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Assessing the Efficacy of MODIS Satellite-derived Start of Growing Season for Jurisdictional Determination of East Texas Bottomland Hardwood Wetlands

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Introduction: Crucial to the determination of a jurisdictional wetland is the definition of "growing season". Satellite imagery is being utilized in other ecological applications, but is lagging in wetland growing season determination. Both cost and temporal limitations historically have restrained use of satellite imagery in assessing the start up of the growing season. Multiple commercial satellites are available that provide high resolution imagery, but the cost are prohibitive for most studies. The National Aeronautics and Space Administration (NASA) and the U.S. Geological Survey (USGS) jointly manage the Landsat and the Moderate-resolution Imaging Spectroradiometer (MODIS) satellite programs. Landsat Enhanced Thematic Mapper Plus images an area every sixteen (16) days. The rapid biological changes indicating the start up of the growing season must be captured more frequently to successfully use satellite imagery for such a time dependent event. In 1999 NASA launched the MODIS program with the Terra satellite and followed with the Aqua satellite in 2000. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning. Aqua will pass south to north over the equator in the afternoon. This continual, comprehensive coverage allows MODIS to complete an electromagnetic picture of the globe every day. MODIS imagery is available on a daily basis, but the trade-off for the increased speed at which the satellites travel is a lower resolution image when compared to other satellite systems. Research utilizing MODIS for studying vegetation phenology is beginning to emerge, but there is a lack of validation through ground observation for these studies. (Figure 1 and Figure 2)

Objective: The purpose of this study is to determine if MODIS satellite imagery can be used as a tool in determining the start of the growing season for use in wetland delineation. If so, how accurate is it in comparison to ground observation of growing indicators? The goal of this study is to provide a comparison between eastern Texas ground observations of the start up of the growing season and the remote sensing-based measures recorded for the same time period by the MODIS sensors of the EOS satellite system. Our study is comparing MODIS satellite imagery with ground observations to discover the efficacy of MODIS satellite imagery as a tool in determining the start of wetland growing season.

Methodology: Bud burst is one of the first indicators of deciduous tree growth activity in the spring. The bud burst of deciduous tree species (woody plants) was selected as "the start of growing season" signal criteria because it is easily observed in the field and is easily detected with satellite imagery vegetation monitoring tools. Satellite detection of vegetative growth is based on differences in photosynthetic biomass. As the green vegetation expands the Normalized Difference Vegetative Index (NDVI) will be utilized to compare green up dates of the satellite imagery to ground observation data (Figure 1, Table 2). The Ground data will be based on observations comparing a bud score scale to stage of development (Table 1). Bud burst date is established when flowering or green foliage becomes visible between the spreading bud scales.

Table 1. Score for bud scale development Source: *Growing Season as a Requirement for the Identification of Wetlands* Dudley et al., 2005

Bud score	*Stage of Development*
0	No observable growth
1	Bud swollen
2	Green between bud scales or flowering
3	Leaf or flower elongation (>1cm)

Photo 1 – January 27, 2010 Bud score: 0

Photo 2 – February 15, 2010 Bud score: 2

Photo 3 – March 4, 2010 Bud score: 3

Preliminary Data: Ground observations during Spring 2009 indicate a start of growing season date as early as February 11. The Spring 2010 data indicates a start of growing season date of February 15. These dates are dependent on two or more species within a plot reaching a bud score of 2. Dates for one species per plot meeting the criteria were met much earlier; 2009: February 9 and 2010: January 27. When two or more species are required to meet the bud score criteria the dates of green up fall within the predicted time frame of the National Water and Climate Center 's Wetland Climate Evaluation Dataset (WETS Table) (Table 2). When one species per plot meet the bud score criteria the date is 2-6 weeks, dependent on temperature, in advance of the WETS table prediction. The objective of the WETS Table is to define the normal range for monthly precipitation and normal range for growing season required to assess the climatic characteristics for a geographic area over a representative time period (http://www.wcc.nrcs.usda.gov/climate/wets_doc.html#Section5a).

Table 2. Growing Season Information

Nacogdoches County, Texas Growing Season

	Temperature		
	24 °F or higher	28 °F or higher	32 °F or higher
Probability	Beginning and Ending Season Dates		
50 percent*	2/3 to 12/12	2/25 to 11/23	3/14 to 11/13
	Growing Season Length		
	313 days	273 days	244 days

*Chance of the growing season occurring between the beginning and ending dates.
Source: http://www.wcc.nrcs.usda.gov/ftpref/support/climate/wetlands/tx/48347.txt

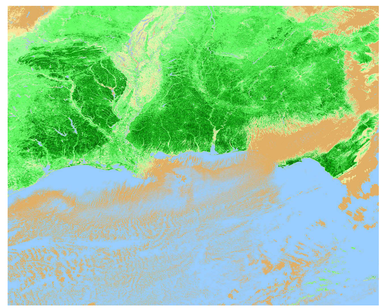

Figure 1. MODIS satellite imagery 01/01/2010 utilizing NDVI index source: http://rapidfire.sci.gsfc.nasa.gov/

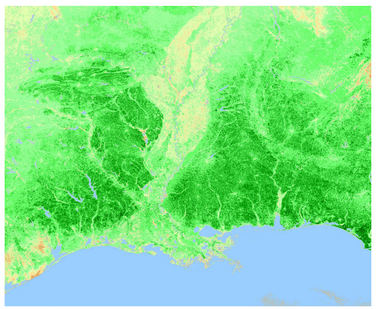

Figure 2. MODIS satellite imagery 03/06/2010 utilizing NDVI index source: http://rapidfire.sci.gsfc.nasa.gov/