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

of

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BSc (University of Calgary, 2009)

“Effects of Natural and Anthropogenic Non-Point Source Disturbances on the Structure and Function of Tributary Ecosystems in the Athabasca Oil Sands Region”

Department of Geography

Thursday April 23, 2015
10:00 A.M.
David Turpin Building
Room B311

Supervisory Committee:
Dr. Fred Wrona, Department of Geography, University of Victoria (Supervisor)
Dr. Max L. Bothwell, Department of Geography, UVic (Member)

External Examiner:
Dr. Joseph Culp, Department of Biology, University of New Brunswick

Chair of Oral Examination:
Dr. John Lutz, Department of History, UVic

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

A multi-integrative approach was used to identify spatial and temporal relationships of natural and anthropogenic environmental variables affecting riverine ecosystem structure and function in the Athabasca Oil Sands Region (AOSR). A series of interrelated field studies were conducted to assess three main components of the freshwater food web (physico-chemical environment, basal productivity, benthic macroinvertebrates) utilizing an a priori environmental disturbance gradient experimental design. The gradient design was formulated to best discriminate the possible effects of natural and anthropogenic environmental variables on two river basins (Steepbank and Ells River) each having different levels of oil sands (OS) land use disturbance. Results from this study showed that anthropogenic catchment-scale disturbances are potentially contributing to downstream alterations in physico-chemical variables in the Steepbank and Ells Rivers. However, OS geological deposits in the lower reaches likely contributed the greatest to downstream changes. Seasonal variations in timing and quantities of catchment runoff between basins were potentially from impervious and unstable landscapes from large-scale OS mining operations on the Steepbank River basin, compared to small-scale land-clearing activities on the Ells River basin. Algal biomass on natural substrates decreased from upstream to downstream sites in the Steepbank River, possibly attributed to sedimentation events causing scouring at sites downstream of OS development, as well as OS deposit effects causing deteriorated algae development and reduced photosynthesis. Algal biomass on artificial substrates declined from upstream to downstream in the Ells River, potentially attributed to inhibitory effects from natural bitumen deposits on the photosynthesis of newly colonized algae. Biofilm biomass increased longitudinally in both rivers as a possible result of higher metabolic rates linked to natural petroleum hydrocarbons within the OS deposit. Seasonal differences in both rivers showed a spring depression in basal production likely from algal scouring during freshet, with increased productivity in summer with warmer temperatures and longer daylight hours. Abundance of sensitive benthic macroinvertebrate taxa declined from upstream to downstream sites in the Steepbank River, potentially attributed to effects from OS mining activities, as well as natural disturbances. Tolerant benthic macroinvertebrate taxa dominated upstream within the Ells River, which was possibly attributed to the elevated natural metal concentrations at upstream sites. Both natural and anthropogenic environmental variables potentially explained longitudinal and seasonal variations in benthic macroinvertebrate community composition within the Steepbank River, whereas natural variables were primarily found for the Ells River. If anthropogenic catchment-scale disturbances continue to increase with projected future OS development of the AOSR, results from this study suggest that key components of river ecosystems will likely be influenced. This study highlights the need for further research to obtain a better mechanistic understanding of the potential effects of natural and anthropogenic disturbance on the structure and function of tributary ecosystems in the AOSR at relevant spatial and temporal scales.