Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Guelph, 2011)

“Biogeochemistry, Limnology, and Ecology of Arctic Lakes”

Department of Geography

Thursday April 23, 2015
2:00 P.M.
David Turpin Building
Room B215

Supervisory Committee:
Dr. Fred Wrona, Department of Geography, University of Victoria (Supervisor)
Dr. Terry Prowse, Department of Geography, UVic (Member)

External Examiner:
Dr. Jim Reist, Fisheries and Oceans Canada

Chair of Oral Examination:
Dr. Roberta Hamm, School of Earth and Ocean Sciences, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Accelerated warming of high latitude systems of the northern hemisphere is expected to cause significant changes to the hydro-ecology of Arctic lakes. To record comprehensive and meaningful baseline hydrological, limnological, and ecological conditions to which future change can be compared, all available environmental information generated on Noell Lake, NWT was compiled and synthesized. Data included: physical and geographical characteristics (bathymetric and drainage basin attributes); general regional climatology; water quality (nutrients, major anions/cations, dissolved oxygen, dissolved organic carbon); biological composition (fish community, macrophyte, phytoplankton, epiphyton and epipelon surveys) and seasonal patterns in primary productivity (as measured by chlorophyll-a (Chl-a)).

A field-monitoring study was conducted from September 2010 to July 2013 assessing the application, reliability, and quality control/quality assurance of a newly developed automated buoy-based Arctic Lake Monitoring System (ALMS). The ALMS continuously measured a range of lake limnological and water quality parameters under both open-water and under-ice conditions. Overall, the ALMS provided a usable, uninterrupted record of changes in measured environmental, hydrological, and limnological parameters in both the epilimnion and hypolimnion. Noell Lake was determined to be spatially homogeneous with respect to the limnological measurements taken and, thus, the data recorded by the instrument arrays were determined to be representative of the lake as a whole. In addition to the measurements made by environmental sensors mounted on the buoy and mooring components, an augmentary array of in-situ sampling campaigns and controlled experiments were conducted to produce a continuous and comprehensive description of daily and seasonal changes to the hydrological and limnological conditions of Noell Lake. The continuous data series confirmed that Noell Lake is dimictic, with mixing events occurring in August and June, and hypoxic oxygen conditions occurring in March. Nutrient limitation experiments revealed that autotrophic productivity in Noell Lake was nitrogen-limited.

Compiling data from existing literature involved >700 northern, high-latitude lakes; patterns in temporal and latitudinal changes in Arctic lake primary productivity (as measured by open-water, epilimnion Chl-a) and geochemistry were assessed. The key hypothesis tested was whether Arctic lakes are showing increased primary productivity (i.e., “greening”), through time and by latitude, similar to that documented for Arctic terrestrial systems. In general, significant decreases in lake Chl-a was observed in Arctic and sub-Arctic lakes over an ≈50 year time span. Separation of lakes by latitudinal bands revealed that trends in the lower Arctic region (60.00-69.99 Degrees North) showed a significant decreasing time trend, while high Arctic lakes displayed no trends. Corresponding temporal trends of total phosphorous (TP), total nitrogen (TN), and dissolved organic carbon (DOC) differed depending on the latitude of the lakes.

Re-evaluation of the original northern-lake productivity models developed by Flanagan et al. (2003) through the use of the new, independent datasets (>700 lakes) as well as the addition of other environmental variables (DOC, dissolved inorganic carbon, lake depth, conductivity, and ice-cover) showed that the original models were valid and the most parsimonious in predicting variation in algal biomass in northern latitude lakes. Only measures of dissolved nutrients (TP, TN) and latitude are required to predict autotrophic water column productivity.