

# Remote Sensing Tools to Detect Water Quality Benefits from Conservation Programs

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# 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	FILI	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/01	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/02	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 5<sup>th</sup>)
- Previous cash crop (corn for grain, corn for silage, soybean)
- Irrigation usage

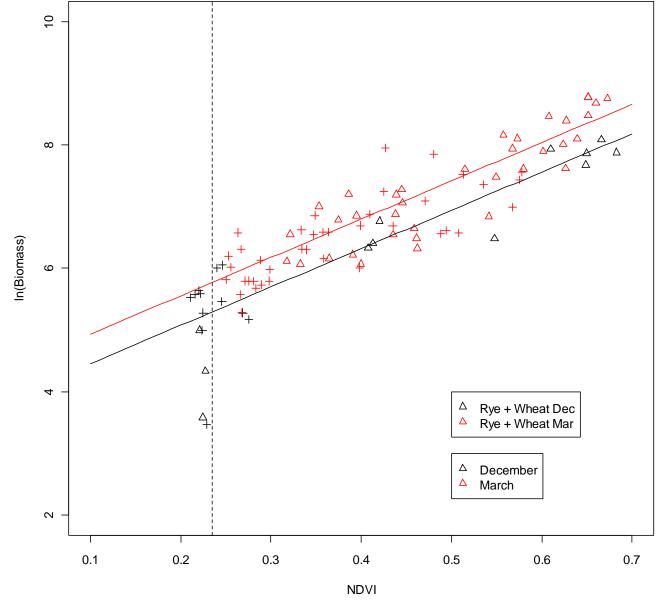


#### Developing the calibration

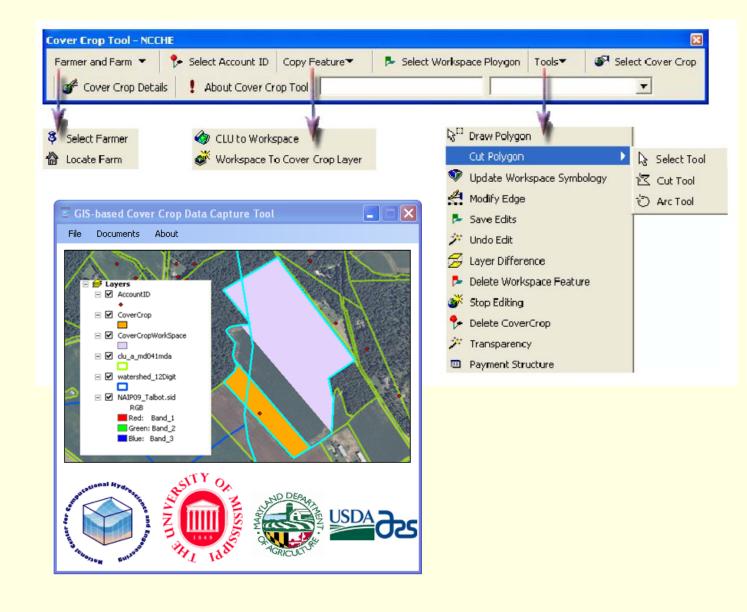


Establishing relationships between satellite derived vegetation index (NDVI) and cover crop biomass production

# Relationship of NDVI to aboveground biomass measurements

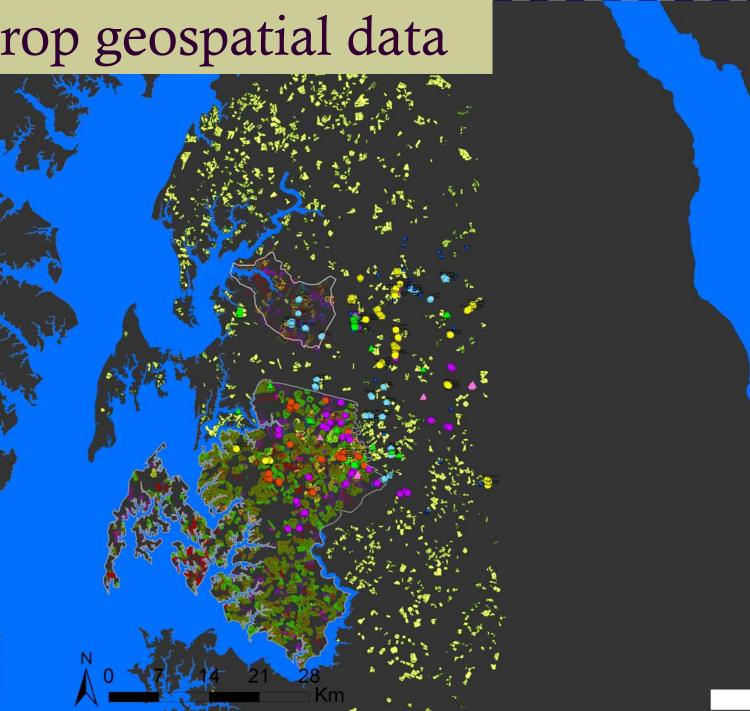


## Enrollment Data Capture Tool



## Cover crop geospatial data





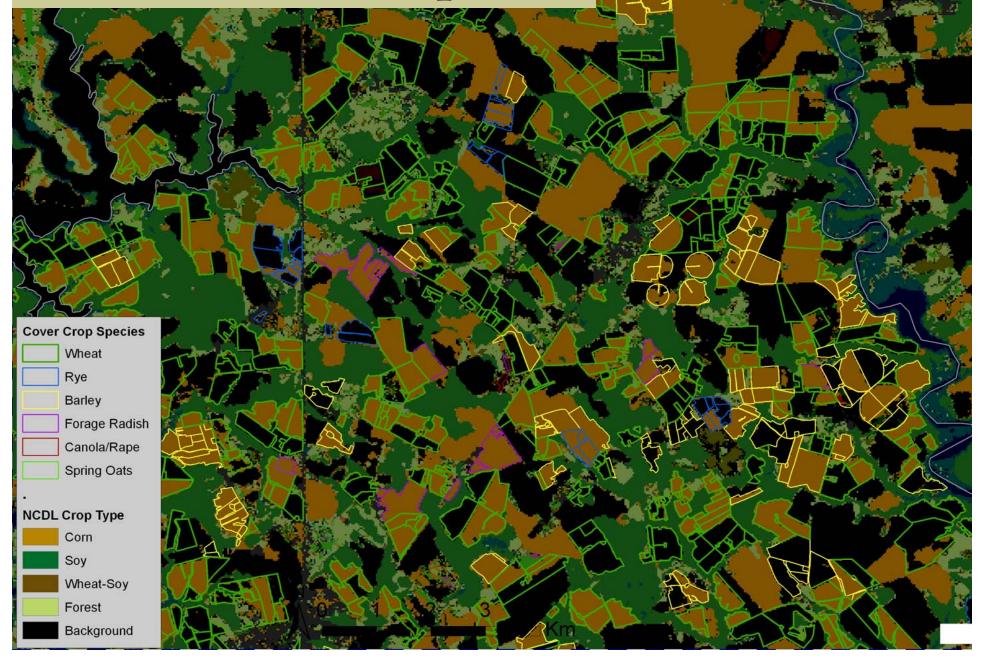
#### Location of cover crops



**Summer 2011** 

#### Previous cash crop

USDA National Cropland Data Layer (NC Summer 2010

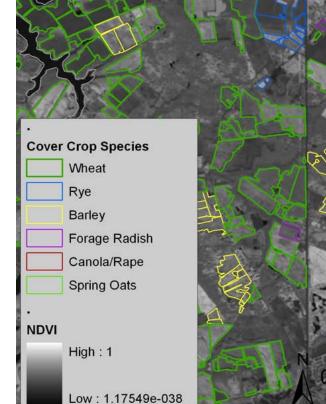


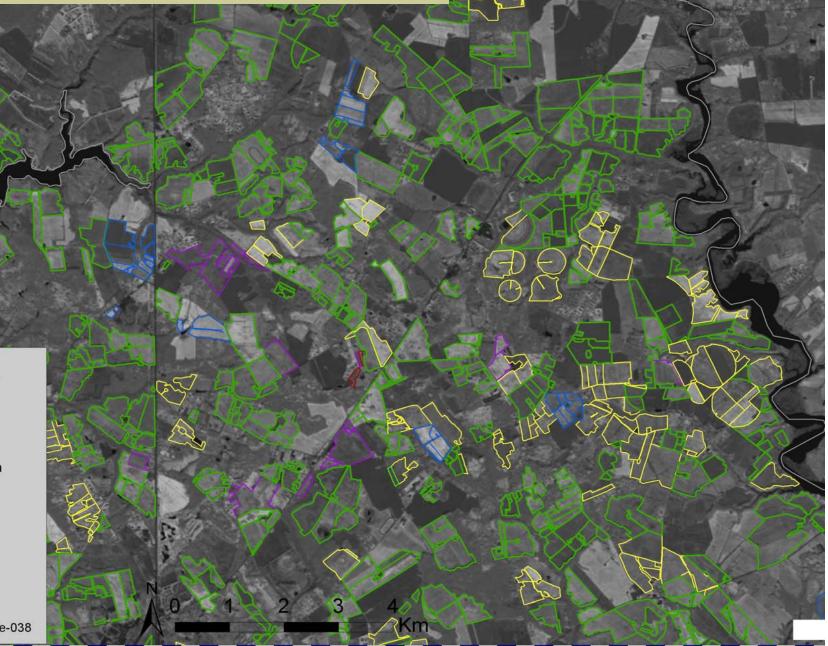
#### Satellite data for analysis



# Vegetation index

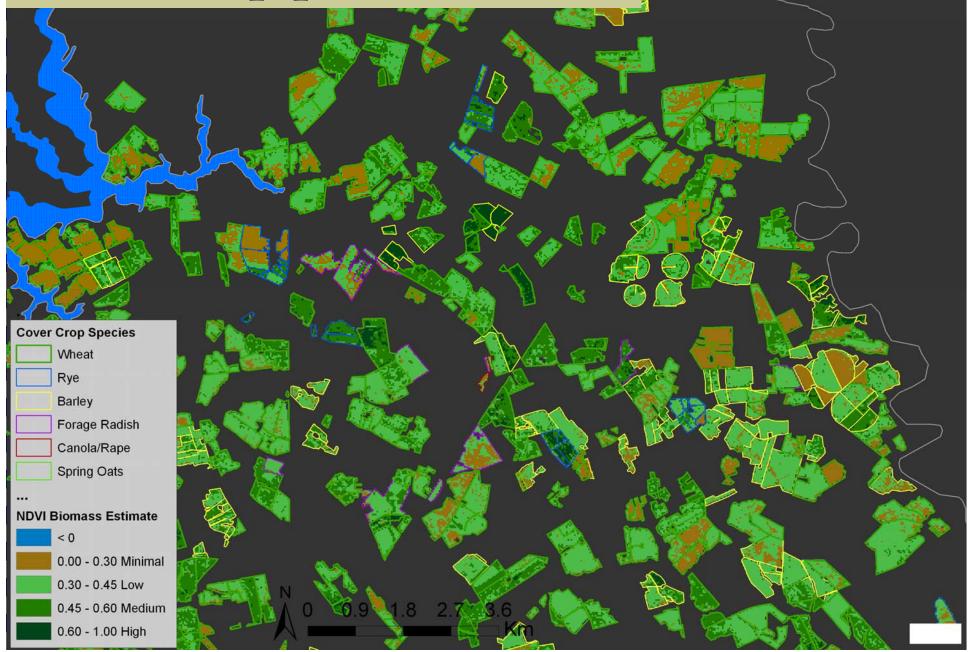
Jan 6th 2011 SPOT5 imagery 56252721101061606141J0\_1T\_toa\_ndvi\_tif.tif





# Cover crop performance

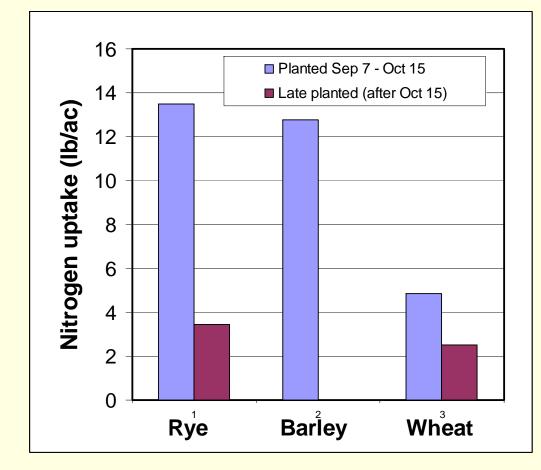
Jan 6th 2011 SPOT5 imagery 56252721101061606141J0\_1T\_toa\_ndvi\_tif.tif



## Cover crop performance analysis

Input County Name Talbot		-	Year 2	010-11	<b>_</b>			
For each county and year cor shapefile, and USDA-NASS c			Contraction of the second s	ery, cover crop I	field boundary			
Satellite Image	F:\Cove	F:\CoverCropTool\56252721101061606141J0_1T_t						
Cover crop field boundaries	F:\Cove	rCropTool <sup>v</sup>	.2010-11_	Corsica_CCEnro	llment.s			
Cropland Data Layer	F:\Cove	rCropTool <sup>y</sup>	.cdl_tm_r_	.md_2010_utm18	3_majorit			
Buffer Distance	-5							
Calibration								
Equation Name Eq_0406	52011							
Input Calibration Coefficients	ntercept (a0)	2.5174		NDVI (a1)	7.2822			
	Species (a2)	0	Planti	ng Method (a3)	0.0			
Plan	ting Date (a4)	0.0	- Pre	vious Crop (a5)	0.0			
	Irrigated (a6)	0		ercent Nitrogen	0.02			

## 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				



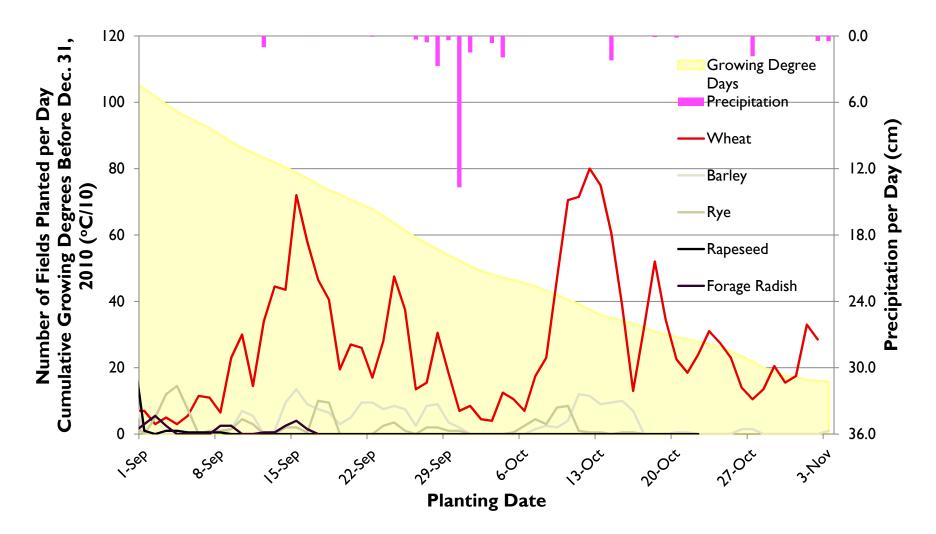
# Watershed Scale Agronomics

- 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

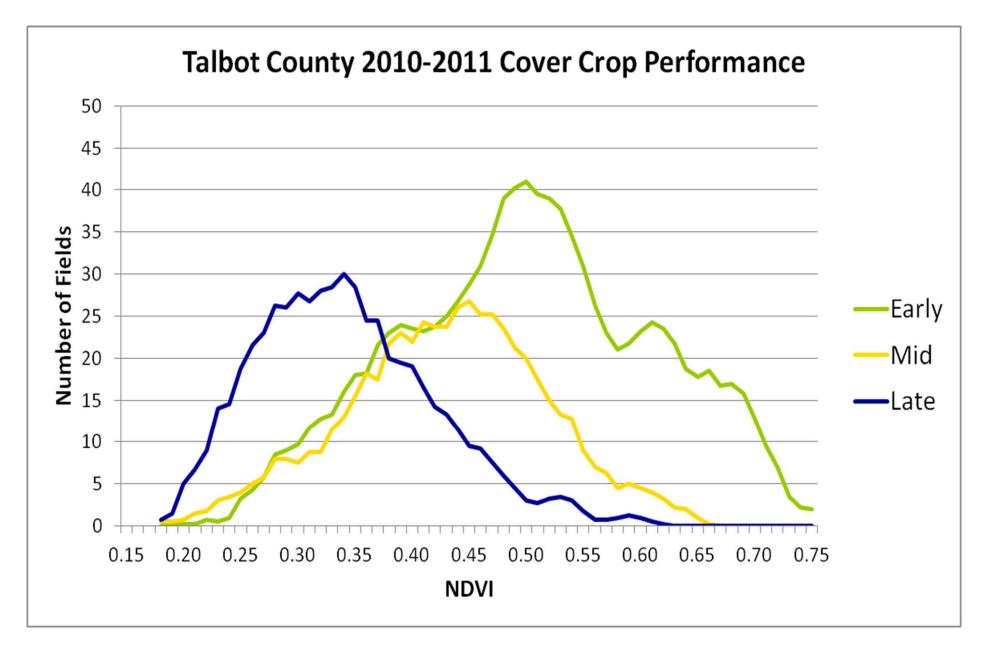


#### Adaptive Management

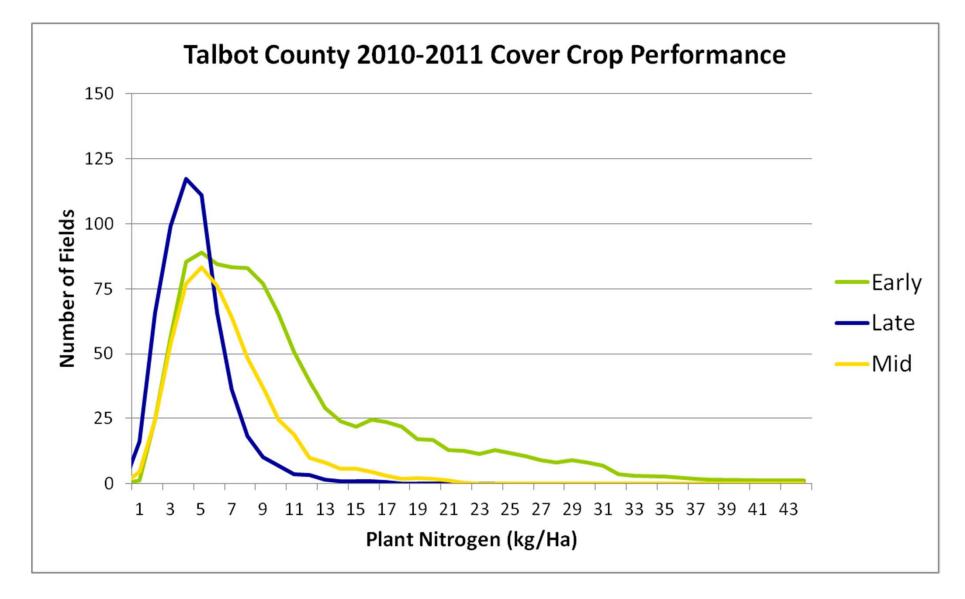
Winter Cover Crop Implementation, Talbot County, MD, 2010-11



#### Adaptive Management



#### Adaptive Management



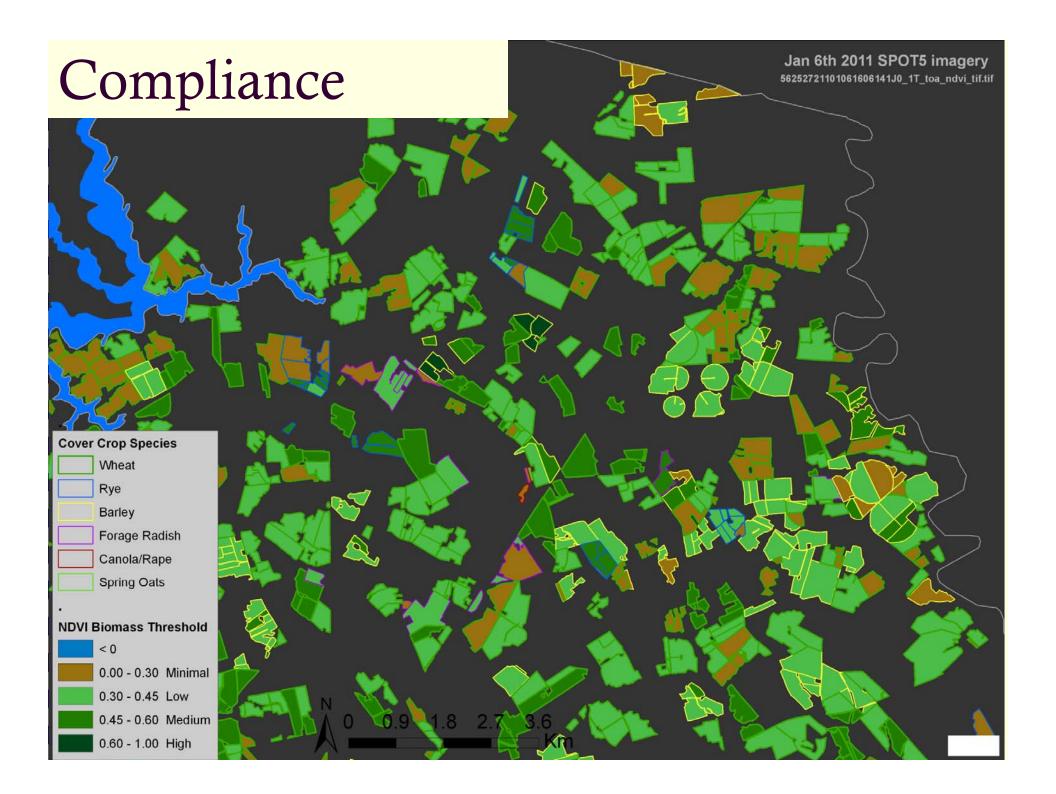


# Voluntary Cover Crops

#### Geospatial toolkit for winter groundcover analysis

🖷 GroundCoverAnalysis		D. Hively, USGS EGSC, USDA-ARS Choptank CEAP, 1-20-2012 Winter Ground Cover Analysis Upper Chester Showcase Watershed, MD	Crop type from Summer 2010 National Cropland Data Layer (NCDL)
Data Analysis Report			Nov 29th 2010 SPOT4 imagery 4625271011291643312/0_1T_toa_ndvi_sm8p_tif.tif
Input Area Interest ShapeFile			
Input Satellite Image		IR AS / A A A A A A A A A A A A A A A A A	
Input CLU ShapeFile			
Input Cropland Data Layer			
Input Temp folder C:\temp			
Input Buffer Distance .5 Input CLU Number	2 •		
NDVI Threshold Values Crops to be Calculated			
Wet -1.0 to 0.1 Alfalfa Almonds	Corn Soybeans		
Bare 0.1 to 0.3 Apples	Dbl. Crop WinWht/S		
Low 0.3 to 0.45 Aquaculture	Other Hay Pasture/Grass		
Medium 0.45 to 0.6 Asparagus Background			
High 0.6 to 1.0 Barley Barren V			NDVI biomass thresholds
			2010 NCDL Corn_geotiff.tif Water -1.0-0.1
Or Configuration file Input Crops Number 0	-		Bare soil 0.1-0.3
Configuration file Input Crops Number 0			Low biomass 0.3-0.45
		KY ART S AN AN	Med biomass 0.45-0.6
Load Save Next			High biomass 0.6-1.0 Upper Chester Showcase_12HUC
		0 1 2 3 4 Km	Upper Chester USGS Watershed

			Bare Soil 0.1 <ndvi<0.3< th=""><th colspan="2">Low Biomass 0.3<ndvi<0.45< th=""><th colspan="2">Medium Biomass 0.45<ndvi<0.6< th=""><th colspan="2">High Biomass 0.6<ndvi<1.0< th=""></ndvi<1.0<></th></ndvi<0.6<></th></ndvi<0.45<></th></ndvi<0.3<>		Low Biomass 0.3 <ndvi<0.45< th=""><th colspan="2">Medium Biomass 0.45<ndvi<0.6< th=""><th colspan="2">High Biomass 0.6<ndvi<1.0< th=""></ndvi<1.0<></th></ndvi<0.6<></th></ndvi<0.45<>		Medium Biomass 0.45 <ndvi<0.6< th=""><th colspan="2">High Biomass 0.6<ndvi<1.0< th=""></ndvi<1.0<></th></ndvi<0.6<>		High Biomass 0.6 <ndvi<1.0< th=""></ndvi<1.0<>	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Entire area of interest Corn	9460 2434	100.0	3111 552	32.9	4529 1086	47.9	1063 573	11.2 23.6	276 218	2.9 9.0
Deciduous Forest Soybeans	2027 1926	21.4 20.4	339 1024	16.7 53.2	1637 730	80.8 37.9	45 153	2.2 7.9	1 17	0.0
Dbl. Crop WinWht/Soy Pasture/Grass Other Crops	713 682 658	7.5 7.2 7.0	554 112 216	77.6 16.4 32.8	127 427 366	17.8 62.6 55.6	25 128 67	3.6 18.8 10.2	6 13 4	0.9 1.9 0.6
Open Water	406	4.3	11	2.8	1	0.2	0	0.0	0	0.0





# 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.



