Forest Change Detection Methodology
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Oak decline and the red oak borer are currently affecting large portions of the Missouri Ozarks. The challenge is that once the decline is visible on the ground, the forest stand is beyond treatment and must be salvage logged. The forest change methodologies implemented here are in response to United States Forest Service and Missouri Department of Conservation Forestry Division desires to have techniques that are able to detect subtle changes in forest health, so forest remediation measures can be applied before the stand is totally lost.

Two techniques were examined to determine if there was a preferred method to access forest change in portions of the Missouri Ozarks. The techniques chosen had to be able to identify areas of subtle change in forest health. The techniques were chosen based on input from the US Forest Service and from Dr. Steven Franklin, University of Calgary, a collaborator on the project. The Forest Service requested that we investigate a technique they have recently been working with, using Band 7 from multiple years to access forest change. Dr. Franklin suggested investigating the “wetness” component from the tassled cap transformation as a means of determining change from multiple satellite scenes. The particulars of each technique follow.

For this application, a time step of 2 years was chosen, giving us data from late August/early September of 1996, and 2000. This short time step was chosen because the view from satellite of the Missouri Ozark forests shows that vegetation regenerates rapidly. Within 5 years cut sites appear to be regenerated (Michael Schanta, Mark Twain National Forest, personal conversation). This does not mean that the trees have regenerated in only 5 years, but that the vegetation signature collected by the satellite makes it appear that the forest has not been disturbed. The time step between successive satellite scenes is determined by user needs. The change detection routines were implemented on a full scene in the heart of the Missouri Ozarks (path 24, row 34).

For the Band 7 technique, from here on referred to as B7, the B7 data collected in the spectral range of 2.09 to 2.35 microns with a spatial resolution of 30m, are extracted from multiple satellite scenes with similar anniversary dates. The B7 data are collected and deposited into the same image file to facilitate visual inspection and latter classification. The B7 image was subjected to an unsupervised clustering algorithm. Initially 100 clusters were specified. The 100 clusters were labeled according to the type of forest change that was exhibited by each cluster (Table 1). The term negative change refers to forest cutting or mortality, where the term positive change refers to forest growth.

Table 1. Forest change terms and descriptions.

Type of Change	Description of Change
Early Negative Change	Negative change from 1996 to 1998. No change from 1998 to 2000.
Negative Change	Gradual negative change from 1996 to 1998, and 1998 to 2000.
Late Negative Change	No change from 1996 to 1998. Negative change from 1998 to 2000.
No Change	No visible change from 1996 to 1998, or 1998 to 2000.
Early Positive Change	Positive change from 1996 to 1998. No change from 1998 to

	2000.
Positive Change	Gradual positive change from 1996 to 1998, and 1998 to 2000.
Late Positive Change	No change from 1996 to 1998. Positive change from 1998 to 2000.
Early Negative Change/Late Positive Change	Negative change from 1996 to 1998. Positive Change from 1998 to 2000.
Early Positive Change/Late Negative Change	Positive Change from 1996 to 1998. Negative change from 1998 to 2000.

It was determined that the inclusion of non-forested areas in the cluster determination resulted in confusion when the operator tried to assign labels. It was decided that the forest areas should initially be masked out to determine the true power of the change methods. A forest mask was generated using classifications that had previously been done for the state of Missouri. They included, the Land Use Data Analysis (LUDA) classification, the Missouri Gap Analysis classification, and the National Landcover Dataset (NLCD) classification. Only those areas that were labeled as forest in all three classifications were included in the forest mask. A more suitable forest mask will be available once the landcover update for this region is complete. After masking, only 75 clusters were required to adequately characterize the B7 scene. The assignment of labels to the forested areas was much less difficult due the masking procedure.

The same set of imagery used for the B7 procedure was also used for the Tassled Cap Wetness procedure, from here on referred to as TCW. The Wetness component from each scene's tassled cap transformed datasets are collected and deposited into the same image file to facilitate visual inspection and latter classification. The same classification procedures used for the B7 routine were applied to the TCW routine. Initially 100 clusters from an un-masked scene were implemented with similar confusion as that discussed above encountered. The scene was then masked and 75 clusters were specified. The assignment of cluster labels more straightforward after the masking procedure.

The change maps from each of the procedures do an adequate job of identifying areas where change in forest makeup is occurring. There are areas where the change detailed in the change maps from each of the procedures is very similar, and areas where the degree of change represented are very different. The change delineated with the TCW procedure appears to be more sensitive to subtle changes in forest composition as compared to the change delineated using the B7 procedure. These results are currently being field checked by Forest Service personal to determine if the change represented by the TCW procedure is in fact change, or possibly just associated with noise generated by the tassled cap transformation procedure.