact, these species are likely to expand their ranges in the coming years.

Using citizen science data and data from museum specimens, scientists have revised the distribution maps for these two lesser known species of spider. They have also predicted what the possible range expansion of these two species might be.

Black widow spiders are predators of many insect species, especially small, soft-bodied insects that are easily captured in the widow's web. Black widow spiders are part of the "cobweb spider" family, Theridiidae. Like most cobweb spiders, Black widows build a compact, tangled web, usually in a sheltered location.

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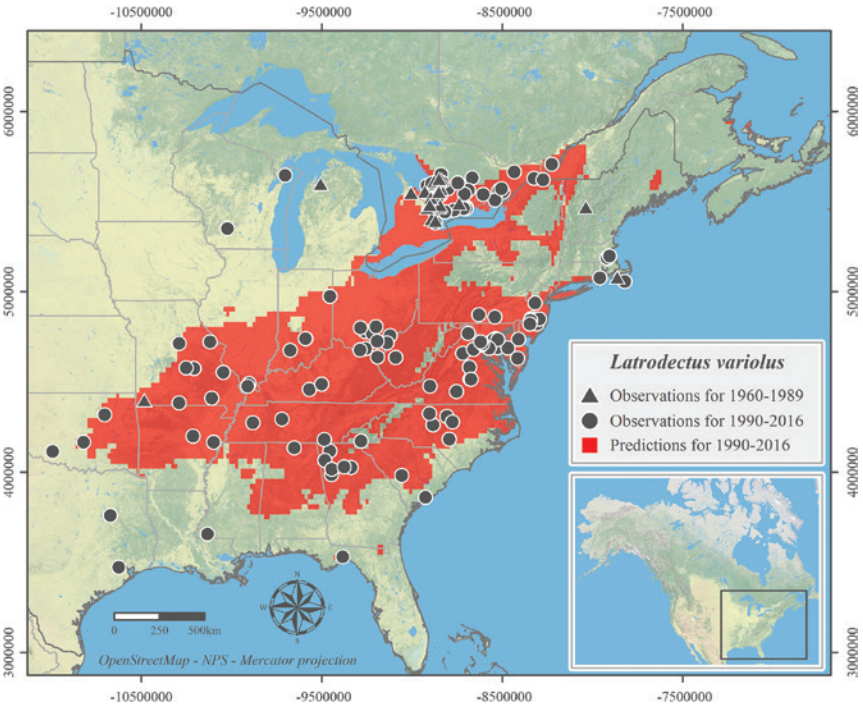
Warmer summers are making it possible for the Northern black widow to move further north. Records kept since 1989 place this species up to 94 km further north than previously recorded. Since it is a prey and habitat generalist, the Northern black widow will likely continue to expand its distribution. In contrast, it is the mean temperature of the coldest quarter that drives the distribution of the Black purse-web spider. Warmer winter temperatures allow this species to survive further north. Range expansion of this species may be slower since it is a habitat specialist (preferring dry sandy/rocky woodlands) and is unlikely to overwinter in shelters made by humans.

These spiders are adapting easily to more northern environments. Although timid species, their shifting distribution should be monitored, and people should be aware if they are present in their area. They should also know what to do in the very rare case of a bite from a Northern black widow (collect spider, clean bite site, apply ice, ibuprofen, see a doctor).

Northern black widow distribution



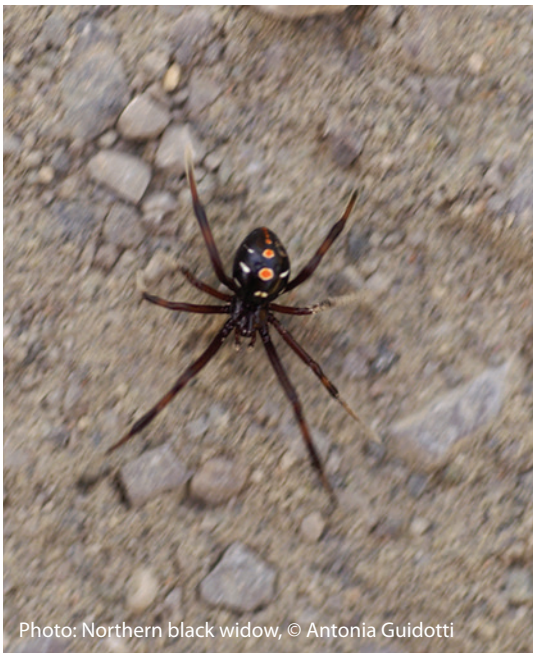


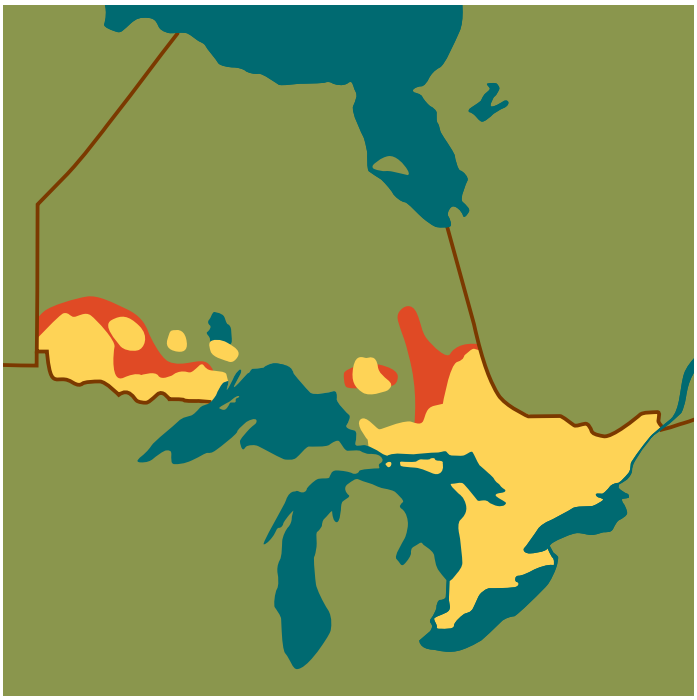
Photo: Northern black widow, © Antonia Guidotti

Some fish like it hot and some do not; things are heating up and fish are moving north

It has long been known that water temperature affects what species of fish you can catch in a given lake. For example, Ontario species such as Brown bullhead, Bluegill, Smallmouth bass, Largemouth bass, Pumpkinseed and Rock bass are warm-and cool-water fishes that live in southern Ontario lakes where summer water temperatures are greater than 19°C. Lake trout on the other hand, a cold-water species, prefer northern Ontario lakes, which stay cooler than 19°C in the summer.

Over the last few decades, warmer air temperatures in Ontario have led to higher water temperatures. A group of scientists from the University of Toronto recently studied the fish collection of the Royal Ontario Museum—an extensive collection of 1.2 million specimens dating back to 1850—to determine if climate warming has had an impact on Ontario fish species.

This group of scientists looked at both contemporary and historical survey data from over 1500 lakes in Ontario, over a 50 year period from 1957 to 2011. They wanted to see if there was a relationship between species occurrences and changing water temperatures. They also looked at both the magnitude and direction of range shifts for these species. Results showed that many fishes are now more likely to occur in lakes where low temperatures were historically a limiting factor. The northern range boundaries for warm- and cool-water sport fishes shifted significantly over 30 years at a rate of approximately 12.9-17.5 km per decade.



Smallmouth bass distribution in Ontario
Yellow represents pre-1986 and orange represents the increase in distribution (present day)

Image source: Margot Thomposon

> **“The northern range boundaries for warm- and cool-water sport fishes shifted significantly over 30 years at a rate of approximately 12.9-17.5 km per decade.**

Ontario fish species are shifting at rates comparable to other taxa in marine and terrestrial ecosystems around the globe. Understanding the range-boundary shifts present in Ontario lake communities will help predict future shifts by freshwater fishes. Citizen science and historical records kept by the ROM show that many warm- and cool- water fishes are now living farther north in lakes that used to be too cold for them. As this warming trend continues, the fish species you might catch in northern lakes will be more similar to those you currently find in southern ones. This could mean a very different experience for anglers of the future, which could also have significant economic impacts.

Ontario's recreational fisheries support robust sport fishing and tourism industries, which are the mainstay of many northern communities. Over 1.25 million anglers fish in Ontario each year, and they collectively spend $2.2 billion dollars in the province. This translates to thousands of jobs, including among the 1,600 licensed tourist operators.

https://www.ontario.ca/page/fisheries-ontario

Photo: Smallmouth bass,© Eric Engbretson

Photo: Tree swallow, © Mark Peck

The impact of climate change on Tree swallows

Tree swallows are one of the best known bird species in North America. They breed throughout much of Canada, with the exception of northern tundra regions, and winter in the southern United States and Mexico. Tree swallows are a familiar sight beside nest boxes along rural roads. One citizen-science study found that Tree swallow egg-laying dates have advanced by at least nine days since 1959. This might not seem like a problem. However, when eggs are laid earlier, young birds also need insects to eat earlier. If the right insects aren't present at the right time, young Tree swallows are less likely to survive.

Tree swallows are a cavity nesting species and readily accept nest boxes, often nesting in nest boxes alongside Bluebirds in Southern Ontario. Swallows are part of a group of birds known as aerial insectivores, which means they catch most of their prey while flying. Aerial insectivores throughout North America are in trouble; recent studies have indicated their decline may be as great as 70%. Tree swallow populations have declined by close to 50 % from 1966 to 2014, according to the USGS North American Breeding Bird Survey. Habitat loss, the prevalence of chemical pesticides and the decreasing availability of nesting sites have all undoubtedly played a role in the decline. But what impact has climate change also had on this species?

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One study, involving 3450 Tree swallow nest records from citizen scientists around North America, found that egg laying dates have advanced by nine days between 1959 and 1991. Another citizen science study from Alaska concluded that the number of Tree swallow young were lower in years of higher rainfall and warmer temperatures. In Ontario, research in the Long Point area along Lake Erie concluded that a warming of 5°C of the average temperature in May could result in Tree swallow egg-laying advancing by seven days. The research suggests that climate change and the impact it will have on both the swallows and their prey will decrease both the available wintering and summering ranges of this species, as well as that of many others.

SO WHY THE WORRY?

Simply put, we depend on biodiversity for our survival. Each time we lose a species we are changing the world around us. We cannot predict what that will mean for our future.

ACTION

Southern Ontario is one of the most heavily developed regions of Canada. It is also one of the most biodiverse regions, as was mentioned earlier, with an array of rare plant and animal species, including 78 endangered species. If we hope to maintain this extraordinary biodiversity, we must continue to research and protect the critical natural habitats and ecosystems found within Ontario's Greenbelt. Through research we can learn how to mitigate the effects of climate change on this biodiversity, and sustainably manage natural areas for the benefit of all Ontarians.

The Greenbelt safeguards sensitive terrestrial and aquatic ecosystems like the Niagara Escarpment and Oak Ridges Moraine, sites that are not replicated anywhere else in Canada. More than just a working and recreational landscape, the Greenbelt is a living laboratory for natural history researchers within the Greater Golden Horseshoe. So how do we ensure the continued protection of this land?

We need Ontarians to be interested and engaged with the nature that surrounds them. Without a personal connection to the landscape, the average citizen may be less vocal about supporting protected areas like the Greenbelt. Getting outdoors, growing native plants and choosing ethical, local and sustainable products that have a lower impact on the environment around you, are all ways you can help. These types of behavioral shifts can steer businesses and policy makers toward incorporating sustainable practices that reduce greenhouse gas emissions and halt biodiversity loss. You can also support green infrastructure projects in your community that help increase habitat, which supports biodiversity. These projects can simultaneously address water quality and pollution problems.

It could be easily argued that previous generations were more connected with the outdoors. Recent advances in technology and a move to urban living have resulted in many of us losing our day-to-day relationship with nature. However, the continued acceleration and digitization of information may also provide a vital link to a better understanding of the impact climate change is having on biodiversity.

The good news is: you can be part of the solution. There are lots of things that the average person can do to help protect Ontario's biodiversity in the face of climate change. Most importantly, know the facts and get involved!

GETTING INVOLVED - THE VALUE OF CITIZEN SCIENCE

Interested in science but not a scientist? One of the most valuable contributions you can make is to join a citizen-science project that monitors and reports on biodiversity. Teams of scientists simply do not have the time to collect all the data they need. This is where you come in.

Citizen science is the collection and analysis of natural history data by average citizens who may have little to no background in science. Members of the public who are interested in participating in citizen science projects have a wide range of opportunities in scientific fields that include astronomy, biotechnology, environmental science and ecology.

The average person can collect meaningful data by categorising galaxies, analysing DNA sequences online, monitoring plants and animal species in the backyard, and even doing hands-on collecting of air or water samples.

Citizen science programs have been around for over a century but were restricted by challenges with accessibility and coordination. Today, thanks to technology, these challenges have been overcome. Data can be easily collated, archived and made accessible for personal use or research purposes.

Programs like iNaturalist, eBird, PlantWatch, eButterfly, the Ontario Reptile and Amphibian Atlas and many, many others help track the distribution, relative abundance and spatial trends in our biodiversity, providing valuable information for present day and future conservation initiatives.

This kind of data analysis is critical to informing climate change adaptation and mitigation strategies, such as:

- The protection and connection of important habitats and migratory routes
- The development of management strategies for forests, lakes and rivers
- Informing investments into ecological restoration initiatives
- International collaborations on migratory species

Citizen science projects are a wonderful and important tool for Ontarians. Their popularity shows that Ontarians love and value their natural heritage. Citizens take joy and satisfaction from engaging with nature – as species are lost, we all become a little poorer.

For more information on Citizen Science programs available in southern Ontario investigate the Citizen Science Portal and the Directory of Ontario Citizen Science.

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ABOUT THIS SERIES:

The Greenbelt Foundation partnered with experts to understand how climate change is affecting our daily lives, and ways that we can individually and collectively respond to these challenges. For other installments in the series, visit www.greenbelt.ca/changing_climate

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