



Effect of changing ice cover on aquatic primary production

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Abstract:

Ice cover is a key feature of many aquatic ecosystems that is expected to change with climate warming. Yet, very little is known about what controls key processes (e.g. gross primary production; GPP) under ice and how that will change with altered ice cover dynamics. Elevated carbon dioxide (CO₂) concentrations that build up under ice may stimulate GPP as light conditions and nutrients are sufficient. We tested this prediction in a large scale experimental pond ecosystem in northern Sweden where we measured whole-ecosystem GPP from late winter to spring ice break-up in 8 (130 m³) enclosures. In 4 enclosures we manipulated ice cover to simulate earlier ice break-up by 2 weeks; 4 enclosures experienced ambient ice conditions. The effect of ice cover on CO₂ and other environmental variables (light, nutrients, temperature) on GPP was measured throughout the season. During the ice cover period with light levels sufficient for photosynthesis, the temporal variability in GPP was positively correlated to CO₂ and negatively correlated to light. Before ice cover manipulation, the highest GPP coincided with peak CO₂ concentration and the lowest light intensity. On the other hand, the lowest GPP value and CO₂ concentration were in the beginning of ice free season with the highest light intensity. The important role of CO₂ availability was confirmed by the experimental manipulation of ice coverage, which decreased CO₂ concentrations and GPP relative to control enclosures. The results suggest that aquatic GPP responses to changing ice cover during the spring thaw period and can be relatively high and depends on the accumulated CO₂ during winter.