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Implications of a 2°C global temperature rise for Canada's natural resources

Executive Summary

Canada is a land of bounty. It is home to 10% of the world's forests and freshwater resources; and has the longest coastlines in the world. Millions of Canadians are employed in the forestry and fishery sectors which contribute billions to the Canadian economy. For a country whose image, economy and livelihood depend so deeply on its natural resources, Canada is especially susceptible to climate change.

In this study we examine the impacts of a 2°C increase in global temperature on aspects of the fishery and forestry sectors. Using the bioclimate (or climate) envelope approach, we established the climatic requirements of animal and plant species based on their current distributions. Mean global temperature is expected to rise by 2°C above pre-industrial levels during the period 2026-2060. Using output from global climate models for this period, we examine the climatic ranges of species under a 2°C warming to determine potential changes in species distribution. Our analysis is focused on marine species in the Northwest Atlantic and tree species in the province of Ontario; a review of literature extends our analyses to include freshwater phases of the Atlantic salmon as well as boreal forests nationwide.

Atlantic marine species

Ectothermic animal species, such as fish and shellfish, are adapted to the temperature range of their natural environment. As climate changes, they are likely to redistribute according to preferred climatic conditions. We determined sea surface temperatures (SSTs) corresponding to the current ranges of three marine species in the Northwest Atlantic (excluding Hudson Bay) and then compared them to the predicted SSTs for the period 2044-2059. Under a 2°C increase in global temperature, SSTs in the Northwest Atlantic are expected to increase by 1.5-2.2°C. On the northeast U.S. continental shelf warming will be roughly equivalent in summer and winter, but in the waters of the Scotian and Newfoundland-Labrador shelves, greater warming in winter means that seasonality will be reduced.

We expect a 2°C warming to cause loss of favorable thermal habitat in the southern part of the range and no northward gain for both the Atlantic salmon (*Salmo salar*) and the Atlantic deep sea scallop (*Placopecten magellanicus*). The temperature regime shifts we foresee likely will seriously hinder attempts at the recovery of endangered Atlantic salmon populations, and the restoration of historic salmon runs where populations have been extirpated. The important freshwater recreational salmon fishery will see more frequent temporary closures of rivers to fishing due to warm water temperatures or because of fewer fish. A warming climate may benefit aquaculture, with expansion into waters of northern Nova Scotia, southern Newfoundland, and the Gulf of St. Lawrence. Scallop abundance is linked to the retention of their planktonic larvae in nearby waters, where SSTs play a major role in larval survival. A 2°C warming may eradicate the small scallop fisheries of in the vicinity of Cape Hatteras and maybe even in Virginia waters.

With the increased SSTs predicted in northern waters the introduced Asian shore crab (*Hemigrapsus sanguineus*) is likely to invade shoreline habitats along the coast of Nova Scotia, Gulf of St. Lawrence and parts of Newfoundland and Labrador, potentially covering the entire Canadian Atlantic. The crab's high densities and large appetite for bivalves could seriously impact soft-shelled clam and blue mussel fisheries. Expanding populations of the Asian shore crab could also lead to considerable changes in native shoreline communities.

Ontario and boreal forests

During the period 2040-2050, the province of Ontario is expected to warm by 1.4-3.4°C. Using information on tree populations in Ontario and the eastern United States; we applied climate, soil, topographic, and land-use information to model existing and future tree distributions in Ontario. Our results indicated the potential for dramatic change in Ontario's forests under a 2°C warming. The modeled climate envelopes (suitable habitats) of most species shifted significantly northward. Declines in dominance were projected in many regions for key commercial species such as black spruce, jack pine, and sugar maple. Changes in forest types were widespread as more southerly species (including species not currently found in the province) moved northwards. However, a number of factors, including fragmentation of habitat and limitations in dispersal capabilities, suggest that tree species will be unable to migrate fast enough to keep up with the enormously high migration rates that our models projected. The implication is that future ecosystem composition increasingly will be driven by the climatic tolerances of species, with only the more climatically tolerant species persisting at a site. Increased stress brought about by climatic conditions outside of usual climate envelopes will presumably make species more susceptible to disease and pest problems. Species may become relegated to refugia where conditions are still satisfactory.

The production of maple syrup may be significantly reduced if temperatures remain above freezing during the sugaring-off period. Although small from a GDP perspective, effects on local economies and regional heritage could be large.

Climate change is also expected to increase the frequency and severity of disturbances, including fires and insect outbreaks in Canada's boreal forests. Increases in disturbances could result in younger forests which would reduce the amount of harvestable timber. This could also lead to loss of habitat for boreal species that are already under pressure from habitat fragmentation and logging activities. Warmer temperatures and forest fires are expected to reduce carbon stocks in boreal forests. In the search for appropriate adaptive responses to climate change, the different management goals of sustainability, biodiversity, and timber harvest should not be mutually exclusive.

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