

An aerial photograph of a vast, dense forest. A river or stream winds through the center of the forest, creating a light-colored path. The trees are a mix of green and brown, suggesting a temperate forest. The overall scene is lush and natural.

Forest One, Inc.

A Change Detection Model for
CREP Enrollments

2005 Governor's Conference on the
Management of the Illinois River System

About Forest One

Forest One is an information technology company specializing in Geographic Information Systems (GIS), Remote Sensing (RS) solutions, and geospatial software development for natural resource management issues.



Forest One Background

- Began operations in 2000
- Currently employs 21 experienced individuals
- Offices in Itasca, IL and Jackson, MS
- Partially owned by the Earth Satellite Corporation
- Clients include:
 - State and federal government
 - Forestry products companies
 - Forest investment companies
 - Environmental management organizations...



Illinois Conservation Reserve Enhancement Program (CREP)

- Created March 1998 to improve water quality in the Illinois River Watershed
- Acres enrolled by Sept 2004: 150,557
- Eligible acres: 232,000
- Total program discounted costs from March 1998 to Sept 2004: \$227,937,571

Source: Illinois CREP 2004 Annual Report



Illinois CREP Goals

- Reduce silt and sedimentation entering the waterway by 20%
- Reduce phosphorus and nitrogen loading by 10%
- Increase certain bird populations by 15%
- Increase native fish and mussels by 10%

Incentives to CREP Participants

- Landowners enroll eligible agricultural land in a Federal 15-year CRP contract and receive financial incentives in exchange for establishing specific conservation practices on the land
- If the land is within the Illinois River Watershed, it may be eligible for the Enhanced CRP program (CREP) and for additional financial incentives
- Once enrolled, landowners have the option to extend their contract by entering into a State conservation easement for an additional 15 years, 35 years, or permanently, and the State provides financial incentives for the different options



Assessment and Monitoring

- Where are the enrolled acres?
- How are contract details tracked?
- What is the status of enrolled acres: are they in compliance with conservation practices?
- How effective is the program in meeting overall goals?

(See report: Assessment of CREP Wetland Habitat Quality for Wildlife, Donald Phillips and Pat Brown)



Where are they? What are the details?

- The Illinois Conservation Practices Tracking System (ICTPS) was developed to individually track the precise location, nature, and duration of all active conservation practices implemented within the Illinois River basin.
- ICTPS, a PC-based spatial and relational database, was designed by the IL-DNR and U of I Extension

Location of Approved Illinois CREP contracts from the
 USDA and State of Illinois - All Years
 (as of 10/21/2004)

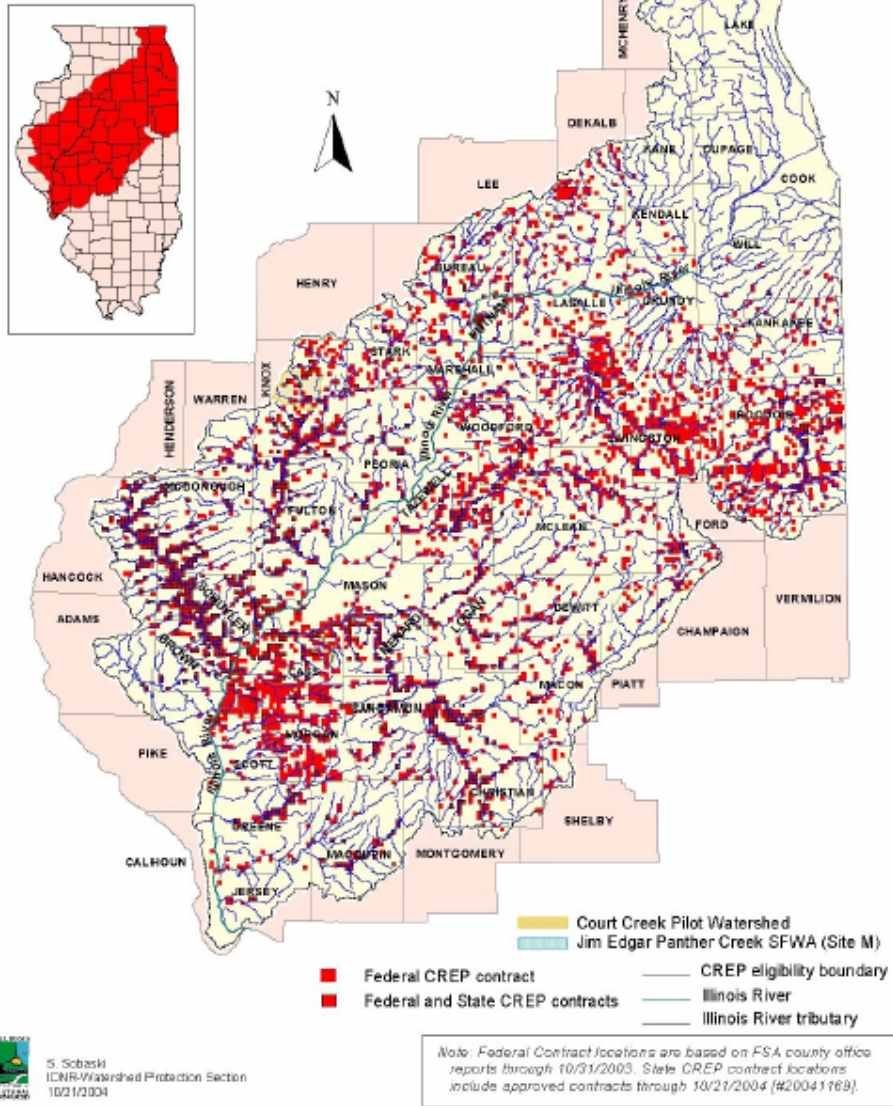


Figure 1. CREP contract enrollments for the Illinois River basin. Red squares denote section (1 mile²) and the area in which one or more enrollments occur.

ICTPS: A comprehensive, GIS-based approach to track conservation practices. It provided the enrollment information needed for the assessment and monitoring project.

Source: The Illinois Conservation Practices Tracking System (ICTPS) and CREP Assessment, Final Report



What is the status of the 5300+ CREP enrollments....



..and how can you
assess compliance in
a cost effective
manner?

Forest One

Assessing Status and Compliance

- Using satellite imagery analysis, Forest One proposed to determine where changes in CREP enrollments might indicate noncompliance with approved conservation practices.
- The goal is not to pinpoint violators at 100 % accuracy, but to reduce the search space and make regulation effort more efficient and effective.
- If successful, this could represent a substantial savings in cost and manpower with respect to monitoring compliance on 232,000 eligible acres.



Objective of Satellite Imagery Project

- Can remotely sensed data identify changes in conservation practices?
(Assumption: Noncompliance may be indicated by unexpected changes in landcover, or by biomass outside different than that expected for CP1)
- What are the opportunities and challenges in the proposed approach?
- How cost-effective is the proposed approach?

Proposed Methodology

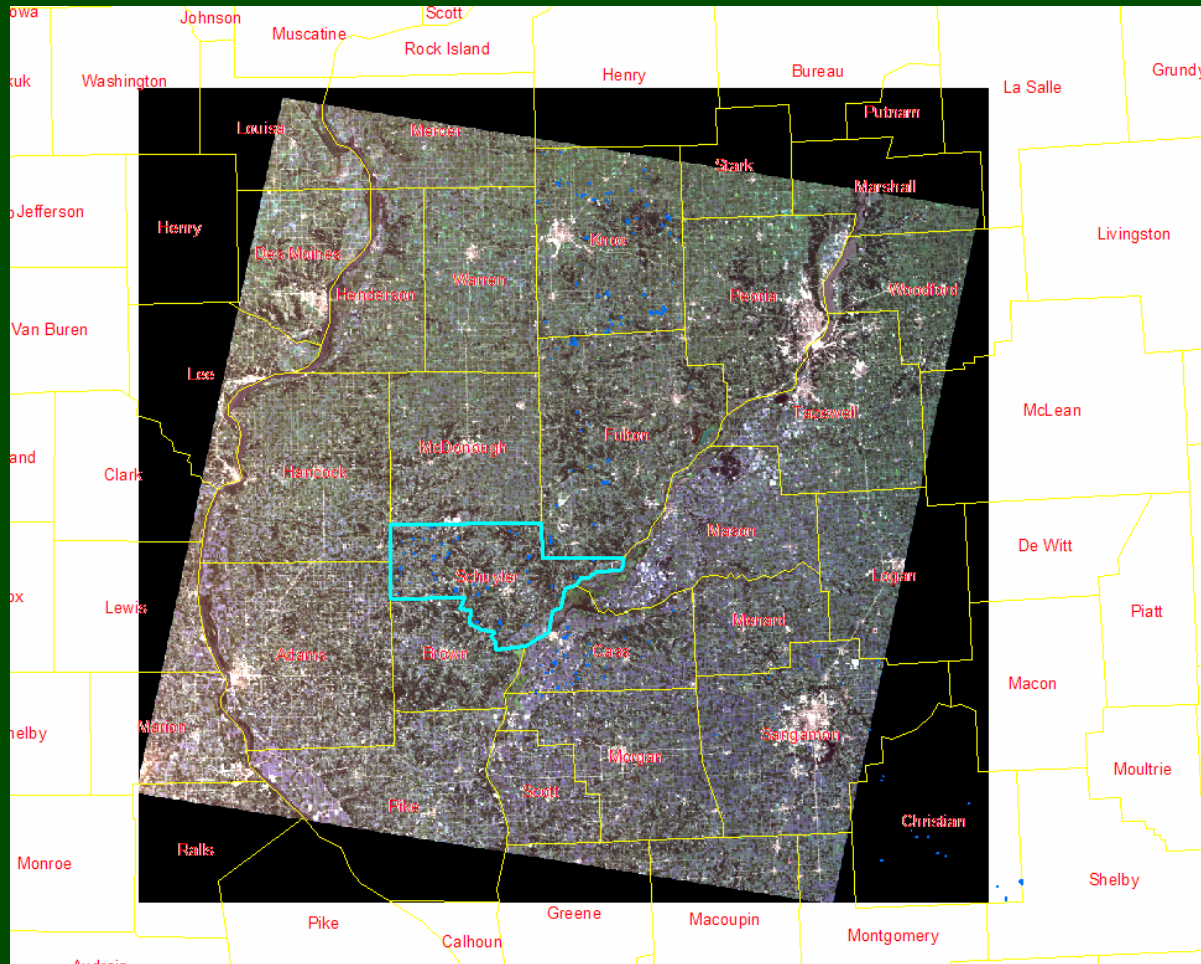
- Select enrollments in a specific conservation practice for analysis
 - CP1, *Establishment of Permanent Introduced Grasses and Legumes*, was selected due to its long history of implementation, its prevalence in the AOI, and its homogeneity within the tract
- Analyze Landsat images from Sept 2003 and 2004
 - Change Detection and Analysis
 - Significant increase/decrease in vegetation, indicating suspect change in practices
 - Outlier Detection and Analysis
 - High/low biomass outside the range of expected for CP1, indicating implementation of improper practices



Proposed Methodology (con't)

- Visit sites where noncompliance may be indicated to verify findings
- Provide web-based interface for providing data and analysis to compliance personnel

Landsat Image Footprint Used for the Analysis: AOI = Schuyler County



Why Landsat?

- Low image acquisition cost and ready availability reduces cost per acre
- Adequate spatial resolution at ~ 30 m per pixel
- Adequate temporal resolution at 16 day intervals

Image Comparison

Satellite	Approximate Cost/Acre	Spatial Resolution (m) Multi-spectral	Frequency of Image Acquisition (Revisit)
Digital Globe (Quick bird)	\$ 0.081	3 (.002 acre)	7 days
IKONOS	\$ 0.061	4 (.004 acre)	3 days
SPOT	\$0.0038	10 (.024 acre)	26 days
Indian Remote Sensing (IRS)	\$0.00052	24 (.142 acre)	5 days
Landsat	\$0.00014	28.5 (.200 acre)	16 days

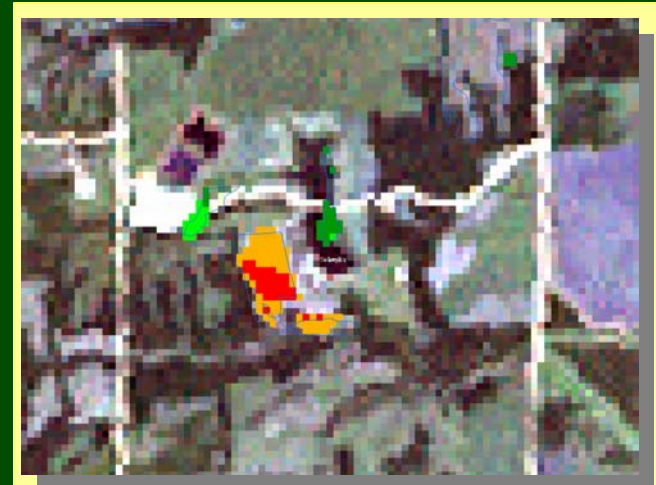
Change Detection and Analysis



September 5, 2002



September 16, 2003



Looking only at
CP1 land, for
areas of
significant
change



Level of Change	Legend
Significant decrease in Vegetation	Red
Moderate decrease in Vegetation	Yellow
Moderate increase in Vegetation	Green
Significant increase Vegetation	Teal

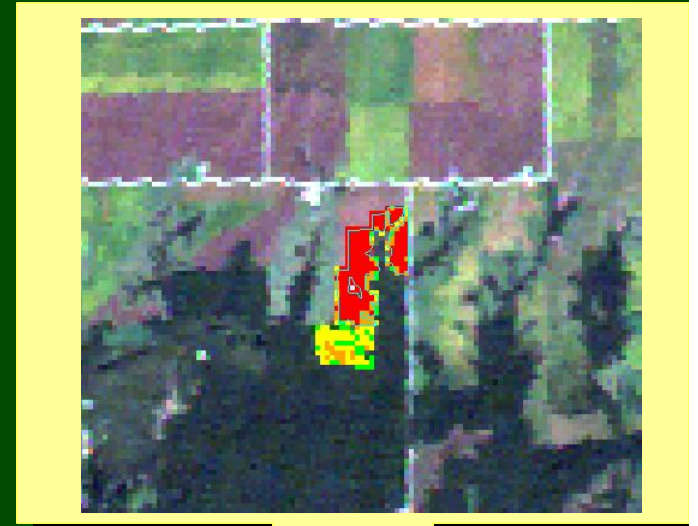
Outlier Detection and Analysis



September 5, 2002



September 16, 2003



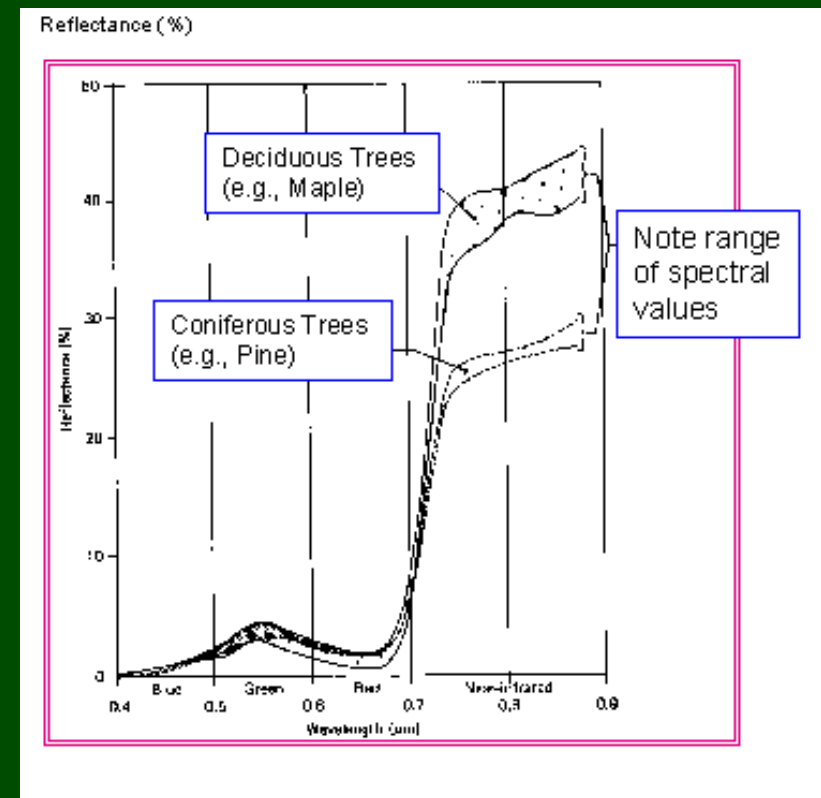
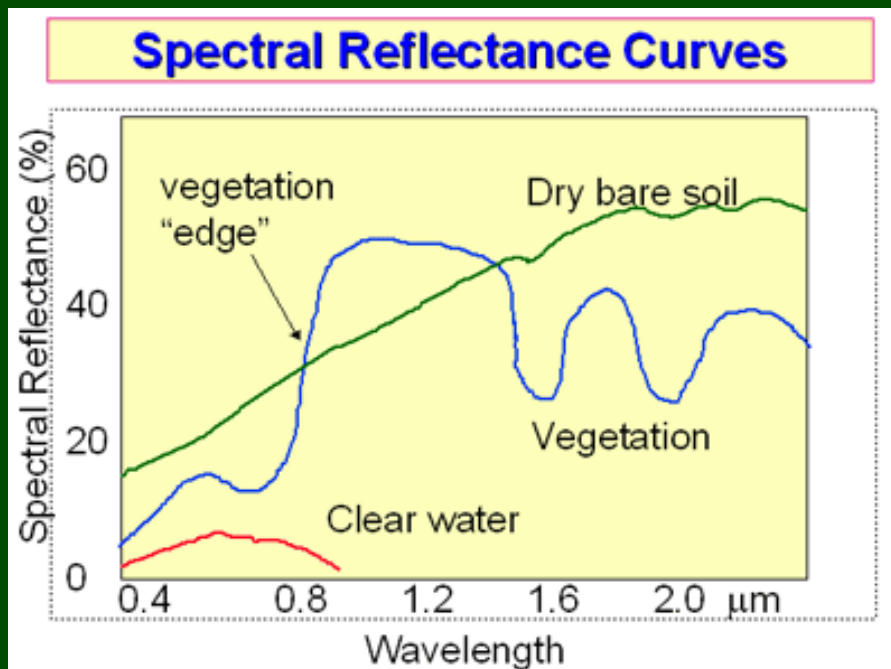
Looking only at CP1 land, for areas of low or high biomass outside the range of what would be expected.



Vegetation Type	Legend
Low Vegetation	Red
Low-Medium Vegetation	Orange
Medium Vegetation	Yellow
Medium-High Vegetation	Green
High Vegetation	Dark Green

Further Analysis of Outliers: What Is It?

Spectral Reflectance Signatures (forestry example)



Semi-automated imagery analysis can differentiate between crops and other vegetation.

Project Results

- Validation of Proposed Methodology for Analysis: Algorithm was validated with CP1 lands. Analysis successfully detected large scale change activity (>5 acres) such as plowing and harvesting, and identified outliers for additional analysis.
- Conclusion: A combination approach of change detection and biomass outlier detection can successfully identify potential violations of CP1 practices, which can greatly reduce the cost of monitoring land for compliance.

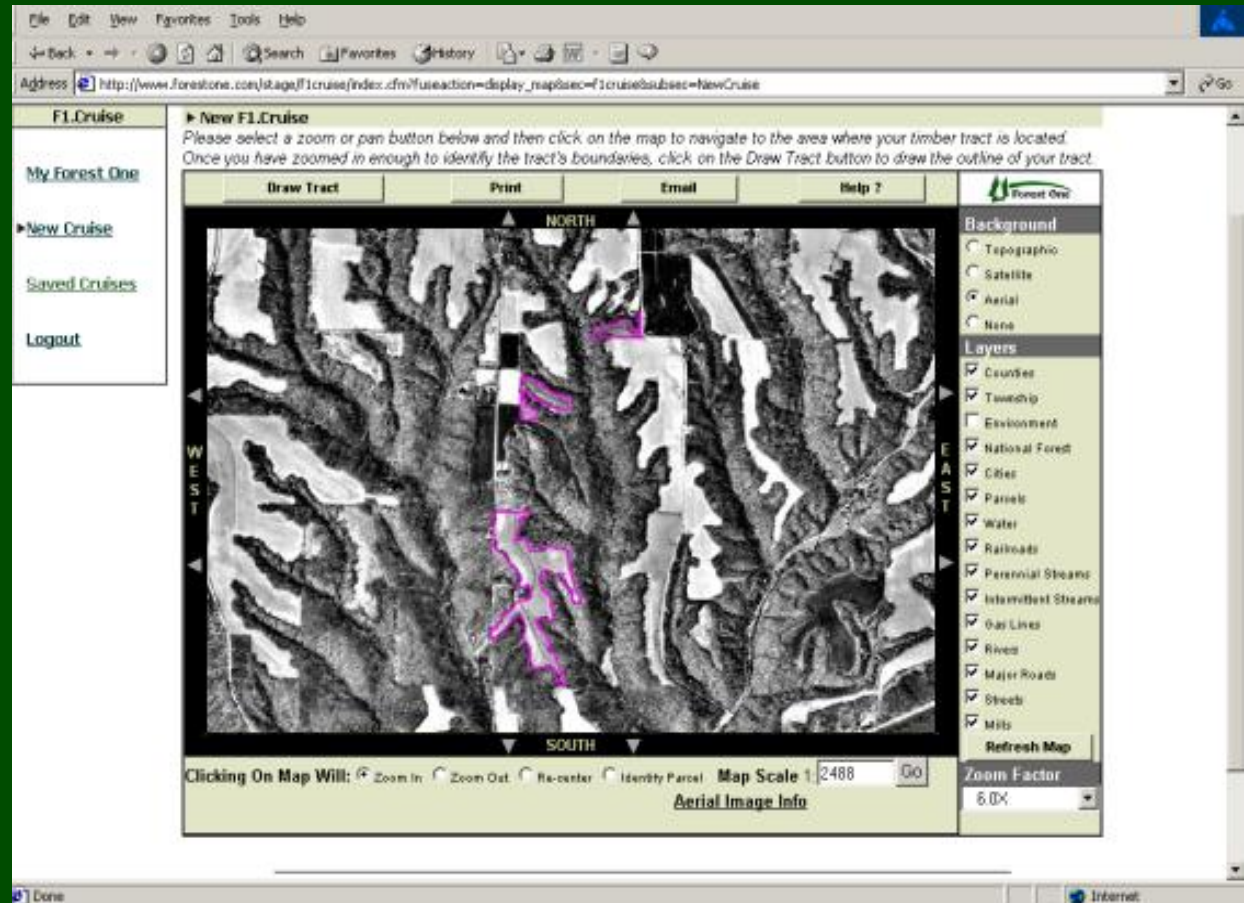
Project Results (con't)

- Site visits within the Area of Interest confirmed the reliability of the imagery analysis
- Cost to monitor compliance using Landsat imagery analysis to identify areas for **selected site visits**, is estimated to be \$0.75 per acre
- Cost to monitor compliance by making **site visits to all enrolled land** is estimated to be \$4.00 per acre

Web-based Data Delivery

www.ForestOne.com

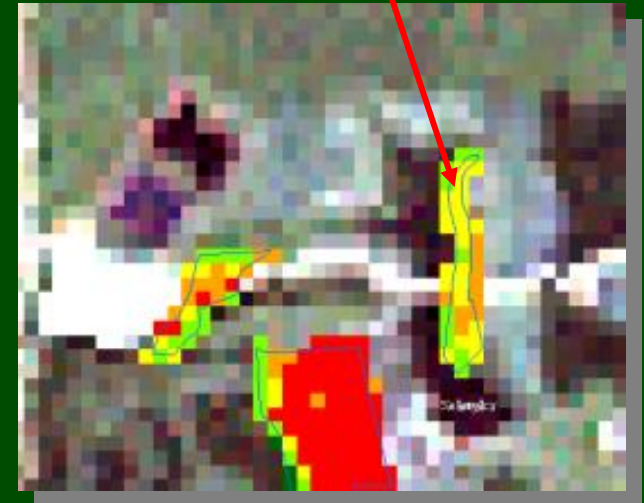
Forest One has developed a website (F1 Cruise) for delivering geographic data to its forestry clients. Data can be interactively viewed and queried. A similar website has been designed for conservation practice monitoring.



Challenges and Opportunities

- Other types of conservation practices need to be tested with the proposed algorithm
- Current satellite imaging technology can provide higher resolution for more accurate monitoring but for greater COST.
- Long linear shape and small scale changes showed limitation of Landsat-based monitoring: Practical mapping unit of monitoring is 5 x 5 pixels (about 5 acres)

Less than
5 pixels
wide



**The Spatial
Resolution Issue:**

**LandSat Image
~30 m resolution**

**AOI
~0.5 km by 0.5 km**

**Can you guess
what this area is?**



**UW Madison
Camp Randall
Stadium
Home of the
Badgers**



Future Steps

The USDA has a challenge to manage a growing conservation program with the same or reduced staff. Satellite imagery analysis is an effective option to increase efficiency in monitoring some conservation practices in some areas.

- Further testing is required over larger land areas and encompassing multiple conservation practices
- Costs/savings for this method and other options (higher resolution imagery at higher cost but greater accuracy?) need to be documented in order to determine best value

An aerial photograph of a vast, dense forest. The trees are a deep green color. In the center of the image, there is a large, irregularly shaped clearing or meadow. The foreground shows a mix of green grass and some taller, yellowish-brown grasses. The background is a continuous expanse of forest stretching to the horizon.

For More Information:

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