Can the Productivity of Forests Be Estimated from Space?

Though estimates from space may seem farfetched, scientists in the Section of Botany and Plant Pathology, under contract with the National Aeronautics and Space Administration (NASA), are investigating the feasibility of determining the productivity of forests by using satellite-collected information.

Civilian satellites from the United States, France, Japan, and other countries continually circle the globe, producing images of large portions of the planet on every cloudless day. The images are transmitted to computers at various locations on earth and made available worldwide to researchers and land managers. In many cases, especially in remote areas, satellite imagery provides the only feasible method of obtaining landscape information. In well-known areas like most of this continent, satellite imagery provides up-to-date information at high resolution, information that would be extremely costly to acquire by other means.

Currently three United States satellite sensors image the globe: Landsat Thematic Mapper (TM), Landsat Multispectral Scanner (MSS), and the Advanced Very High Resolution Radiometer (AVHRR). Each sensor has its own spectral and spatial attributes and each

Wavelengths recorded by each of three U.S. satellite sensors. Also shown is the absorbance spectrum for green vegetation.

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The procedure is to precisely relate biologically to landscape variables and then to analyze the relationship of landscape variables to forest productivity obtained from space. The following explains the Huntington Wildlife Forest representative of all the study areas.

The data used in this research include the seven TM bands (June 17 and September dates, slope angle, and sun radiance (June 17 and September dates, slope angle and sun radiance) with radiometric data collected via a map coordinate system and related to the TM and GIS variables to assess the feasibility of estimating forest productivity from space.

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available for them, in addition to the diversity of forest ecosystems they encompass.

The procedure followed in the study is to precisely register all data sets geographically to a common coordinate system and then to statistically analyze the relationship of the spectral and landscape variables to the estimates of forest productivity obtained on the ground. The following results from the Huntington Wildlife Forest are representative of all the study areas.

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The data used in making the regression and correlation analyses included the seven TM bands from two TM scenes (June 17 and September 21, 1984), various ratios of the TM bands including ratios between the June and September dates, slope angle, slope aspect, potential sun radiance (calculated for slope aspect and slope angle at a given latitude), and site index as an estimate of woodland productivity based on soil characteristics. The ground information was taken from 173 continuous forest inventory plots which had measurements taken in 1970, 1976, and 1981. From these data and published biomass regression equations, forest productivity was estimated as the total change in live above-ground biomass at each site per year (kg/ha/yr).

Results of this work indicate potential for predicting forest productivity using spectral and soil information. The best four variables—the ratio of middle infrared to near infrared (TM Band 5 to TM Band 4), site index, sun radiation index, and ratio of the two red regions of the visible spectrum (TM Band 3 in June to TM Band 3 in September) allowed a significant predictability of forest productivity.

If forest productivity estimates from space can be refined sufficiently, the dividends would be large. Accurate forest data will enable us to manage our remaining forests more wisely and to track areas undergoing rapid forest gain or loss. The study is also investigating the use of high-resolution TM data to calibrate the coarse-resolution AVHRR data. This procedure could allow projections about forest productivity across continents, thus reducing both the cost and volume of data for global carbon studies important to current and future ecological research.

By Louis R. Iverson and Elizabeth A. Cook, Section of Botany and Plant Pathology

Kankakee River Mussel Relocation

The freshwater mussel fauna of North America has undergone an alarming decline over the past century. Populations have decreased in size, and the range of many species has shrunk or disappeared altogether. The decline in the fauna resulted with the growth of urbanization, industry, and agriculture throughout North American watersheds and points out the sensitivity of mussels to human activities. Concern for this declining resource has led to the listing of several species as endangered or threatened at both the federal and state levels. In addition, both federal and state conservation agencies have recommended that significant mussel populations (“beds”) be protected also from adverse affects of construction and other activities.
The Kankakee River is one of the few streams in Illinois where dense, diverse mussel populations still exist, supporting the richest mussel assemblage of any in the state. In August of 1984, Illinois Natural History Survey (INHS) personnel conducted a preliminary survey of Kankakee River mussels in the immediate vicinity of the Washington Avenue Bridge (U. S. Routes 45 and 52) in Kankakee, a bridge proposed for removal and reconstruction by the Illinois Department of Transportation (IDOT). During that survey, 579 mussels representing 17 species were collected, identified, and placed live back into the river.

Subsequent to that preliminary survey and upon the recommendations of the U.S. Fish and Wildlife Service and INHS personnel, IDOT requested that the INHS remove mussels from the immediate vicinity of the Washington Avenue Bridge and relocate them to suitable habitat either upstream or downstream of the impact area. Although several mussel relocation projects have been conducted in other states, few have followed the relocation with long-term monitoring in order to determine the efficacy of relocation.

During August and September 1987, INHS personnel, under the direction of Survey malacologist Jeanine M. Berlocher and zoologist Mark J. Wetzel, completed the first phase of the Washington Avenue Bridge mussel relocation project on the Kankakee River.

The objectives of the first phase of the project were: 1) To evaluate several Kankakee River localities upstream of the city of Kankakee as potential sites for receiving relocated mussels; 2) To select and establish plots into which relocated mussels were to be placed; and 3) To remove mussels from the area to be affected by the removal and reconstruction of the Washington Avenue Bridge, mark them, and place them into the relocation plots.

Over 4,000 live unionid mussels representing 20 species were marked and placed into plots during the initial phase of this project. Objectives of Phase 2 of this project include: 1) Estimation of density and distribution of mussels downstream of the direct impact area associated with the reconstruction of the Washington Avenue Bridge during 1988; and 2) Monitoring of the relocated mussels, including growth, movement of plots, and mortality after 1 year. Phase 3 of this project will include: 1) A survey of the Washington Avenue Bridge site after construction has been completed to determine whether this area was affected adversely; and 2) Annual surveys for at least 5 years to monitor both the relocated mussels as well as the recolonization of the construction site.

By Jeanine M. Berlocher and Mark J. Wetzel, Faunistic Surveys and Insect Identification Section