Remote Sensing of Freshwater Bacterial Populations Using Spectral Analysis of Satellite Imagery

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Abstract
Remote sensing of bacterial populations in small and large bodies of water can significantly enhance our ability to understand fresh water ecosystems and monitor water quality. Although the identification of individual species is still unfeasible, the detection of certain bacterial groups and the likelihood of occurrence would be very valuable. Spectral analysis of satellite imagery is currently used to determine water parameters like temperature, turbidity, phytoplankton and dissolved organic matter. In order to establish a correlation between some of these parameters and the presence of microorganisms, we collected water samples from several locations in the Lake Ontario Rochester Embayment and Irondequoit Bay that were imaged by the new Landsat 8 OLI and TIRS sensors. Using bacterial 16S rRNA, we mapped the diversity and distribution of microorganisms isolated from the samples and then linked this information to the bio-optical properties of the water. Our results represent an early attempt to develop a method for the remote detection of bacteria. A comprehensive understanding of the factors affecting the conditions favoring the establishment of the various colonies will require a library of seasonal ground truth sampling and remote sensing observations to assess potential probability and geographic distributions of the bacterial populations.

Disciplines
Biology

Comments
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Remote Sensing of Freshwater Bacterial Populations Using Spectral Analysis of Satellite Imagery

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Our aim is to build a database that will allow us to predict the occurrence of microbial groups in bodies of freshwater using satellite images

Abstract
Remote sensing of bacterial populations in small and large bodies of water can significantly enhance our ability to understand fresh water ecosystems and monitor water quality. Although the identification of individual species is still unfeasible, the detection of certain bacterial groups and the likelihood of occurrence would be very valuable. Spectral analysis of satellite imagery is currently used to determine water parameters like temperature, turbidity, phytoplankton and dissolved organic matter. In order to establish a correlation between some of these parameters and the presence of microorganisms, we collected water samples from several locations in the Lake Ontario Rochester Embayment and Irondequoit Bay that were imaged by the new Landsat 8 OLI and TIRS sensors. Using bacterial 16S rRNA, we mapped the diversity and distribution of microorganisms isolated from the various colonies will require a library of seasonal ground truth sampling and remote sensing observations to assess potential probability and geographic distributions of the bacterial populations.

Methods
Waters were collected from 9 locations on Lake Ontario: The locations were; Braddock’s Bay, Lake Ontario off Braddock’s Bay, Lake Ontario offshore (318 feet), Bay North of bridge, Lake Ontario Genesee Plume, Lake Ontario North Bay (315 feet), Long Pond North (3 meters deep), Long Pond South (2 meters deep), and Cranberry Pond (2 meters deep). Water samples were filtered through a 0.2 µm Milipore membrane to collect bacteria. Membranes were placed on EDA plates and incubated at room temperature for 24 hours. Bacterial colonies were then streak plated onto fresh R2A plates and allowed to grow for 48 hours. Colonies were sub-cultured until pure colonies were obtained. Pure cultures were stored in 10% skim milk/50% glycerol nutrient solution and frozen at -80°C. Gram staining was performed to help characterize bacteria. PCR was performed to amplify the 56s rRNA gene and gel electrophoresis was used to confirm DNA presence. DNA purification kit was used to extract and purify the amplified DNA. Gel electrophoresis was performed to visualize DNA present and the purified DNA was sequenced.

Results
49 colonies from 10 locations were isolated and described. 8 different genera were found and a total of 15 different species were identified. For some of the colonies we were able to assign a species based on their 16s rRNA sequence. Overall, the flora found in the lake and ponds was composed of bacteria are expected to be present in this environment. Some of them are fish, plant or human pathogens, and some belong to less well described genus (e.g. Pantoea).

The ultimate goal of this project is to build a database in which microbial species are associated with certain water optical parameters that can be obtained through satellite imagery. As can be seen in figure 1, chlorophyll, suspended solids and organic matter amounts follow a linear pattern: the increasing presence of one is matched by the others. It is along this line or range of parameters that can be obtained through satellite imagery that we will be able to perform statistical analyses that predict the occurrence of microbial groups in bodies of water with properties similar to the ones used in this study.

We now intend to expand our flora identification efforts through spectral analysis of satellite imagery. In order to develop a method for the remote detection of bacteria, a library of seasonal ground truth sampling and remote sensing observations to assess potential probability and geographic distributions of the bacterial populations. We are now working to expand our flora identification efforts through spectral analysis of satellite imagery. In order to develop a method for the remote detection of bacteria, a library of seasonal ground truth sampling and remote sensing observations to assess potential probability and geographic distributions of the bacterial populations.