Remote Sensing Tools to Detect Water Quality Benefits from Conservation Programs

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Chesapeake Bay

Watershed

64,000 mi^2

Maryland Cover Crop Program

- Conventional Cover Crops
  - Plant by Sept 15 (early), by Oct.15 (mid) or by Nov. 5 (late) with spring kill down (after March 1)
  - Receive up to $100/acre to plant traditional cover crops ($45/acre base payment and up to $55/acre in add-on planting incentives)
- Commodity Cover Crops
  - Crop taken to harvest with no fall fertilization
  - Farmer receives $25 incentive payment

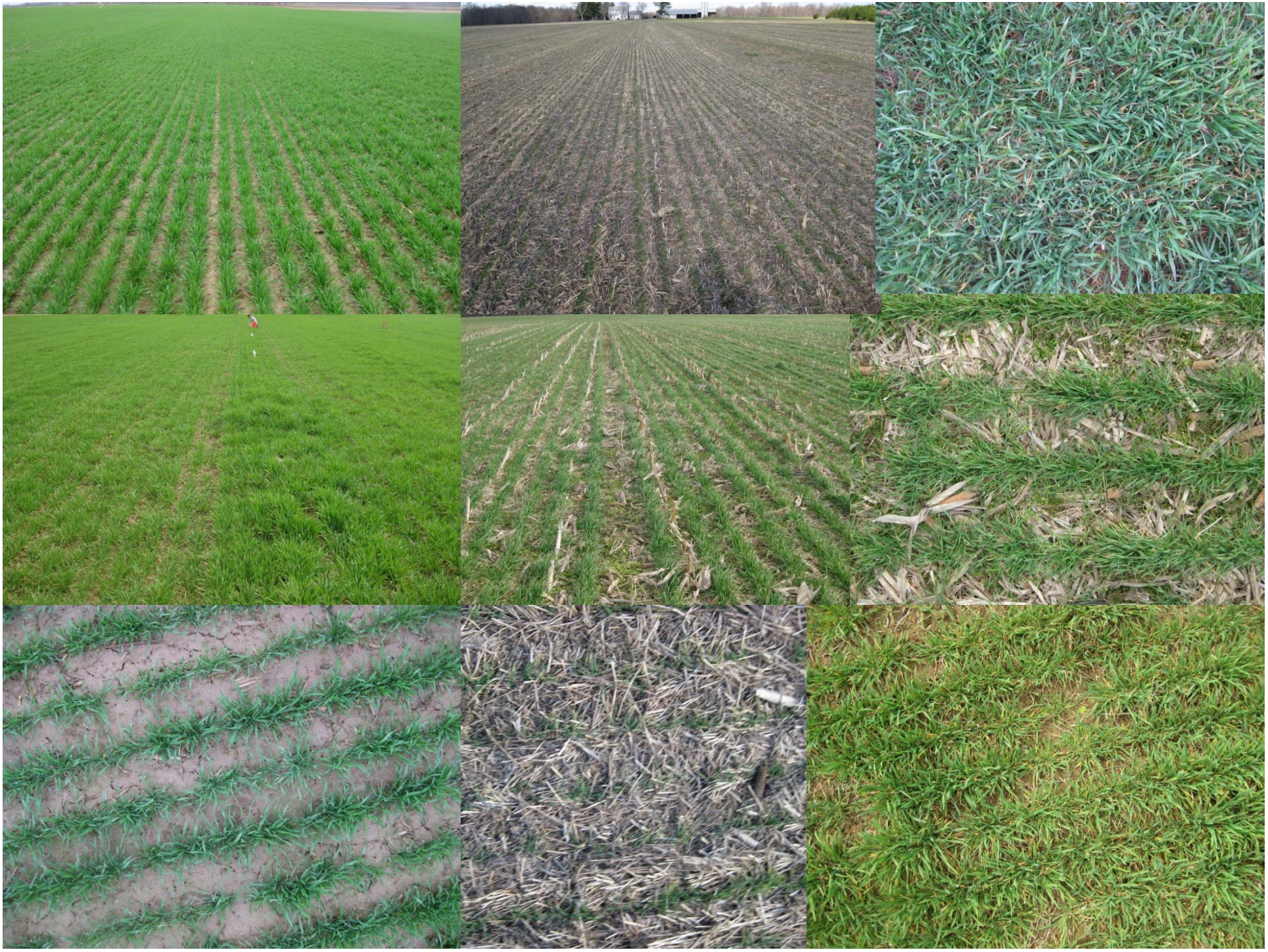
Cover Crop Evaluation

- Collaboration with MDA since 2004
- Link program and agronomic information obtained from farmer enrollment to remote sensing data
- Provides a powerful means to assess agronomic performance over large regions
- Can provide accurate watershed estimates of nutrient uptake by winter cover crops

Obtain cover crop cost-share program enrollment data from Maryland Department of Agriculture

SEQNO	FILE	FARM_TRACT	FIELD_NO	SPECIES	RATE	METHOD	PLANTING_DATE	PREVIOUS_CROP
10716	CC	822T1070	1	SPRING OATS	3	BROADCAST	8/15/2007	CORN
10717	CC	822T1070	1,7,4	WHEAT	2	BROADCAST	9/1/2007	CORN
10719	CC	440T1110	P/O1	BARLEY	2.5	NO TILL	9/13/2007	CORN
10734	CC	1207T6243	1	WHEAT	2.5	BROADCAST	9/20/2007	CORN
10744	CC	2232T603	1	WHEAT	2	CONVENTIONAL	9/30/2007	SOYBEANS
10745	CC	2384T13345	1-3	WHEAT	2	CONVENTIONAL	9/28/2007	SOYBEANS
10746	CC	178T909	1	WHEAT	2	CONVENTIONAL	9/27/2007	SOYBEANS
10747	CC	2229T13221	4	RYE	2	BROADCAST	10/1/2007	CORN
10748	CC	1815T632	3,30	RYE	2	BROADCAST	10/1/2007	CORN
10749	SG	1104T149	1	BARLEY	2.5	NO TILL	9/22/2007	CORN
10750	SG	1020T171	1,P/O2	BARLEY	2.5	NO TILL	9/23/2007	CORN
10751	SG	1019T182	1	BARLEY	2.5	NO TILL	9/23/2007	CORN
10752	SG	1935T13008	2-4	BARLEY	2.5	NO TILL	9/22/2007	CORN

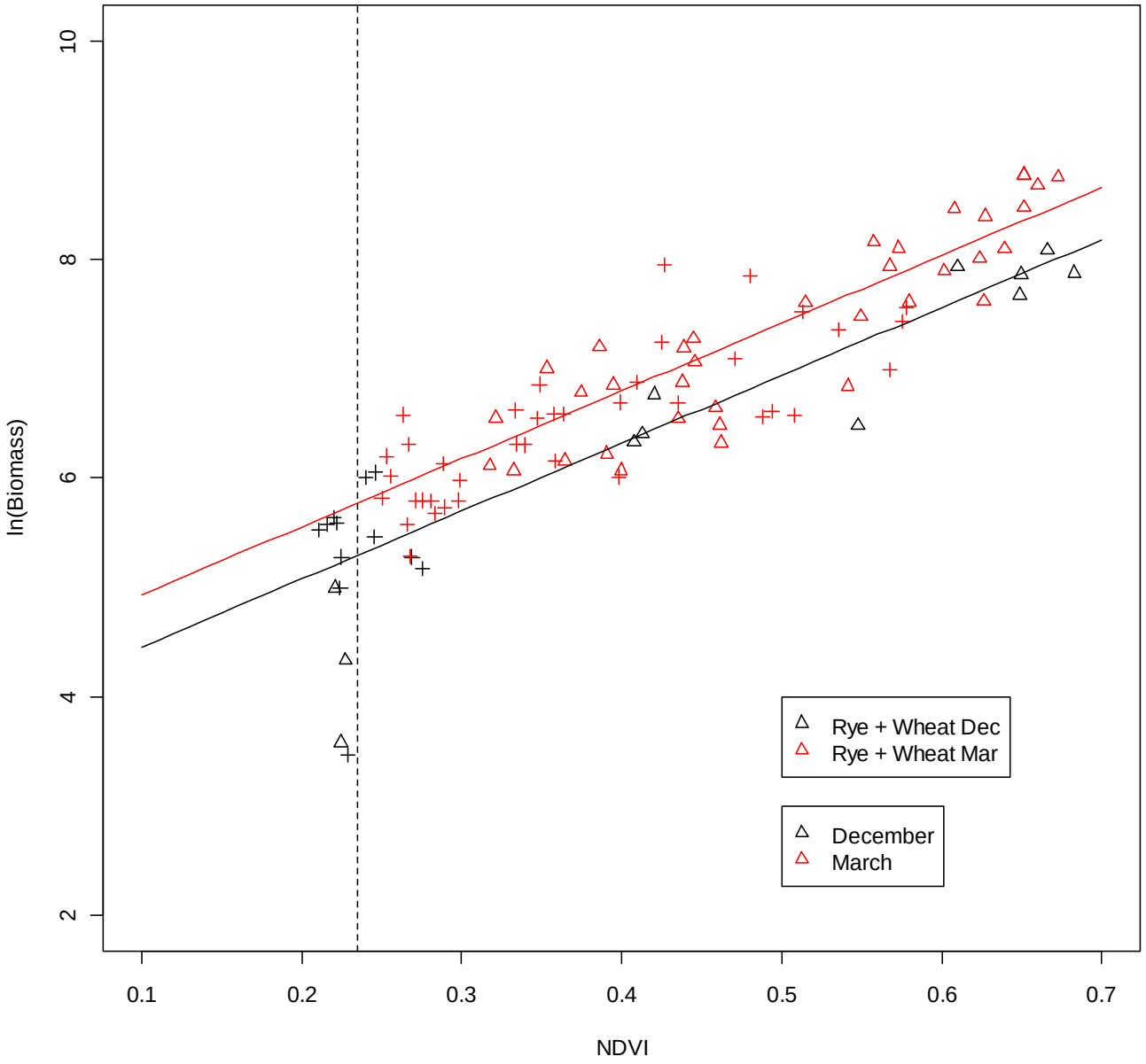
- Field location
- Species (rye, barley, wheat, brassicas)
- Planting method (drilled, broadcast, aerial)
- Planting date (Mid-September to Nov 5th)
- Previous cash crop (corn for grain, corn for silage, soybean)
- Irrigation usage



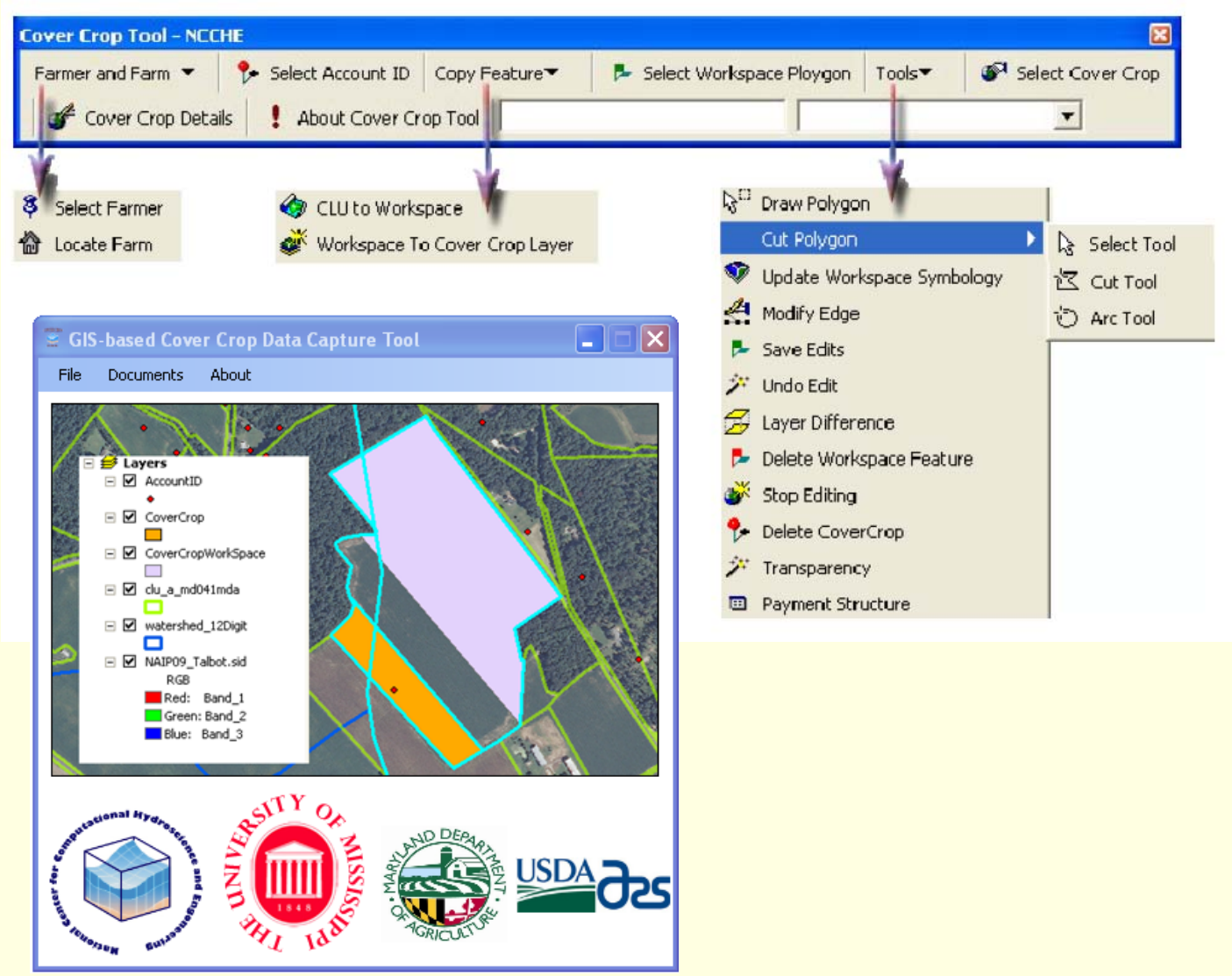
Developing the calibration

Establishing relationships between satellite derived vegetation index (NDVI) and cover crop biomass production

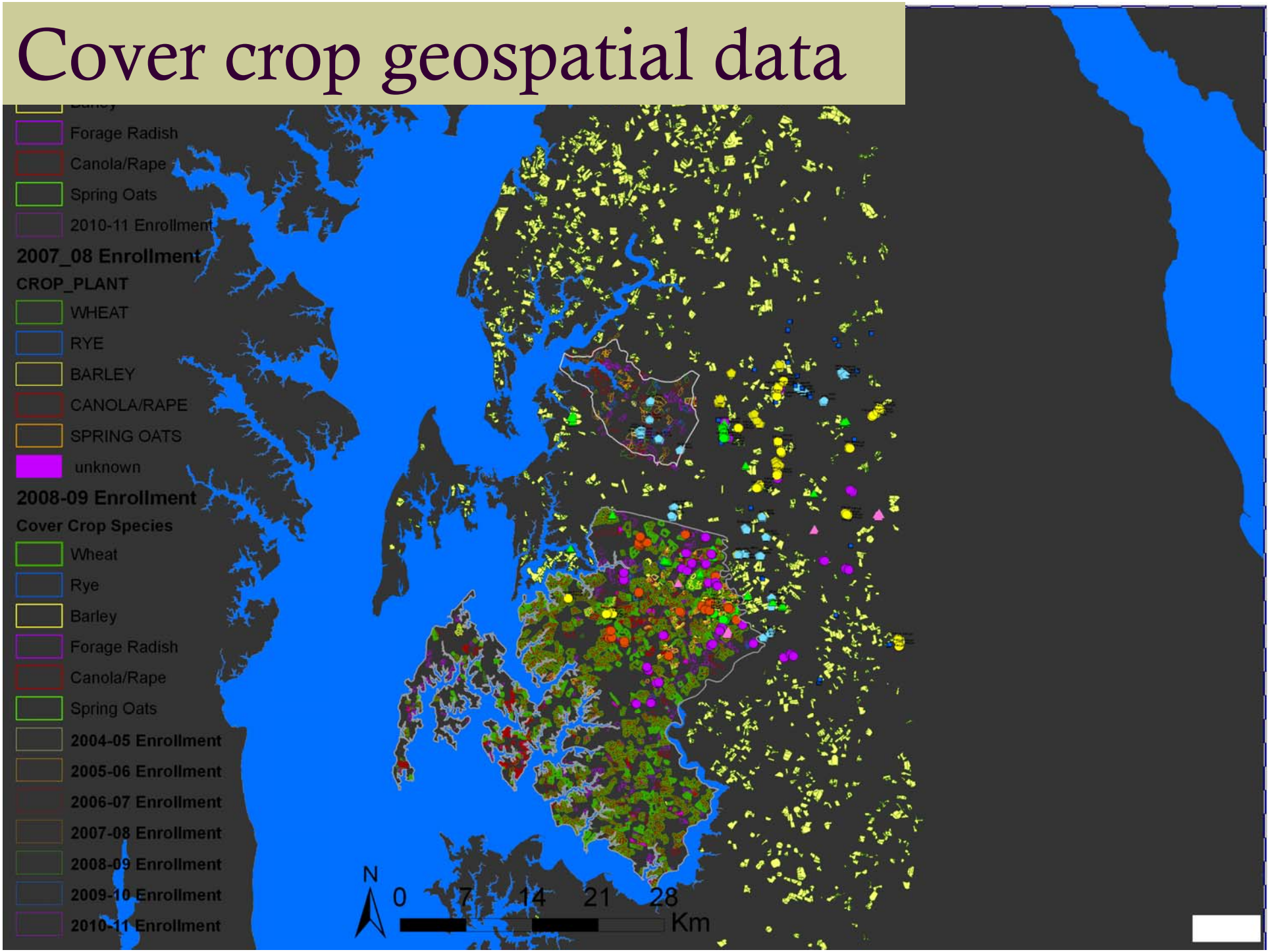
Relationship of NDVI to aboveground biomass measurements



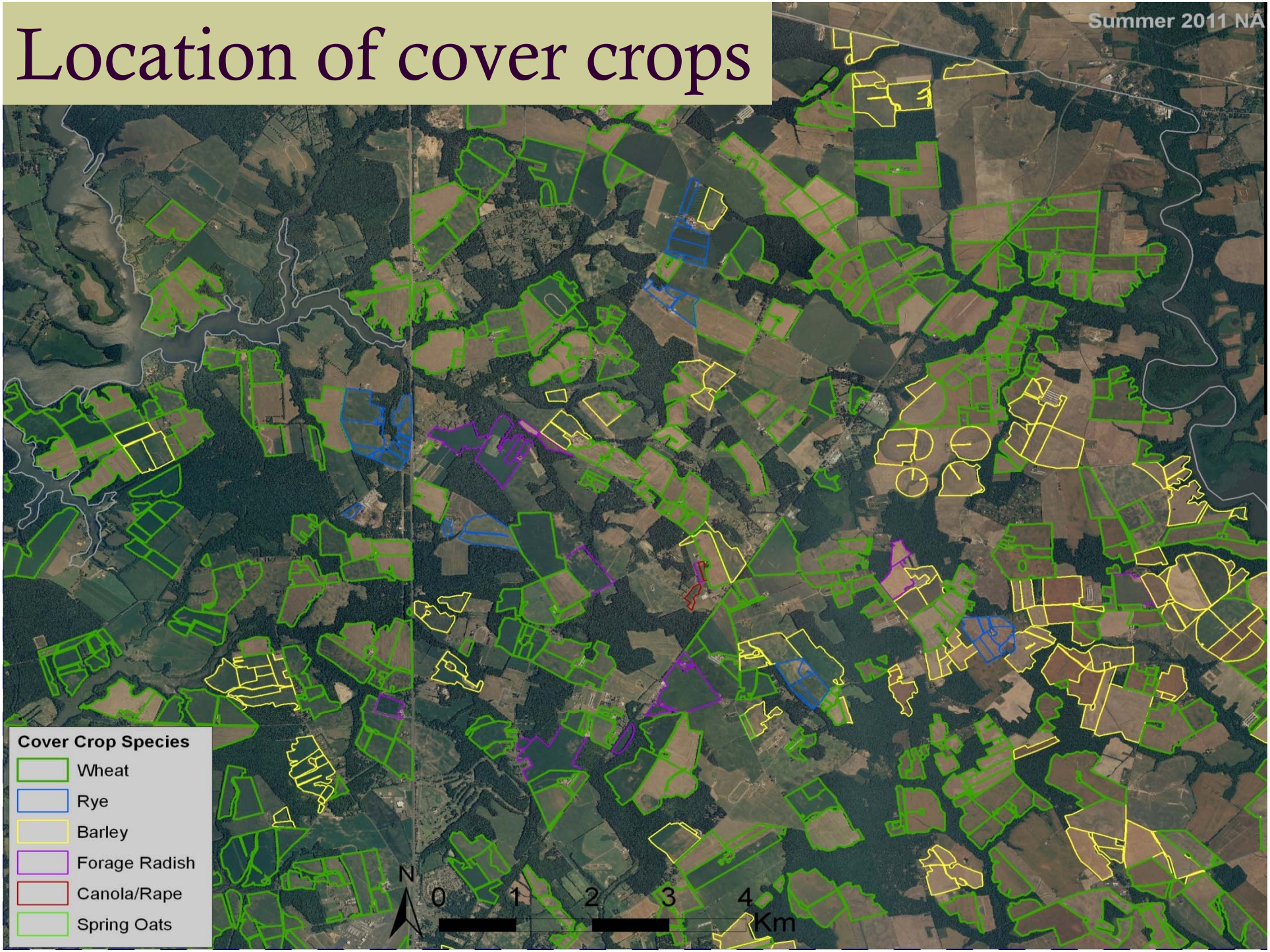
Enrollment Data Capture Tool



Cover crop geospatial data

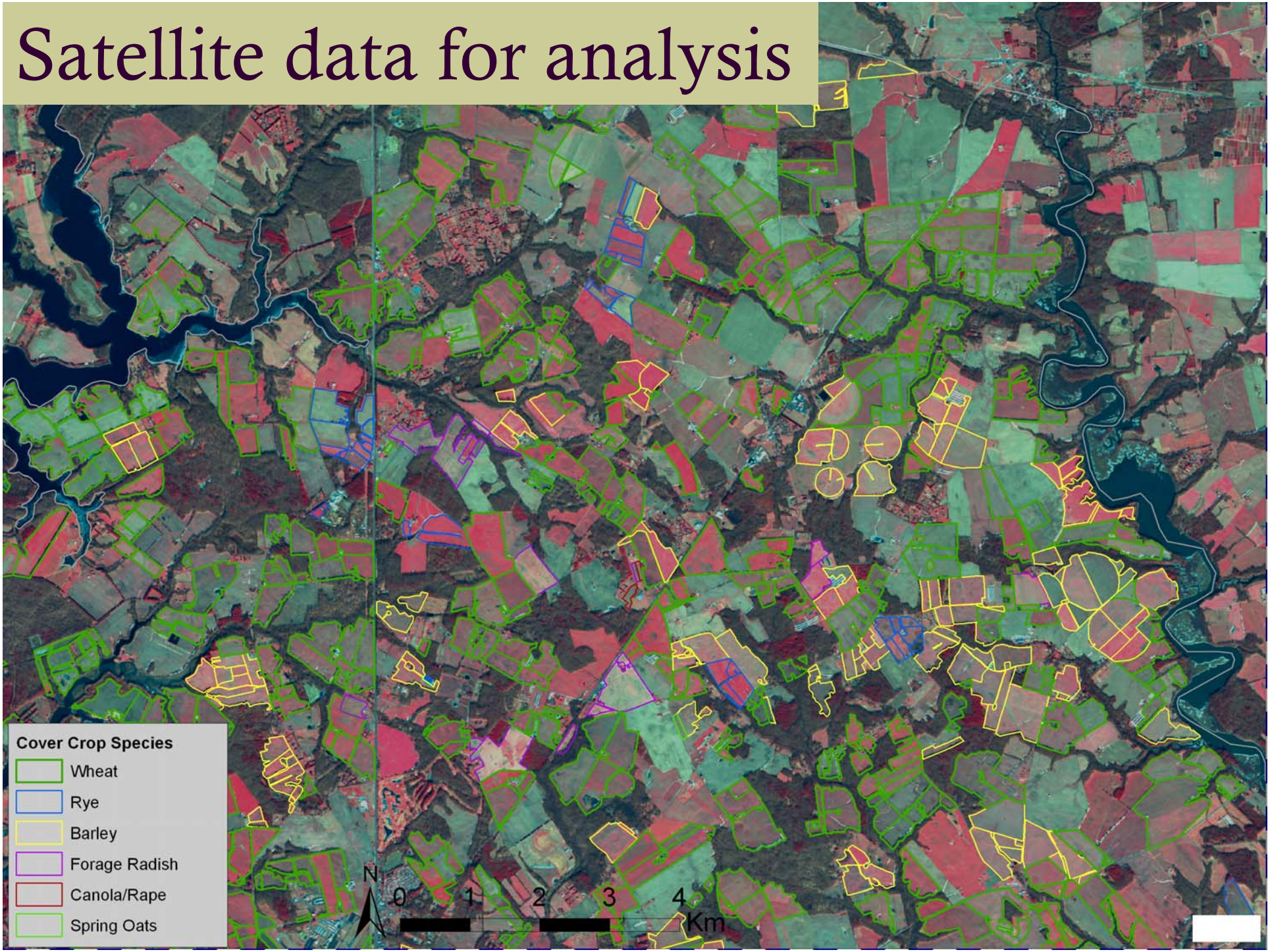


Location of cover crops

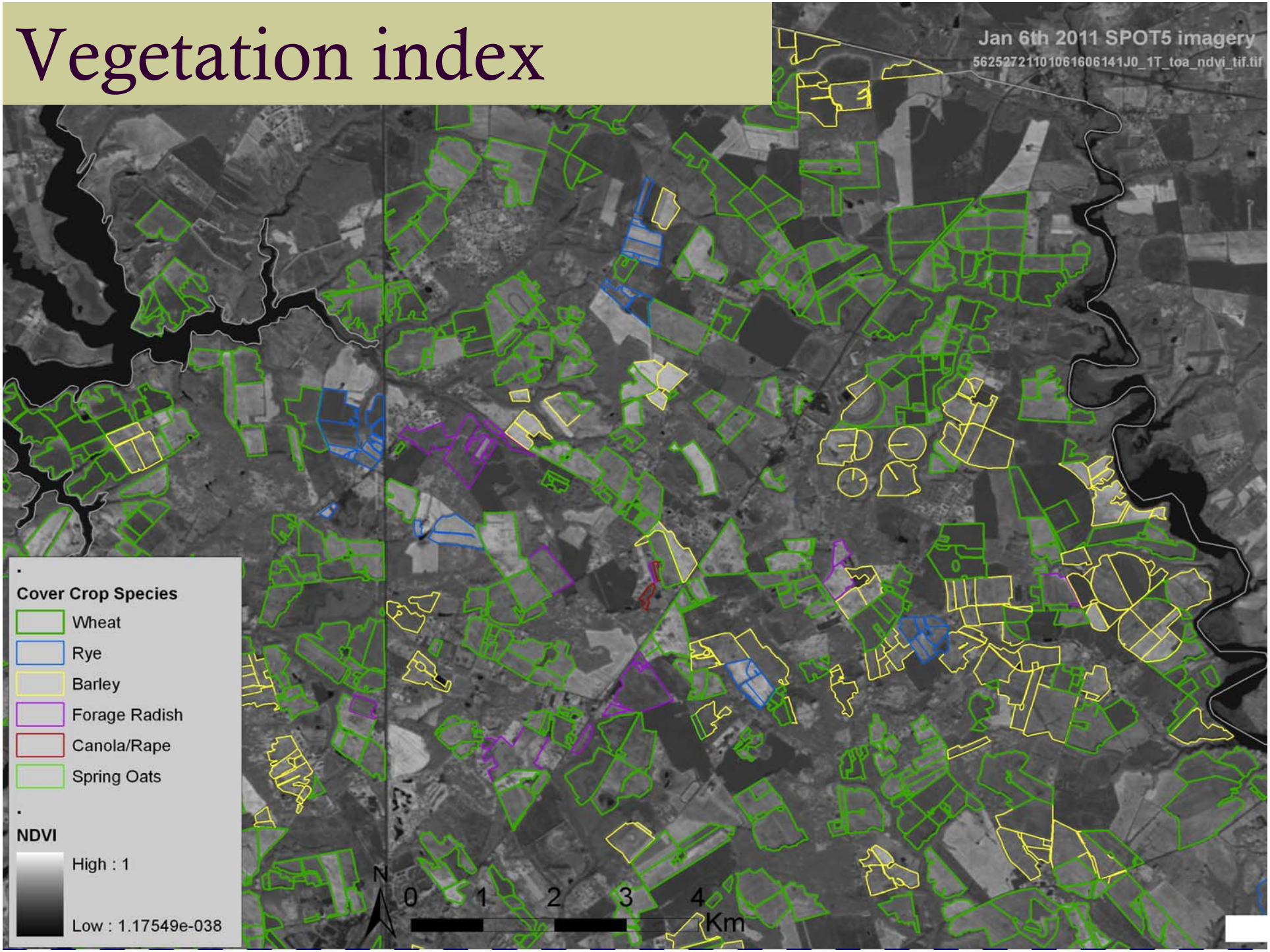


Previous cash crop

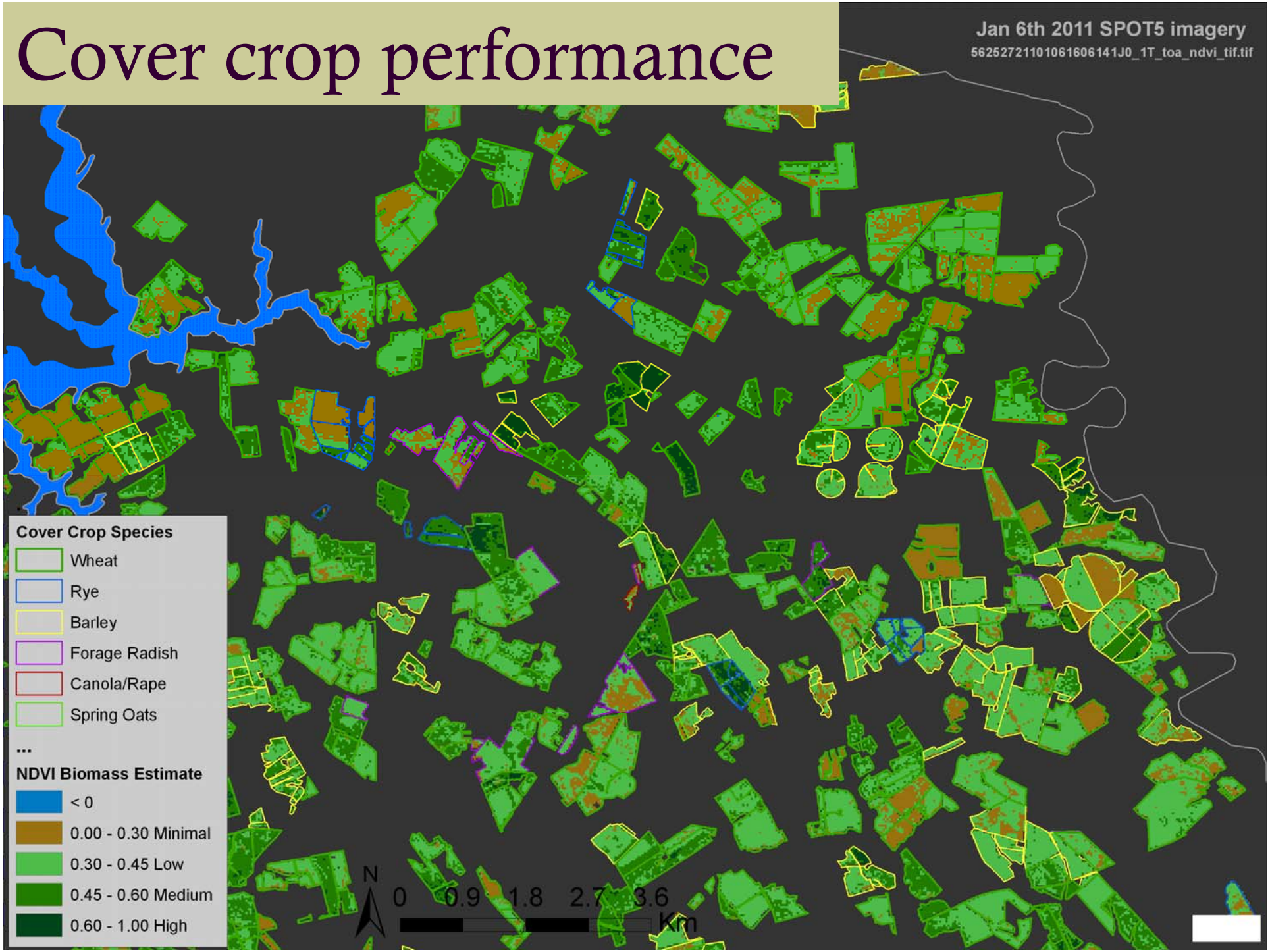
Satellite data for analysis



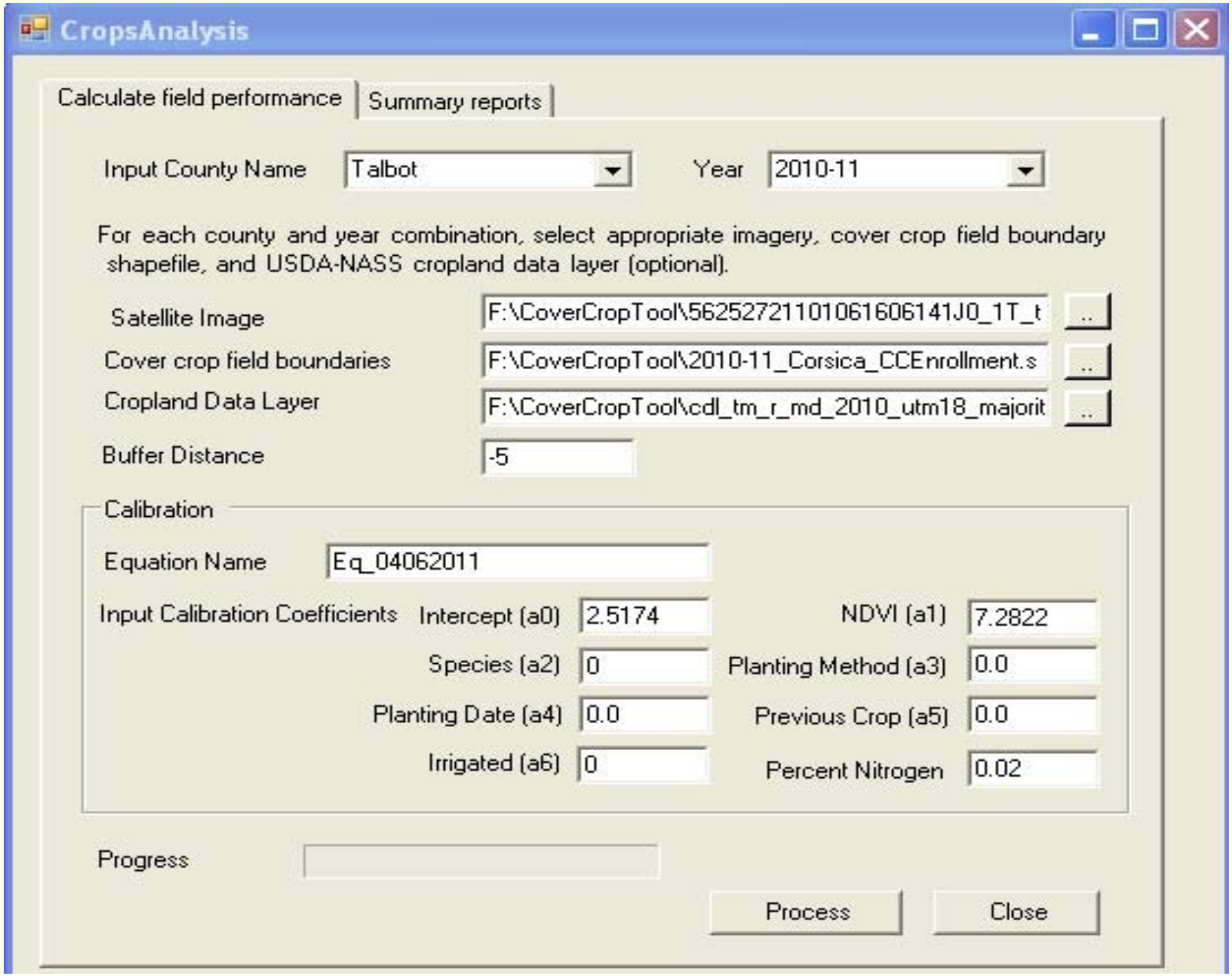
Vegetation index



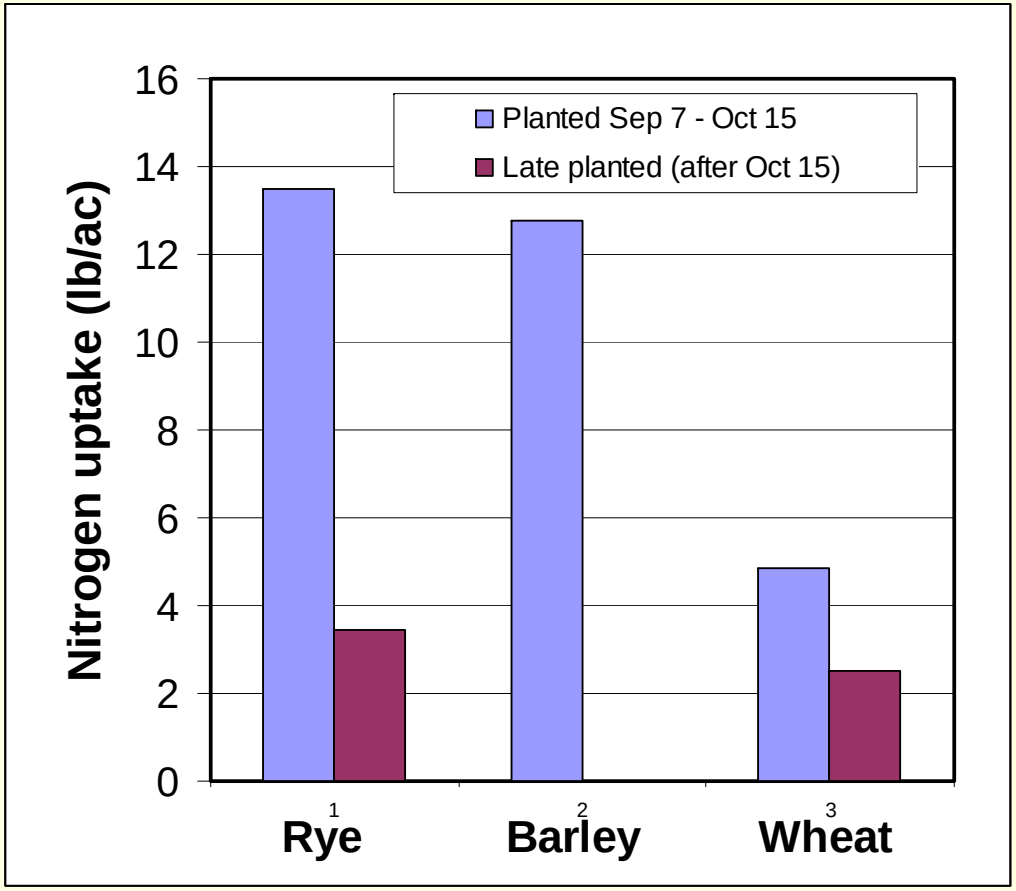
Cover crop performance



Cover crop performance analysis



Cover Crop Valuation

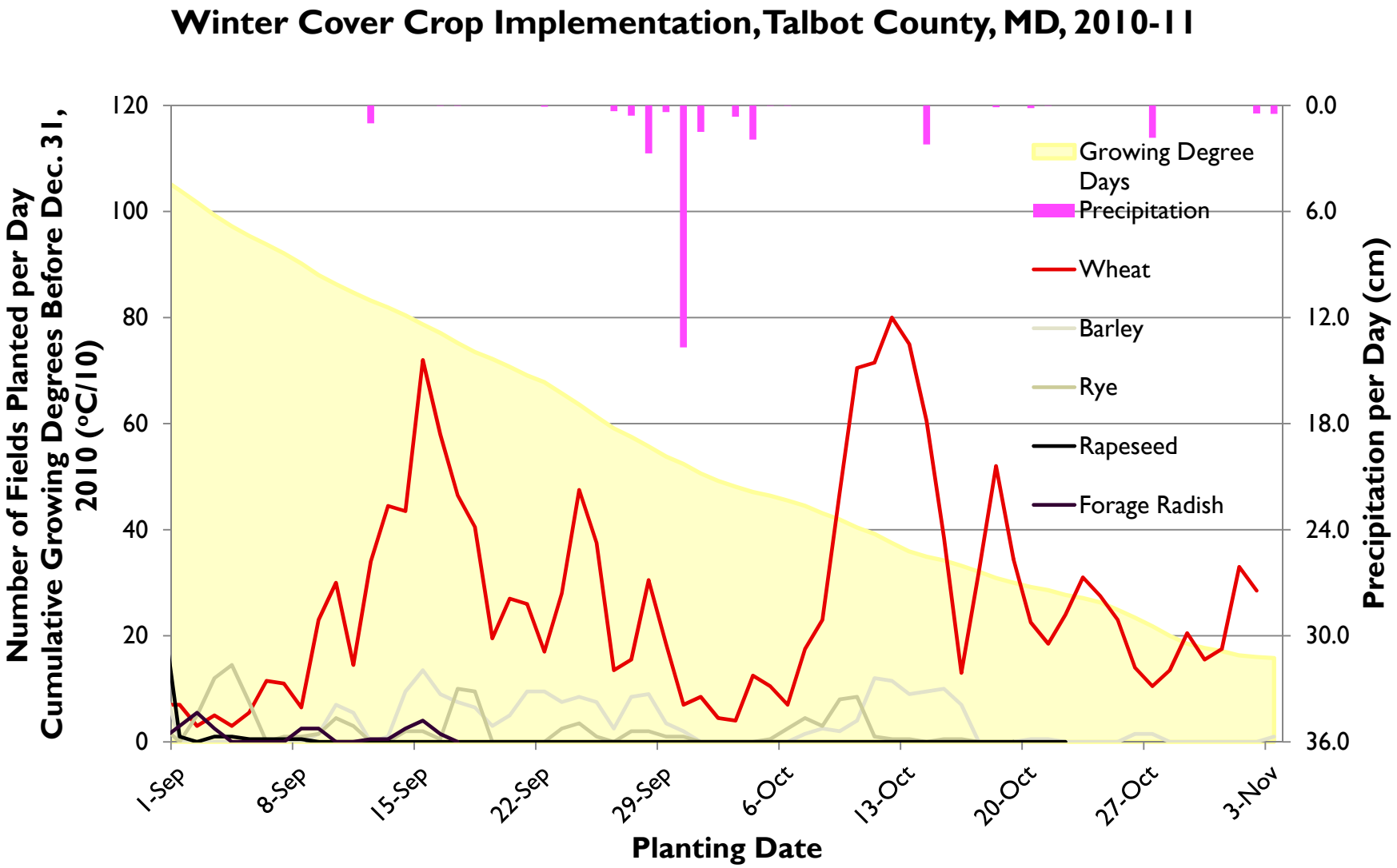


Species Planting Date	Cost per pound of N abatement
Rye	
before Oct 15	$ 3.07
after Oct 15	$ 7.02
Barley	
before Oct 15	$ 3.46
after Oct 15	-
Wheat	
before Oct 15	$ 8.99
after Oct 15	$ 9.36

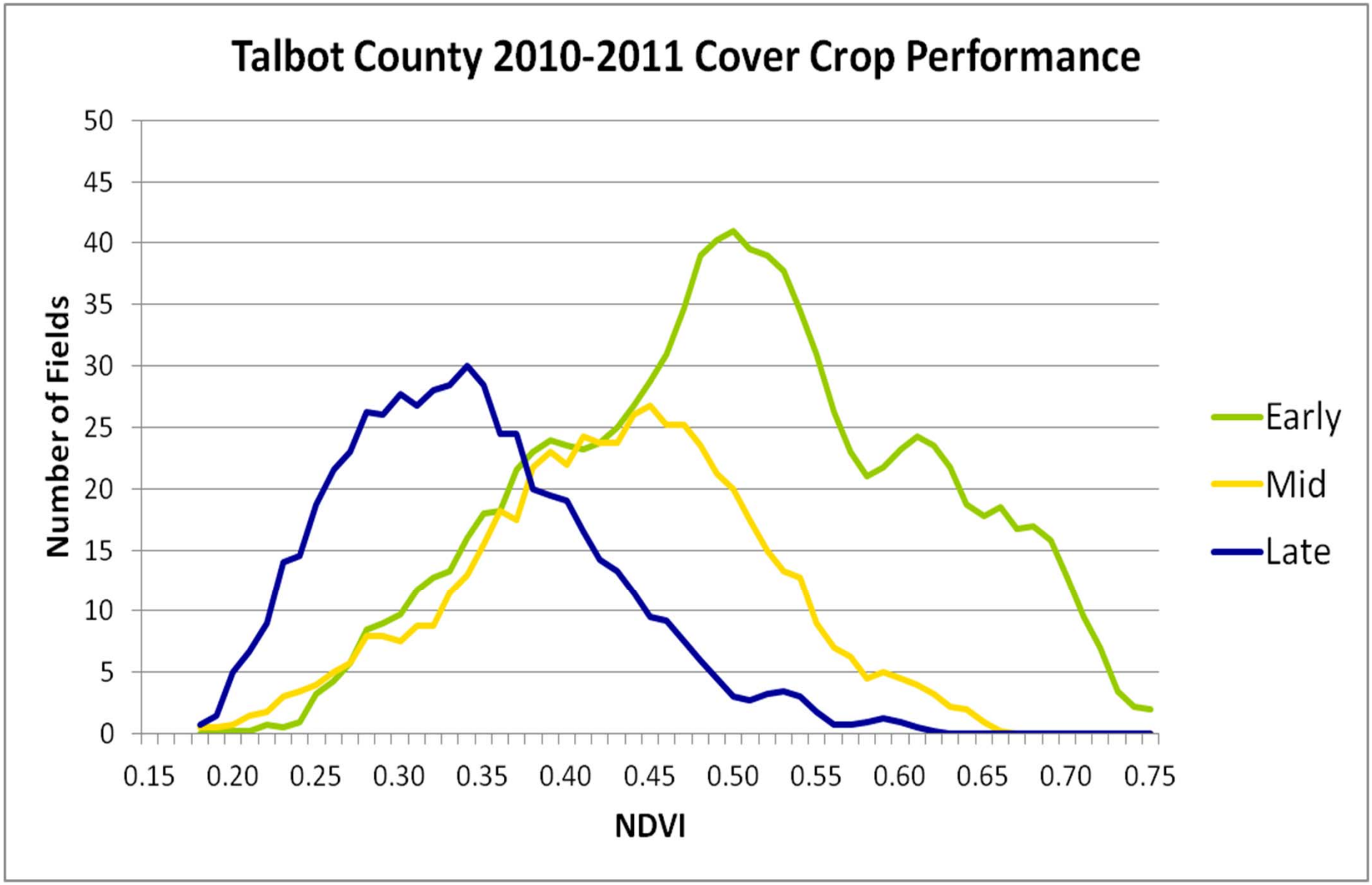
Watershed Scale Agronomics

- A powerful approach for evaluating agronomic practices on working landscapes.
  - The agronomist's *vs.* geographer's view
  - Both agronomic and crop performance data for thousands of fields within an image.
  - Great statistical power for analysis of factors affecting performance.
    - Practice, landscape, and climatic influences
  - Need for expanded agronomic data
    - Nutrient management plans and yield goals

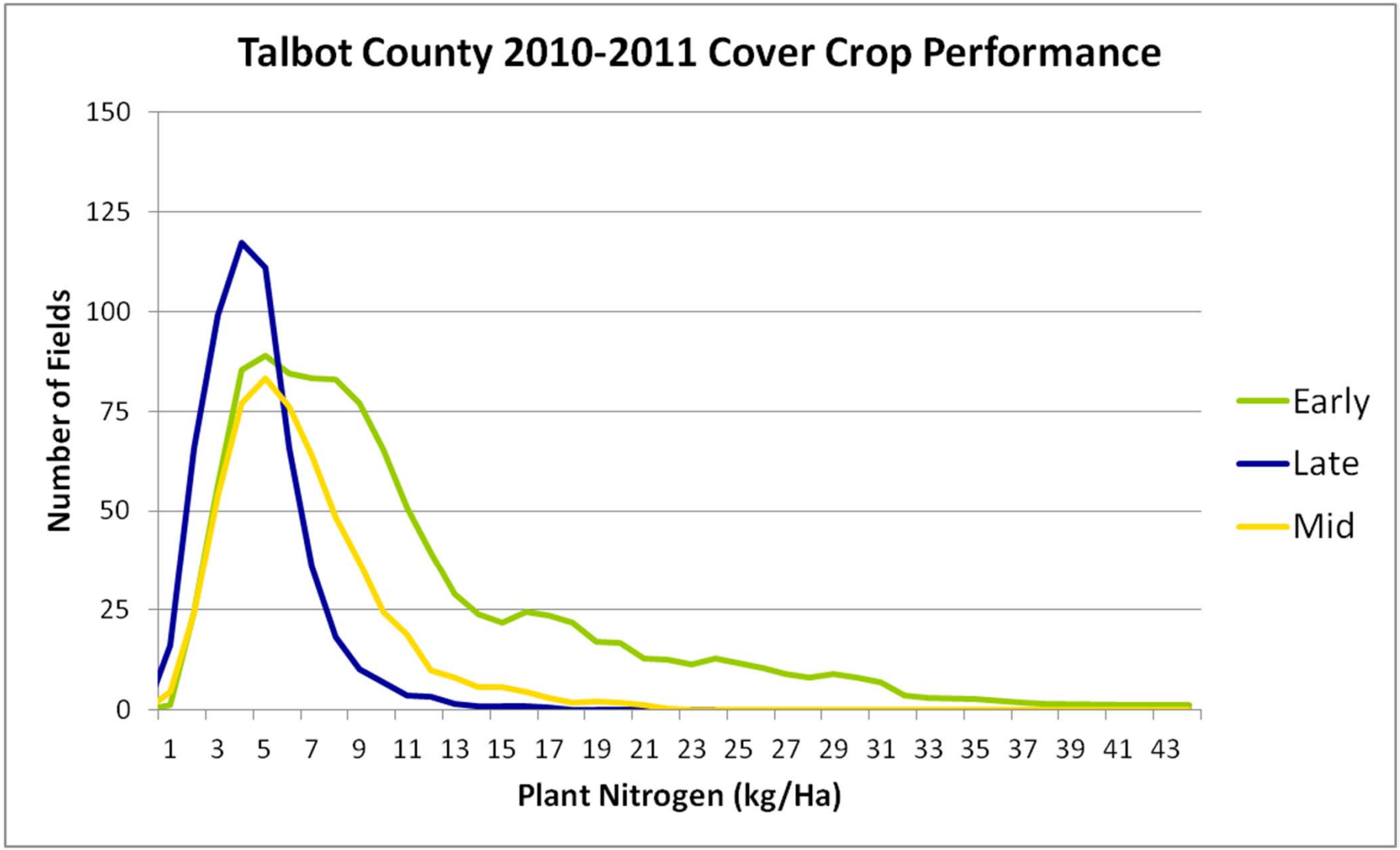
Adaptive Management



Adaptive Management

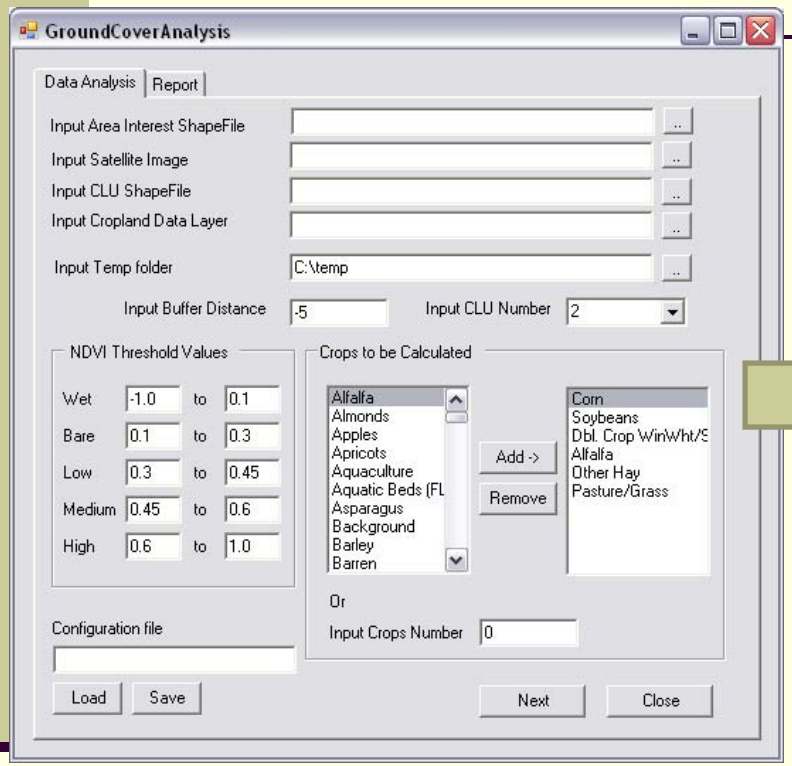


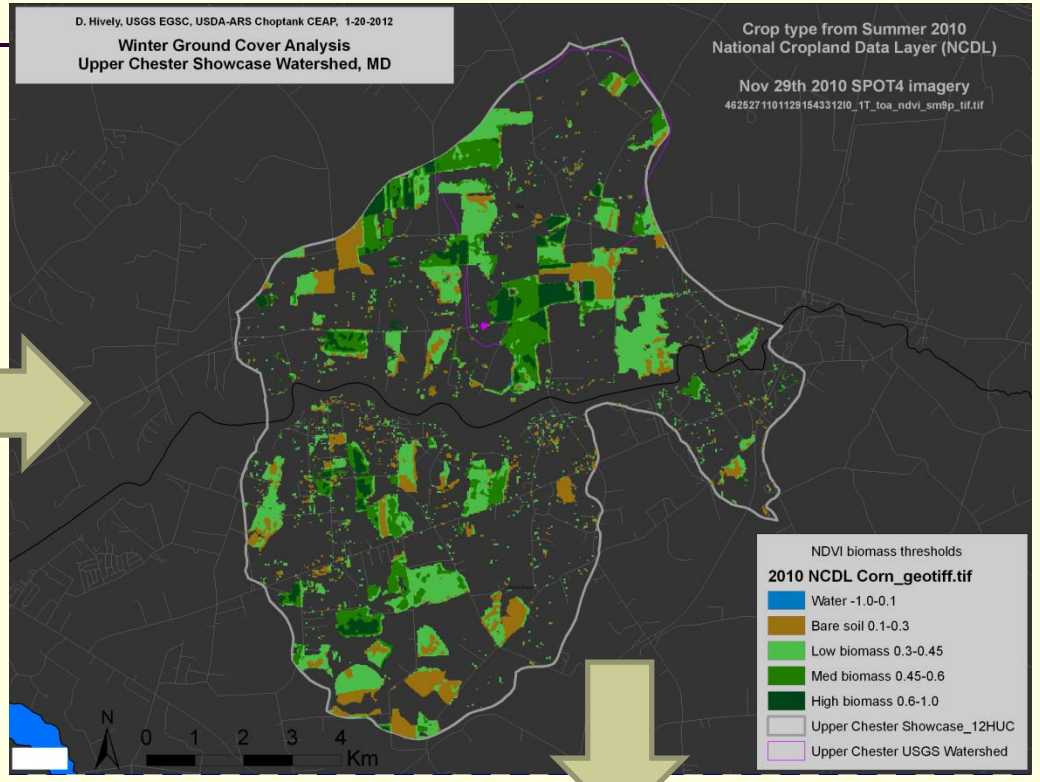
Adaptive Management



Voluntary Cover Crops

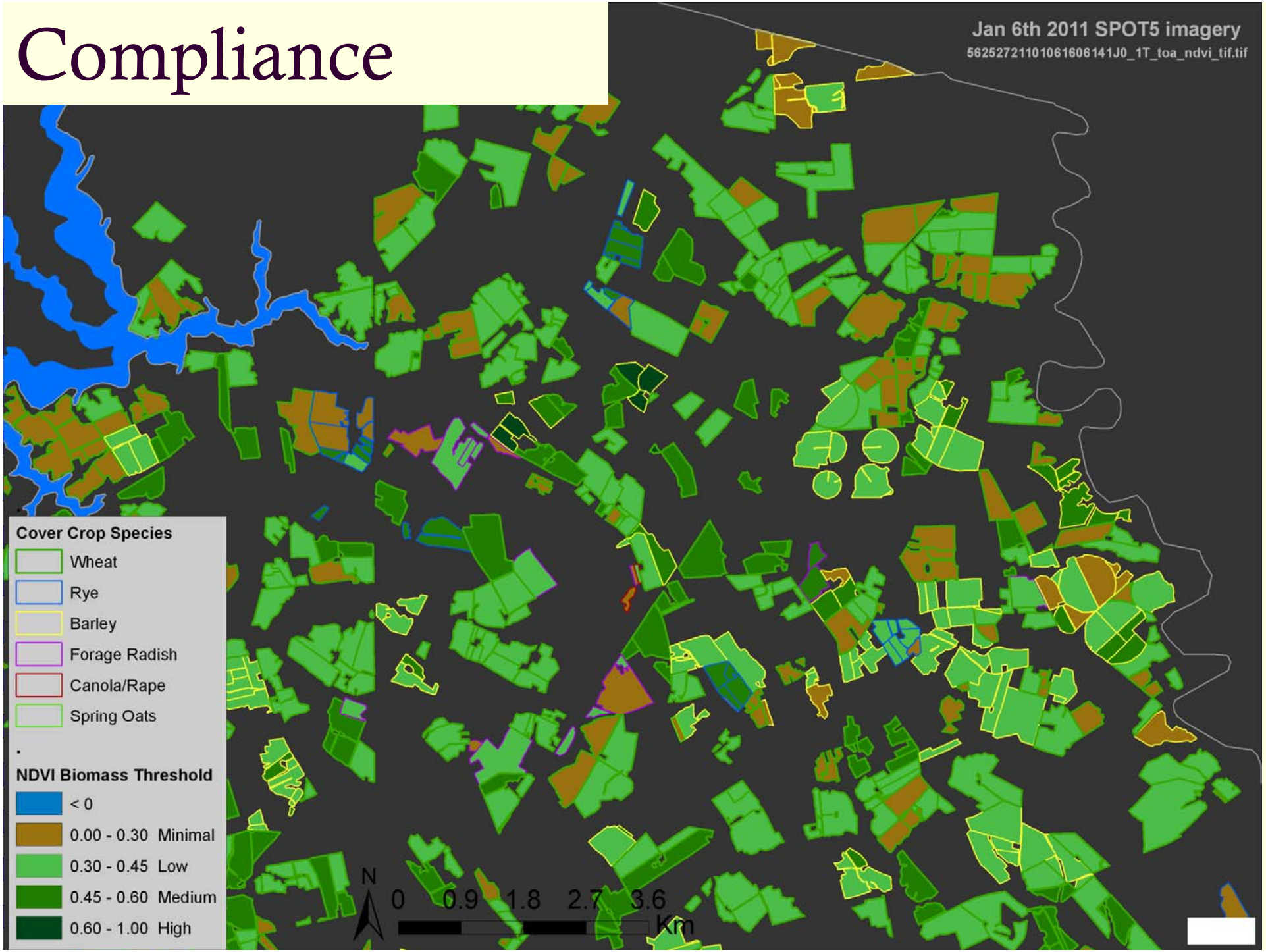
Geospatial toolkit for winter groundcover analysis





			Bare Soil 0.1<NDVI<0.3		Low Biomass 0.3<NDVI<0.45		Medium Biomass 0.45<NDVI<0.6		High Biomass 0.6<NDVI<1.0	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Entire area of interest	9460	100.0	3111	32.9	4529	47.9	1063	11.2	276	2.9
Corn	2434	25.7	552	22.7	1086	44.6	573	23.6	218	9.0
Deciduous Forest	2027	21.4	339	16.7	1637	80.8	45	2.2	1	0.0
Soybeans	1926	20.4	1024	53.2	730	37.9	153	7.9	17	0.9
Dbl. Crop WinWht/Soy	713	7.5	554	77.6	127	17.8	25	3.6	6	0.9
Pasture/Grass	682	7.2	112	16.4	427	62.6	128	18.8	13	1.9
Other Crops	658	7.0	216	32.8	366	55.6	67	10.2	4	0.6
Open Water	406	4.3	11	2.8	1	0.2	0	0.0	0	0.0

Compliance


Jan 6th 2011 SPOT5 imagery
5625272110106160614 1J0_1T_toa_ndvi_tif.tif
Cover Crop Species
Wheat
Rye
Barley
Forage Radish
Canola/Rape
Spring Oats
NDVI Biomass Threshold
< 0
0.00 - 0.30 Minimal
0.30 - 0.45 Low
0.45 - 0.60 Medium
0.60 - 1.00 High
N
0 0.9 1.8 2.7 3.6
Km

Elements of Accounting

- Quantification – Based on real measurements
  - Reduced uncertainty and discounting of credits
- Compliance – Use imagery to assess
  - Can target ground based assessments of compliance
- Additionality – Improved baseline establishment
  - Measurement of winter greenness by remote sensing
- Leakage – Commodity market distortions
  - Perverse incentives may lead to increased nutrient loading.
- Transactions costs
  - Low cost remote data sources (free Landsat data)
  - Agronomic geospatial data collected with farmer enrollment

Conclusions

- Remote sensing provides a powerful tool for quantifying conservation practice performance.
- Measurement has inherent advantage over modeling.
- Combined use of distributed measurements provided by remote sensing and distributed modeling may provide the best assessment of impact of conservation practices on watershed health.

Thank you!