Impact of Lake Champlain Water Quality on Vermont's Economy, Ecology, and Society

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Introduction

As a host of various types of recreational activity, Lake Champlain has become a prominent tourist location and source of revenue for Vermont. High phosphorus loadings in the Lake, however, have increased its vulnerability toward having toxic blue-green algae blooms (Watzin et al.). With tourism as an important aspect of Vermont's economy, it is hypothesized that poor water quality will have a negative impact on revenues generated from touristic and recreational activities in or near Lake Champlain. To understand the Lake's contribution to Vermont's economy would require a market benefit valuation. When implementing such a study it is important to note the challenges associated with it; for example, individuals participating in recreational and touristic activity on or around the Lake are engaging in various forms of economic activity. Some individuals may visit for sailing, bikeways, fishing derbies, or the scenic view of the Lake.

Because of the large range of visitors and activities that contribute to Vermont's economy, it is difficult to provide an all-encompassing economic study based on Lake Champlain. With these challenges in mind, this study seeks to determine how much revenue is generated from recreational and touristic activity at various Vermont state and city parks located along Lake Champlain. To understand how the Lake's water quality would impact visits to state and city parks, surveys were administered to tourists and individuals engaging in recreational activity at different park locations. These short surveys asked basic questions about tourist/ recreational activity and posed different water quality scenarios to assess potential changes in visits.

Methodology

Modeling Revenues and Chlorophyll-a Concentrations

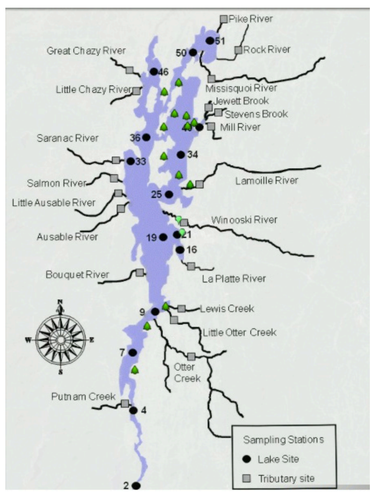
To determine how much lake-based revenue is generated from touristic and recreational activity, Vermont State Parks located along/ on the Lake were chosen for this study. The parks sales and service manager for Vermont State Parks was contacted to provide the revenues generated from visits to the 13 park locations from 2008 to 2013. To see if there was a relationship between the yearly average revenues generated at each park and the water quality, the revenues were modeled with the average chlorophyll-a concentrations. The data collected on the chlorophyll-a concentrations was obtained from the Lake Champlain Long-term Water Quality and Biological Monitoring Project, and the Lay Monitoring Water Quality Data from the Lakes & Pond Management and Protection Program.

Survey Design and Water Quality Index

To understand how tourist behavior will change in response to the fluctuating water quality of Lake Champlain, short surveys were administered at different park locations. The first half of the survey requested basic information regarding miles traveled, visits to the parks per year, and travel expenses for each visit. The second half of the survey focuses on potential changes in visits per year based on different water quality scenarios that occur in Lake Champlain. Using the Algae Bloom Intensity scale from the Lake Champlain Committee, a water quality index was created. The index used for this study had three different categories depicting various water quality conditions that occur on Lake Champlain. For the survey, each participant was presented with these categories and asked to determine if their average visits to parks along the Lake would change in response to the water quality.

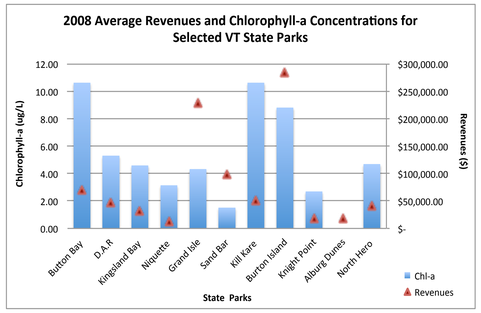
Testing Site Map

This is a map of the Lake Champlain Long-term Water Quality and Biological Monitoring Project's testing site locations in relation to Vermont park Locations along/ on Lake Champlain.

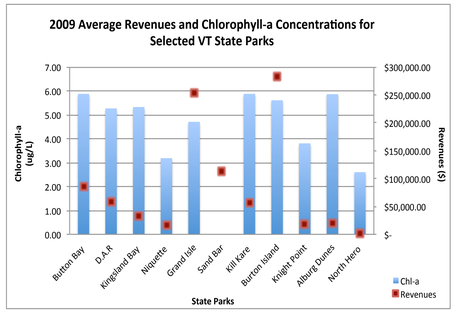


Results

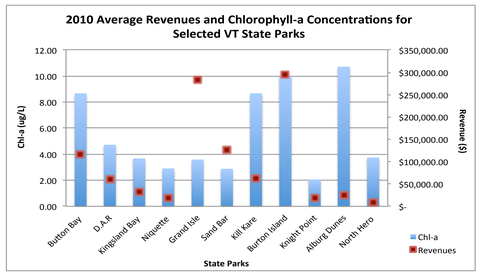
For 2008 to 2011 the chlorophyll-a concentrations were averaged for each year using data from the Lake Champlain Long-term Water Quality and Biological Monitoring Project and the Lay Monitoring Water Quality Data. Years 2012 and 2013 were omitted due to lack of data.

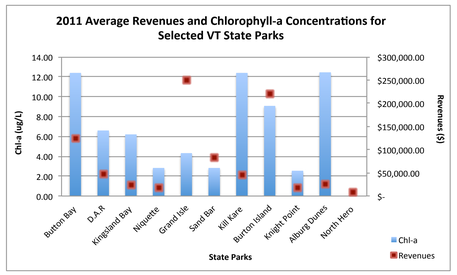


The missing average chlorophyll-a concentration for Alburg Dunes is due to the lack of data collected for testing site Northeast Arm 29 for Lay Monitoring Water Quality Data.



The missing average chlorophyll-a concentration for Sand Bar is due to the lack of data collected for testing site Northeast Arm 31 for Lay Monitoring Water Quality Data.

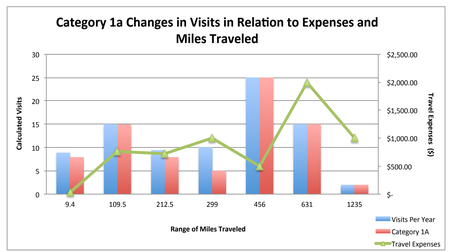




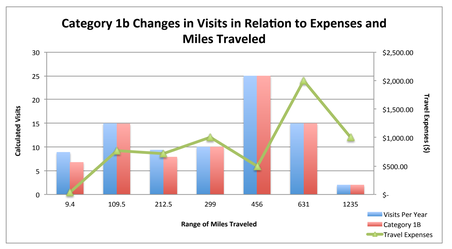
The missing average chlorophyll-a concentration for North Hero is due to the lack of data collected for testing site Northeast Arm 22 for Lay Monitoring Water Quality Data.

Survey Results

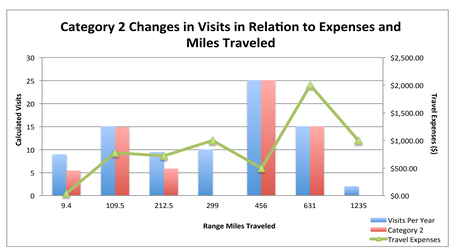
*Category 1c served as the control for unimpared water quality conditions in Lake Champlain. There were no changes in visits for each of the survey participants for this category.



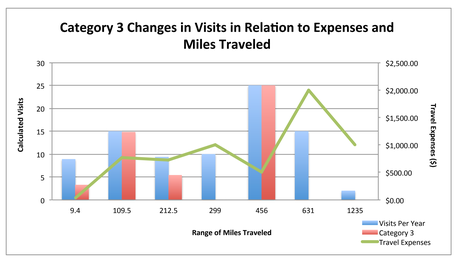
*Category 1a: brown and turbid with low visibility throughout the water column. Little to no blue-green algae.



*Category 1b: other materials present in the water. Small bright mustard yellow (pollen) or grass green (duckweed particles). Algae attached to rocks or lake bottom.



*Category 2: Blue-green algae present, but less than 'bloom' level- enjoyment of the water is slightly impaired.



*Category 3: full Blue-green algae bloom in progress. Continuous layer of algae throughout the water column.

Conclusion

• The results of the regression analysis to determine the relationship between 2008-2011 average revenues and the associated chlorophyll-a concentrations revealed a p-value of 0.13 for the overall data. This p-value is insignificant and suggests there is not enough evidence to reject the null hypothesis that the average chlorophyll-a concentration at each park had a negative impact on revenues generated from recreational and touristic activities. Examination of the p-values for each year revealed that they are each higher than 0.13 (e.g. 2008 p-value is 0.74). The low statistical significance could mean there is no actual relationship between revenues and chlorophyll-a concentrations at each park—the results could be due to randomness or other outside factors.

• The R^2 is 0.06, indicating that only 6.0% of the total variation in revenues is explained by the variation in chlorophyll-a concentrations. The R^2 is not high enough to indicate a relationship between average annual revenues for Vermont State Parks on or along Lake Champlain and average chlorophyll-a concentrations at each location.

• The results from the surveys show that changes in visits to Lake Champlain are a factor of miles traveled and water quality conditions. In each category (except for category 1c) individuals who traveled the farthest distance had a higher frequency of changes in visits. Survey participants who lived in Vermont or in a nearby state had a lower frequency of changes in visits when presented with the water quality conditions depicted in category 1a through category 2. In the case of category 3, only a few individuals traveling less than 5 miles indicated that they would have little to no changes in visits to the Lake. I conclude that though there is no significant relationship between the average annual revenues and chlorophyll-a concentrations at the 13 state park locations, the survey results indicate that the water quality of the Lake is a factor that people participating in touristic and recreational activity consider. To gain a comprehensive understanding of Lake Champlain's contribution to Vermont's economy, and determine the impact its water quality may have on revenues generated from lake-based tourism and recreational activity, requires a statewide multi-year study.

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