

Historical Trends, Drivers, and Future Projections of Ice Phenology in Small North Temperate Lakes in the Laurentian Great Lakes Region

Supplementary Materials: The following are available online at www.mdpi.com/link, Tables S1 and S2, Figures S1–S9. Table S1: The change in climatic variables (mean annual temperature and mean annual precipitation), day of ice breakup, and day of ice freeze up under each climate change scenario for 2050 and 2070. Table S2: Slope, explained variation, and significance of linear regressions examining the relationship between lake ice breakup and freeze up and lake morphometric characteristics, including volume (m³), surface area (km²), and depth (m). Figures S1–S9: Lake ice **a**) breakup and **b**) freeze up trends for each lake during the study period.

Table S1. The change in climatic variables (mean annual temperature and mean annual precipitation), day of ice breakup, and day of ice freeze up under each climate change scenario for 2050 and 2070. RCP = Representative Concentration Pathway, *n* = number of models, MAT = mean annual temperature, MPPT = mean annual precipitation, DOY_b = breakup day of year, DOY_f = freeze up day of year.

Region	Year	RCP	<i>n</i>	ΔMAT	ΔMPPT	ΔDOY _b (min ΔDOY, max ΔDOY)	ΔDOY _f (min ΔDOY, max ΔDOY)
Wisconsin	2050	2.6	15	2.63	4.01	−8.34 (−27.61, 2.20)	7.58 (3.48, 12.43)
		4.5	19	3.23	4.56	−10.80 (−29.65, −2.15)	9.56 (5.28, 15.51)
		6.0	12	2.76	4.50	−8.98 (−26.98, 3.79)	8.28 (3.34, 12.09)
		8.5	17	3.91	4.93	−13.03 (−35.80, 1.21)	10.93 (4.73, 17.73)
	2070	2.6	15	2.61	5.09	−8.01 (−24.95, 2.83)	7.74 (3.34, 12.60)
		4.5	19	3.94	4.39	−13.15 (−35.31, 0.51)	10.97 (4.46, 20.97)
		6.0	12	3.68	4.19	−13.05 (−35.79, −1.32)	10.40 (5.56, 17.04)
		8.5	17	5.63	5.99	−19.09 (−43.16, −3.59)	15.62 (8.85, 24.39)
Ontario	2050	2.6	15	0.51	−2.07	−6.56 (−23.72, 1.23)	6.65 (1.20, 13.77)
		4.5	19	1.13	−1.85	−9.07 (−25.01, −2.32)	8.72 (3.30, 17.50)
		6.0	12	0.68	−1.62	−7.19 (−22.61, 3.28)	7.85 (1.85, 13.64)
		8.5	17	1.84	−0.96	−11.63 (−30.86, 1.25)	10.89 (1.37, 17.96)
	2070	2.6	15	0.47	−0.96	−5.81 (−22.83, 1.98)	6.81 (1.53, 14.30)
		4.5	19	1.82	−1.17	−11.52 (−31.00, −1.23)	10.80 (0.56, 23.01)
		6.0	12	1.58	−1.18	−10.94 (−27.95, −3.19)	10.30 (4.43, 19.40)
		8.5	17	3.50	0.93	−17.39 (−38.93, −4.49)	16.43 (6.04, 28.23)
Regional	2050	2.6	15	1.57	0.97	−7.94 (−27.61, 2.20)	7.37 (1.20, 13.77)
		4.5	19	2.18	1.36	−10.41 (−29.65, −2.15)	9.38 (3.30, 17.50)
		6.0	12	1.72	1.44	−8.58 (−26.98, 3.79)	8.18 (1.85, 13.64)
		8.5	17	2.87	1.98	−12.72 (−35.80, 1.25)	10.92 (1.37, 17.96)
	2070	2.6	15	1.54	2.06	−7.52 (−24.95, 2.83)	7.54 (1.53, 14.30)
		4.5	19	2.88	1.61	−12.78 (−35.31, −0.51)	10.94 (0.56, 23.01)
		6.0	12	2.63	1.51	−12.58 (−35.79, −1.32)	10.37 (4.43, 19.40)
		8.5	17	4.57	3.46	−18.71 (−43.16, −3.59)	15.80 (6.04, 28.23)

Table S2. Slope, explained variation, and significance of linear regressions examining the relationship between lake ice breakup and freeze up and lake morphometric characteristics, including volume (m³), surface area (km²), and depth (m). DOY = day of year.

Ice Variable	Morphometric Variable	Slope	R ² _{adj}	p-value
Breakup Trend	Volume	-0.44	0.10	0.21
Breakup Trend	Surface Area	-0.01	0.14	0.17
Breakup Trend	Mean Depth	0.00	-0.14	0.97
Breakup Avg. DOY	Volume	16.17	0.03	0.31
Breakup Avg. DOY	Surface Area	0.23	0.01	0.32
Breakup Avg. DOY	Mean Depth	0.46	0.28	0.08
Freeze Trend	Volume	0.00	-0.11	0.65
Freeze Trend	Surface Area	-0.02	-0.11	0.66
Freeze Trend	Mean Depth	-0.02	-0.12	0.70
Freeze Avg. DOY	Volume	0.00	0.23	0.11
Freeze Avg. DOY	Surface Area	1.08	0.25	0.10
Freeze Avg. DOY	Mean Depth	1.64	0.49	0.02

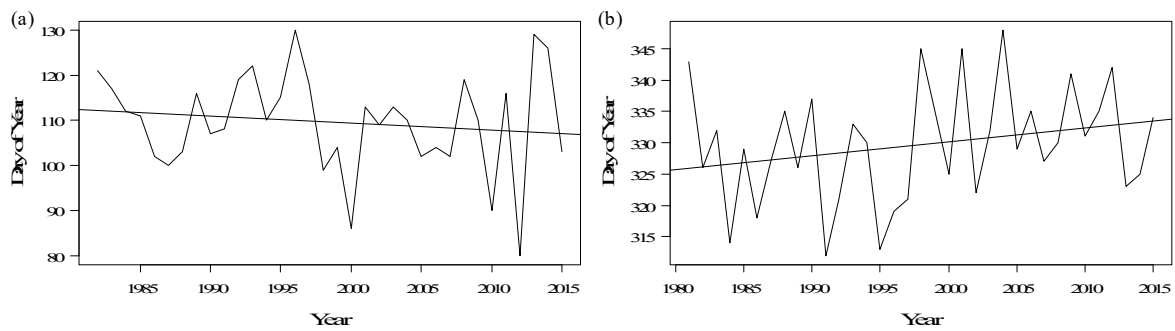


Figure S1. Lake ice a) breakup and b) freeze up trends for Allequash Lake during the study period.

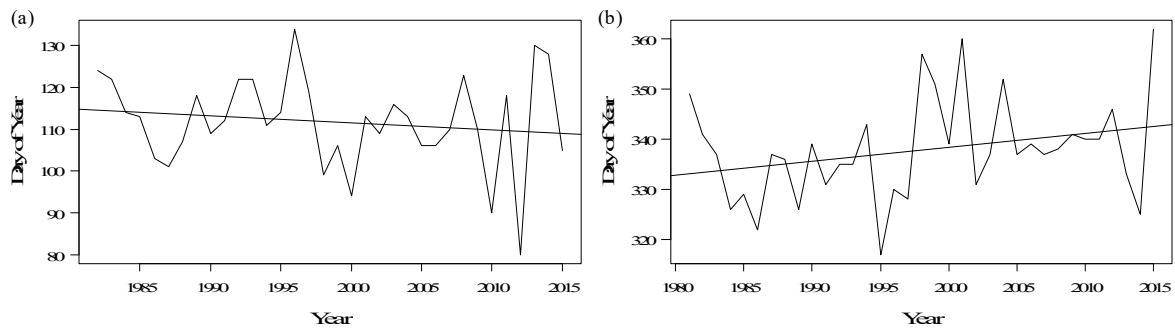


Figure S2. Lake ice a) breakup and b) freeze up trends for Big Muskellunge Lake during the study period.

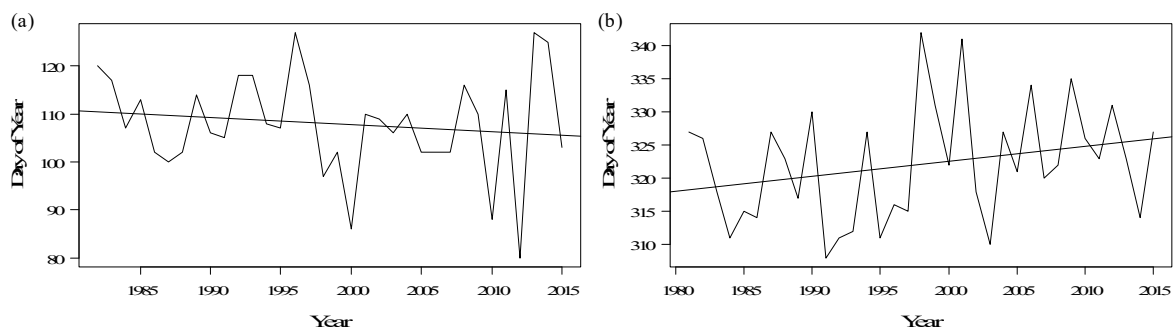


Figure S3. Lake ice a) breakup and b) freeze up trends for Crystal Bog during the study period.

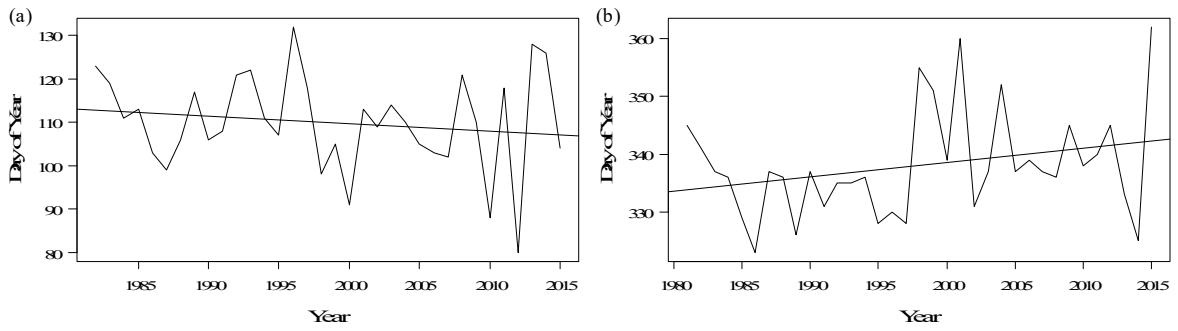


Figure S4. Lake ice a) breakup and b) freeze up trends for Crystal Lake during the study period.

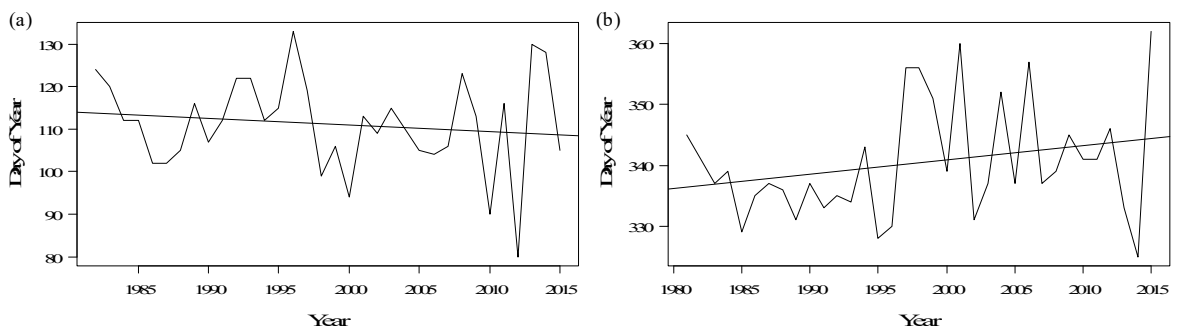


Figure S5. Lake ice a) breakup and b) freeze up trends for Sparkling Lake during the study period.

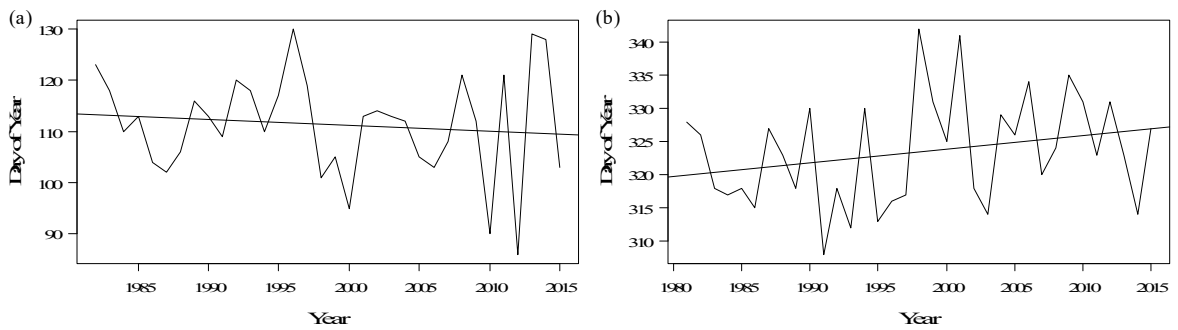


Figure S6. Lake ice a) breakup and b) freeze up trends for Trout Bog during the study period.

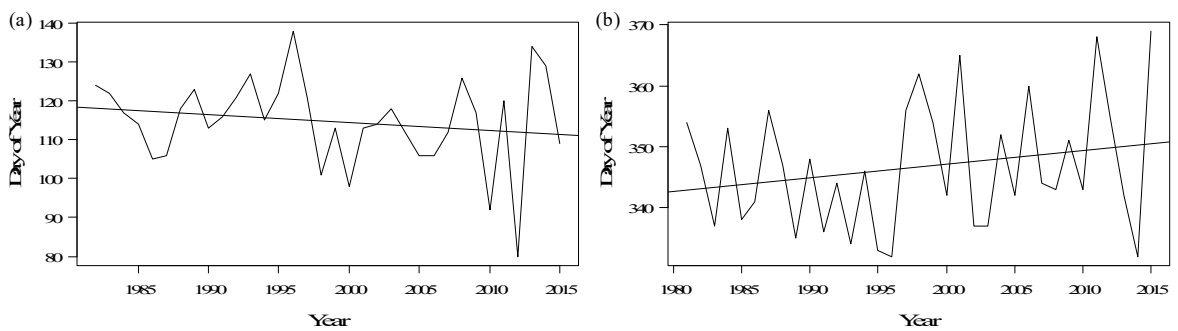


Figure S7. Lake ice a) breakup and b) freeze up trends for Trout Lake during the study period.

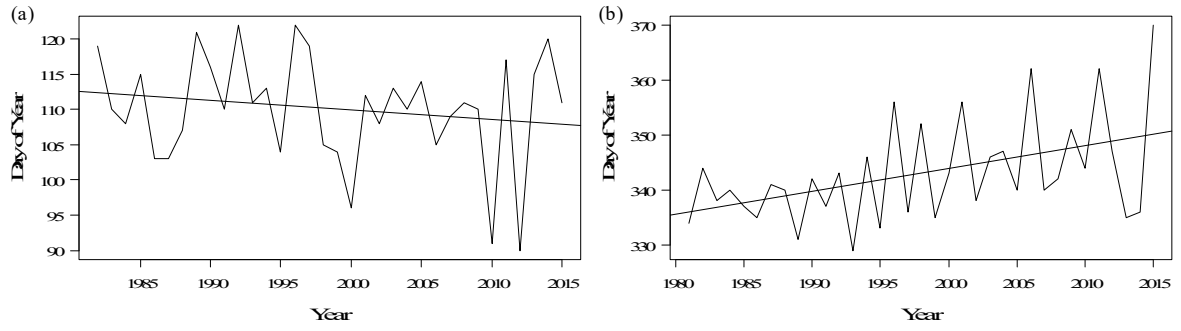


Figure S8. Lake ice a) breakup and b) freeze up trends for Grandview Lake during the study period.

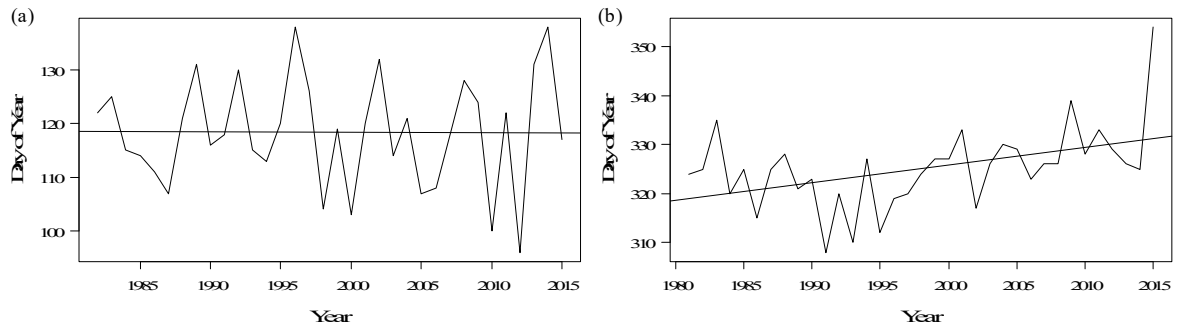


Figure S9. Lake ice a) breakup and b) freeze up trends for Lake 239 (Rawson Lake) during the study period.