

A greenhouse design for simulating warmer, shorter winters in small ponds

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April 20, 2023

Abstract

1. Ice coverage duration on lakes and ponds is decreasing due to climate change, but experimentally testing the effects of decreased ice coverage on aquatic communities is challenging in field settings. 2. To assess whether we could simulate changes predicted to occur in aquatic habitats as climate change progresses including shorter ice duration, warmer temperatures, and thinner ice and associated water chemistry changes, we designed and constructed greenhouses to place over a set of ten experimental ponds, roughly 3x3m in area which slope to a maximum depth of 1m, dug into the ground at the Koffler Scientific Reserve (Ontario, Canada). Half of the wedge-shaped greenhouses were enclosed on all sides (n=5) while the other half were open on three sides, with only the top fitted with plastic sheeting (n=5). The open greenhouses provided a less-warmed treatment while controlling for precipitation reduction and light filtering caused by the sheeting. In November 2019 greenhouses were placed over the ponds. Snow was cleared from the greenhouses and water chemistry measures were taken once weekly through the 2019-2020 winter. 3. Ice was thinner across the winter and melted on average 10.6 days earlier in closed greenhouses compared to open greenhouses. Average winter water temperatures were also significantly higher in closed versus open greenhouses although these differences were not significant in all months. Similarly, maximum and minimum water temperatures were also higher in ponds with closed compared with open greenhouses. We successfully demonstrate a method for simulating expected changes in ice conditions as climate change progresses including decreasing ice coverage duration at levels similar to those observed in north temperate ecosystems (per century) and alpine ecosystems (per 36 years) and raising temperatures in a highly manipulatable experimental system.

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