An Ecological Assessment of Vegetation Change (1970's - 1990's) in the Laurentian Great Lakes Basin

Project Team Members & Affiliation

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Project Description - Purpose

- The goals of this project include quantifying the amount of change in vegetation and land cover from the early 1970's to the early 1990's in the Laurentian Great Lakes Basin. Another goal of this project is to quantify some key relationships between vegetation change and the ecological characteristics of the Great Lakes Basin. Determination and quantification of vegetation cover in the Great Lakes Basin is accomplished using Landsat (satellite) images of the earth's surface. Since the 1972 launch of Landsat, satellite imagery has been collected to study the earth's environment on a regular schedule. The MultiSpectral Scanner (MSS), onboard Landsat, has been used to produce a fairly constant view of the Earth from the 1970's to the 1990's. Patterns of change in vegetation can be measured by comparing MSS images from the 1970's, 1980's, and 1990's.
- In future research efforts the land cover type could be determined for every region of each image for the two dates, using specialized computer software. The difference in land cover type could then be calculated to determine if there have been changes from one land cover type to another land cover type, at what location the changes occurred, and what area of land cover change occurred. For example, in the Lake Michigan Basin, some of the losses of forest since the early 1970's have been the result of increases in the expansion of agricultural areas. Detection of such development trends are important to measure because the replacement of vegetation cover by paved surfaces (for example, roads and parking lots) may be important for explaining changes in the quality of wildlife habitat and water quality in the Great Lakes Ecosystem.

Photo Credit: USEPA, Karen Holland

Major Deliverables

1) USEPA Research Report: An Ecological Assessment of Land-Cover Change (1970's - 1990's) in the Laurentian Great Lakes Basin
2) Peer-reviewed journal articles:
   a) Assessment of vegetation change in the Laurentian Great Lakes Basin (1970's - 1990's)
   b) Assessment of land-cover change in the Laurentian Great Lakes Basin (1970's - 1990's)
   c) Techniques for quantifying large-scale mosaic quality
   d) An assessment of the relationships between land-cover change (1970's - 1990's) and ecological characteristics of the Laurentian Great Lakes Basin
3) Lake Michigan Basin mosaic and vegetation change images, analyses, and original data
4) Land-cover maps and associated data sets

Photo Credit: National Park Service

Project Approach & Design

General approach: Vegetation and land-cover change in the Great Lakes Basin can be determined pixel-by-pixel (i.e., for each 60 meter by 60 meter region of land) in each image of the earth, during the 1970's, 1980's, and 1990's. These changes can then be measured to determine shifts in greenness or land-cover type over the 20 year study period. Such changes in land-cover characteristics may be related to changes in the physio-chemical and biological characteristics of water bodies, and in the habitat characteristics of the Great Lakes Basin.

Study area: The conterminous Great Lakes Basin - United States and Canada

Data needs and availability: All United States and Canada imagery is currently available.

Data analyses: Canadian data can be processed and resampled to match the NALC data set characteristics. Normalized Difference Vegetation Index (NDVI) will be performed and future efforts may include land-cover classification, calculated from imagery for the Great Lakes Basin.

Scale of analyses: Data resolution is 60 meters. NDVI performance will be analyzed for the Lake Michigan Basin. We propose to analyze land-cover change for the entire Great Lakes Basin in 2001 and 2002; smaller watershed scale analyses can also be performed to address specific ecological questions (e.g., relationships between land-cover change and water quality/habitat characteristics). Subsequent work would extend beyond international boundaries to include the Canadian portion of the Great Lakes Basin.

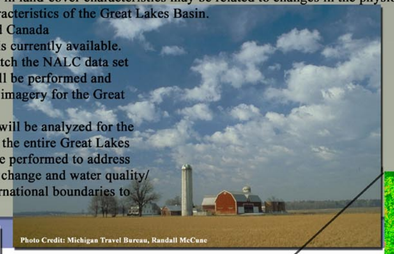
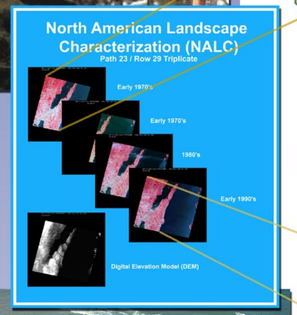


Photo Credit: Michigan Travel Bureau, Randall McCune

Photo Credit: Emerson and Linda Fleury



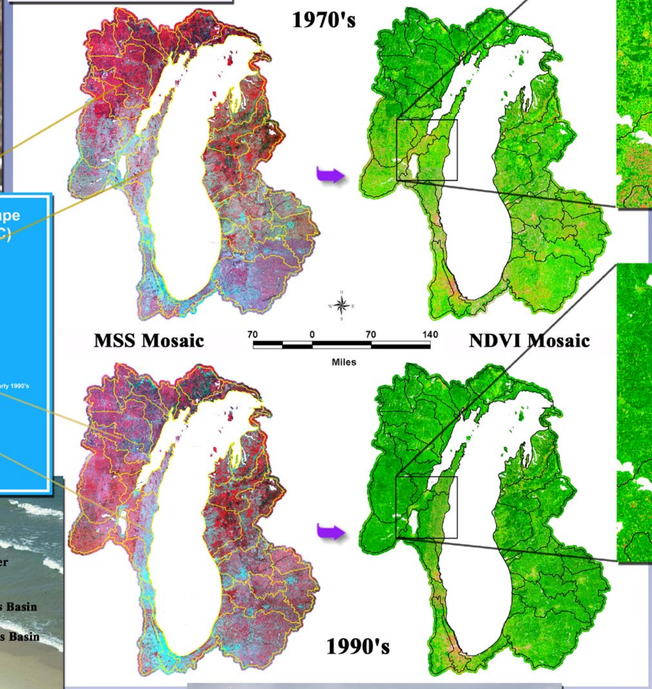
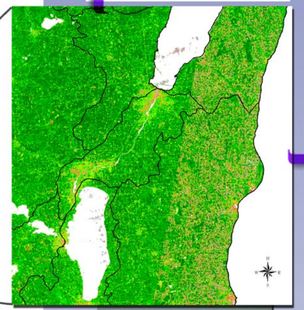


Photo Credit: Web Clip Empire

Project Background, Rationale, and Need

The North American Landscape Characterization project was initiated under the Global Climate Change Program in 1993 for the purpose of providing a consistent database over multiple decades for use in assessment of landscape changes. The NALC database has been used in several areas of the United States to assess vegetation change since the early 1970's. The need for additional research is indicated by these earlier studies, especially when large geographic regions (such as the Great Lakes Basin) are to be assessed. The results of this project will yield an analysis of the Great Lakes Basin as an ecosystem, and facilitate the study at finer, sub-basin scales. The goals of the project are supported by the Great Lakes National Program Office, Region 5 USEPA, the Canadian Centre for Remote Sensing, and are closely aligned with the goals of the international forum of the State of the Lakes Ecosystem Conference (SOLEC). Information about the SOLEC can be obtained by visiting http://www.on.ec.gc.ca/solec/solec2000-e.html. This project meets the USEPA Office of Research and Development (ORD) goal of advancing the Agency's ability to conduct regional-scale environmental assessments, while helping identify those areas of greatest concern relative to potential nutrient and sediment loadings to the Great Lakes. The goals of this study are closely aligned with the goals of the Great Lakes Regional Assessment being conducted by ORD's Global Change Research Program and will contribute to our understanding of how landscape change, along with global climate change, may be linked to the ecological integrity of the Great Lakes Ecosystem and public health in the region.

(NDVI Difference Procedures Applied)



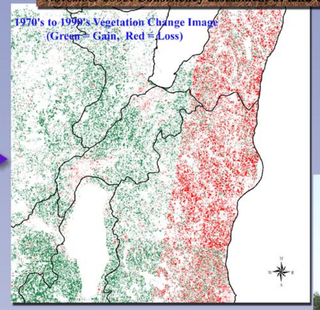


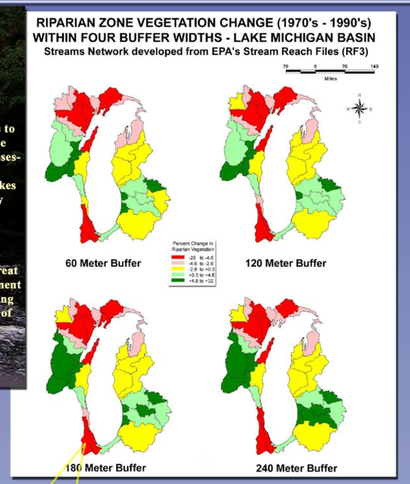
Photo Credit: Michigan Travel Bureau

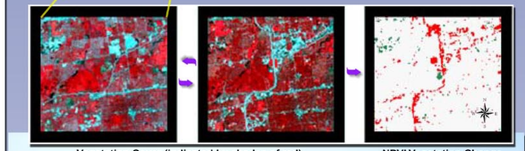
Photo Credit: Indiana Sea Grant, David Klarke

Project Milestones

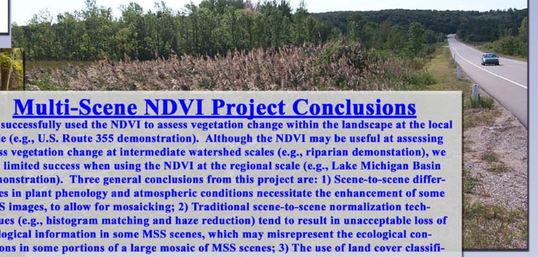
November 1999: GLNPO Technical Workshop, refine project objectives, formulate technical procedures
December 1999: Pilot boundaries established for multi-scene NDVI assessment
October 2000: Multi-scene NDVI assessment completed
December 2000: Land-cover assessment research plan completed

Proposed Future Research:
January 2001: Supplemental imagery purchased
August 2001: 1990's land cover map completed
December 2001: 1970's land cover map completed
April 2002: 1980's land cover map completed
November 2002: Consistency assessment of land-cover maps





U.S. Interstate Route 335 Corridor Development as detected using NDVI Vegetation Change Procedure



Multi-Scene NDVI Project Conclusions

We successfully used the NDVI to assess vegetation change within the landscape at the local scale (e.g., U.S. Route 355 demonstration). Although the NDVI may be useful at assessing gross vegetation change at intermediate watershed scales (e.g., riparian demonstation), we had limited success when using the NDVI at the regional scale (e.g., Lake Michigan Basin demonstration). Three general conclusions from this project are: 1) Scene-to-scene differences in plant phenology and atmospheric conditions necessitate the enhancement of some MSS images, to allow for mosaicking; 2) Traditional scene-to-scene normalization techniques (e.g., histogram matching and haze reduction) tend to result in unacceptable loss of ecological information in some MSS scenes, which may misrepresent the ecological conditions in some portions of a large mosaic of MSS scenes; 3) The use of land cover classification to separate certain types of land cover (e.g., forest from agriculture) will likely assist the regional effort to quantify landscape change in the Great Lakes Basin.