Executive Summary of 2022 LSPA-Calhoun-VT Fellows Report

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Human impacts on the environment such as climate change and land use change threaten freshwater ecosystems around the globe, especially clear-water lakes such as Lake Sunapee. We sought to address this problem by:

- Leveraging long-term manually-collected data and high-frequency buoy data provided by the Lake Sunapee Protective Association (LSPA) to calibrate a lake ecosystem model and simulate water quality;
- Developing long-term projections of Lake Sunapee water quality to the end of the 21st century based on multiple different climate change scenarios, climate models, and lake models; and
- Analyzing the effects of potential future land-use change on Lake Sunapee water quality based on potential watershed change scenarios.

From our long-term projections based on climate-change scenarios, we found that:

- Lake Sunapee's summer **surface temperature is projected to increase 2-5ºC by 2099 over current conditions** (Figure 1A).
- Lake Sunapee is projected to **lose 25-75 days of ice** over the next century (Figure 1B).

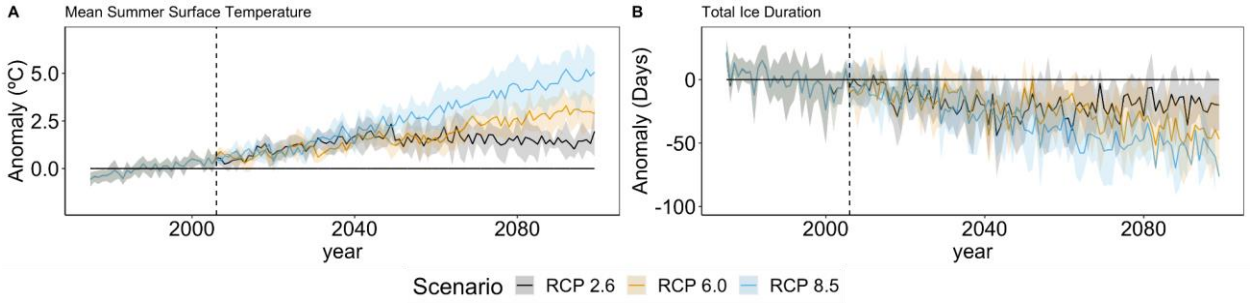

Figure 1. Projected changes from "historical conditions" for A) mean summer surface water temperature, and B) total ice duration from 2006-2099. The vertical dashed line represents the beginning of the projection time period, with the left of the dashed line representing the historical mean calculation period (1975-2005). The data presented represent the anomaly, or change from historical conditions. Each solid line represents the mean of a group of ensembles under three different climate scenarios of increasing intensity of greenhouse gas emissions: RCP 2.6, 6.0 or 8.5. Each shaded area around the solid lines represents total projection uncertainty.

The effects of climate change are likely to be compounded by changing land-use (Ward et al. 2020). We quantified the potential effects of increased inflow nutrients and discharge rates from the 11 sub-watersheds of Lake Sunapee on Lake Sunapee's water quality as part of a sensitivity analysis. We found that:

- **Increases in stream nutrients and discharge rates in the sub-watersheds increased within-lake nutrients.**
    - A scenario in which Georges Mills' nitrogen and phosphorus concentrations doubled would potentially lead to a ~23% increase of within-lake nutrients above current conditions.
- **Some sub-watersheds led to greater increases in within-lake nutrients than others.**
    - A scenario of doubling of nutrients and discharge rates in Georges Mills, Chandler Brook, and Pike Brook resulted in the greatest change in within-lake nutrients relative to current conditions.
    - All of these scenarios were hypothetical and used to test the response of the modeled lake to potential changes in stream nutrients, highlighting the importance of controlling nutrient runoff into Lake Sunapee.