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Ecology of the Phototrophic Community in Base Mine Lake

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Summary

The Alberta oilsands industry has amassed about 1 trillion litres of fluid tailings, which contain naphthenic acids (NAs), toxic semi-soluble contaminants. End pit lakes (EPLs) have been proposed as a long-term reclamation strategy. Base Mine Lake (BML) is the only full-scale EPL developed in the oilsands industry in Canada. Research has shown increases in phototroph abundance and diversity in BML and has demonstrated that certain phototrophs are capable of NA biodegradation. More study is needed to elucidate the potential of phototrophs for NA biodegradation and their dynamics in BML.

The first objective was to characterize and quantify the phototrophic community over time in BML from 2015 to 2019 to determine how community composition and abundance shifts seasonally. Characterization used Illumina sequencing targeting 16S rRNA, 18S rRNA, and 23S rRNA gene amplicons. Gene amplicon sequencing yields relative abundance data over time for given phototroph taxa so that the most abundant groups can be identified. The phototrophic community was also quantified over time using quantitative PCR with primers targeting a sequence in the 23S rRNA gene ubiquitous to cyanobacteria and chloroplast-carrying organisms. *Cryptomonas curvata*, an abundant phototroph in BML, was quantified using primers targeting its 18S rRNA gene. More primers will be designed and applied to specifically quantify other abundant phototrophic groups in BML.

Analysis of 23S Illumina sequencing data demonstrated that major members of the phototrophic community include *Cryptomonas* spp. (*Cryptophyceae*), *Choricystis* spp. (*Trebouxiophyceae*), *Euglena* spp. (*Euglenales*), and *Synechococcus* spp. (*Synechococcales*). These four groups appear to show patterns of seasonal blooms from 2016-2019. Based on relative abundance data, *Cryptomonas* spp. has peaks in August or September, *Choricystis* spp. peaks in June or July, *Euglena* spp. in May, and *Synechococcus* spp. in July or August.

The 23S qPCR results show a gradual increase in phototroph populations in BML from 2015-2019. The maximum number of gene copies per millilitre of BML water was about 95,000 in 2015-2016. By 2017 it increased to over 400,000 and has remained within that range from 2018-2019. *C. curvata* qPCR results demonstrate an increase in gene copies after 2015. Both 23S and *C. curvata* qPCR results show higher numbers of gene copies compared to tailings water and natural lake water.

Overall, the BML phototrophic community has demonstrated an increase in chloroplast-carrying organisms over time and patterns of seasonal blooms. Further experiments will test the potential of major members in the phototrophic community for their ability to biodegrade NAs.