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Measuring cover crop performance in the Eastern Shore landscape

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Keep it green! – maintain winter vegetation

- The amount of green winter groundcover (growing plants) on agricultural landscapes has important implications for water quality
- Winter cover crops can reduce agricultural nutrient and sediment loss from farmland
- They also improve soil health and agroecosystems
- Regional conservation programs prioritize implementation of winter cover crops on Chesapeake Bay farmland

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On-farm performance is variable
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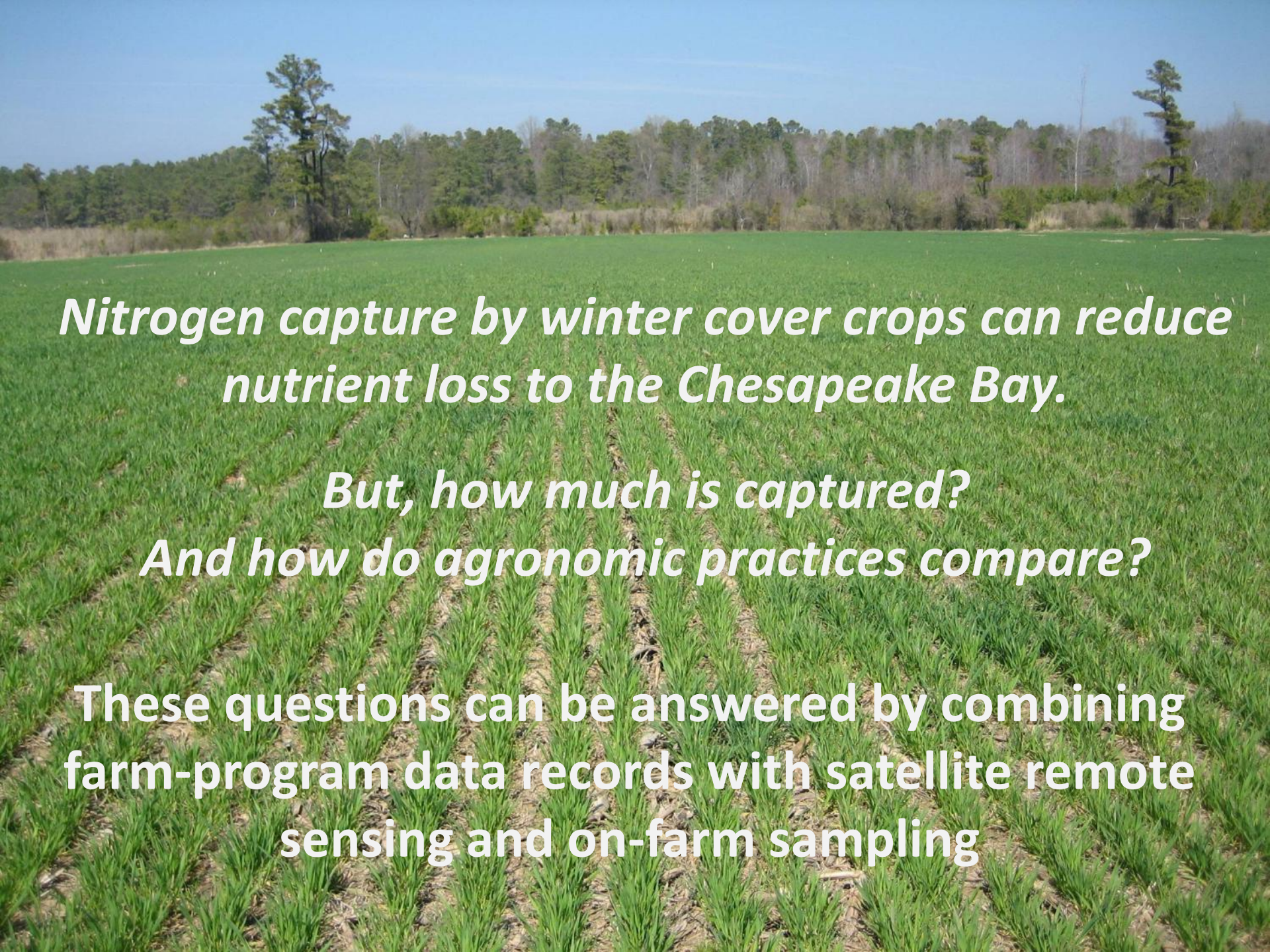

Nitrogen capture by winter cover crops can reduce nutrient loss to the Chesapeake Bay.

But, how much is captured?
And how do agronomic practices compare?

These questions can be answered by combining farm-program data records with satellite remote sensing and on-farm sampling

Strategy

- Working directly with Soil Conservation Districts
- Supporting Maryland Department of Agriculture (MDA) winter cover crop cost-share program
- Protecting privacy of farm conservation data to meet Farm Bill (Section 1619) and state requirements
- Support adaptive management of winter cover crops

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Three tools

- Knowledge of site-specific management practices (Maryland cover crop program enrollment data)
- Use of satellite imagery to map wintertime biomass (and estimate cover crop nutrient uptake)
- Annual USDA maps of crop type, e.g. corn, soybean (another satellite data product: National Cropland Data Layer)

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Cover crop management practices

The first tool

Information on farmer enrollment in the Maryland cover crop cost-share programs was provided by Talbot County Soil Conservation District

<u>Complete</u> annual digitized records from 2007-2013

- **Field locations**
- **Species (wheat, barley, canola, rye, radish, oats)**
- **Planting methods (drilled, broadcast + disk, aerial)**
- **Planting dates (Mid-September to Nov 5th)**
- **Previous crop (corn, soybean, vegetables)**

Thanks to Shawn Smith, Jason Keppler, MDA, NFWF, and farmers for supporting this data collection

USGS

Cover crop management practices

The first tool

Number of cover crop fields in Talbot County (county records)

Species	2008-09	2009-10	2010-11	2011-12	2012-13
Wheat	1209	1012	1726	2188	2046
Barley	120	76	236	199	240
Canola/Rape	86	117	54	13	0
Rye	48	26	123	80	30
Forage Radish	0	0	26	110	67
Spring Oats	1	2	2	0	0
Total	1464	1233	2167	2590	2383

Number of cover crop fields by previous crop (county records)

	2008-09	2009-10	2010-11	2011-12	2012-13
Corn	850	740	1211	1296	1193
Sorghum	0	37	53	150	140
Soybeans	612	451	897	1136	1046
Vegetables	2	6	6	8	7
Total	1464	1234	2167	2590	2386

These data are preliminary and are subject to revision.
They are being provided to meet the need for timely 'best science' information.
The assessment is provided on the condition that neither the U.S. Geological Survey nor the United States Government may be held liable for any damages resulting from the authorized or unauthorized use of the assessment.

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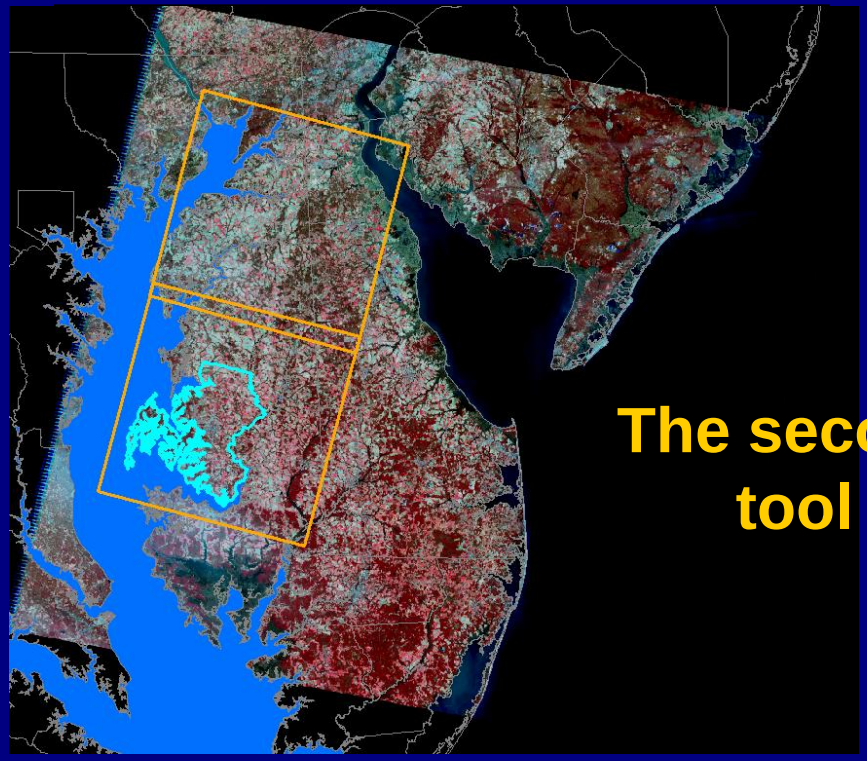
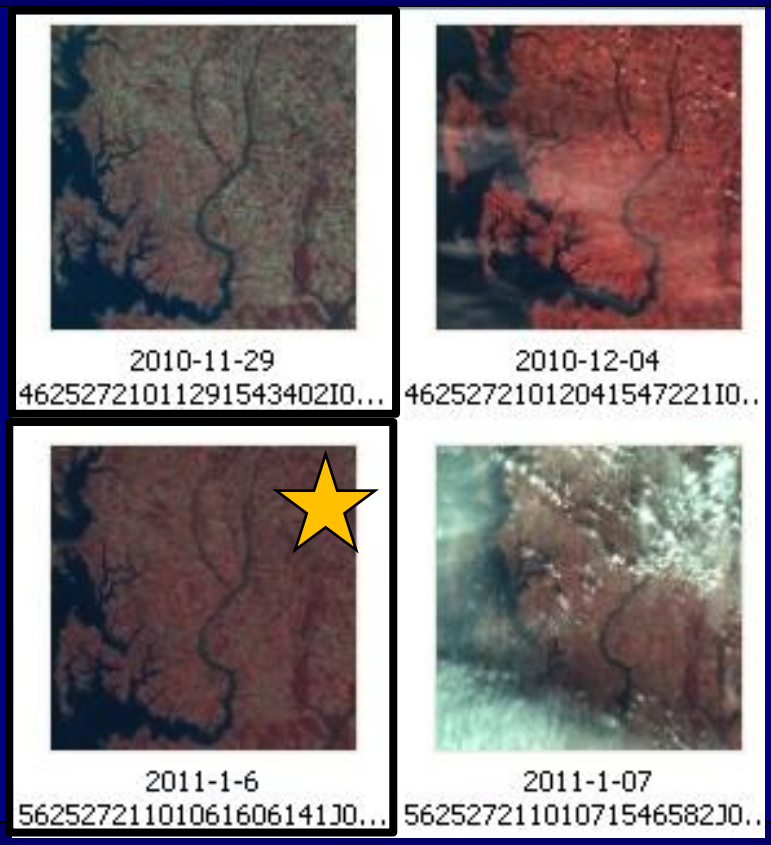
Satellite Imagery

USGS provides Landsat and SPOT (for free)

Landsat5 Imagery March 8th, 2011



The second tool



- Sometimes cloudy, sometimes clear
- Each image is a snapshot in time
- Fairly accurate mapping of agricultural vegetation
- We are most interested in mid-winter imagery

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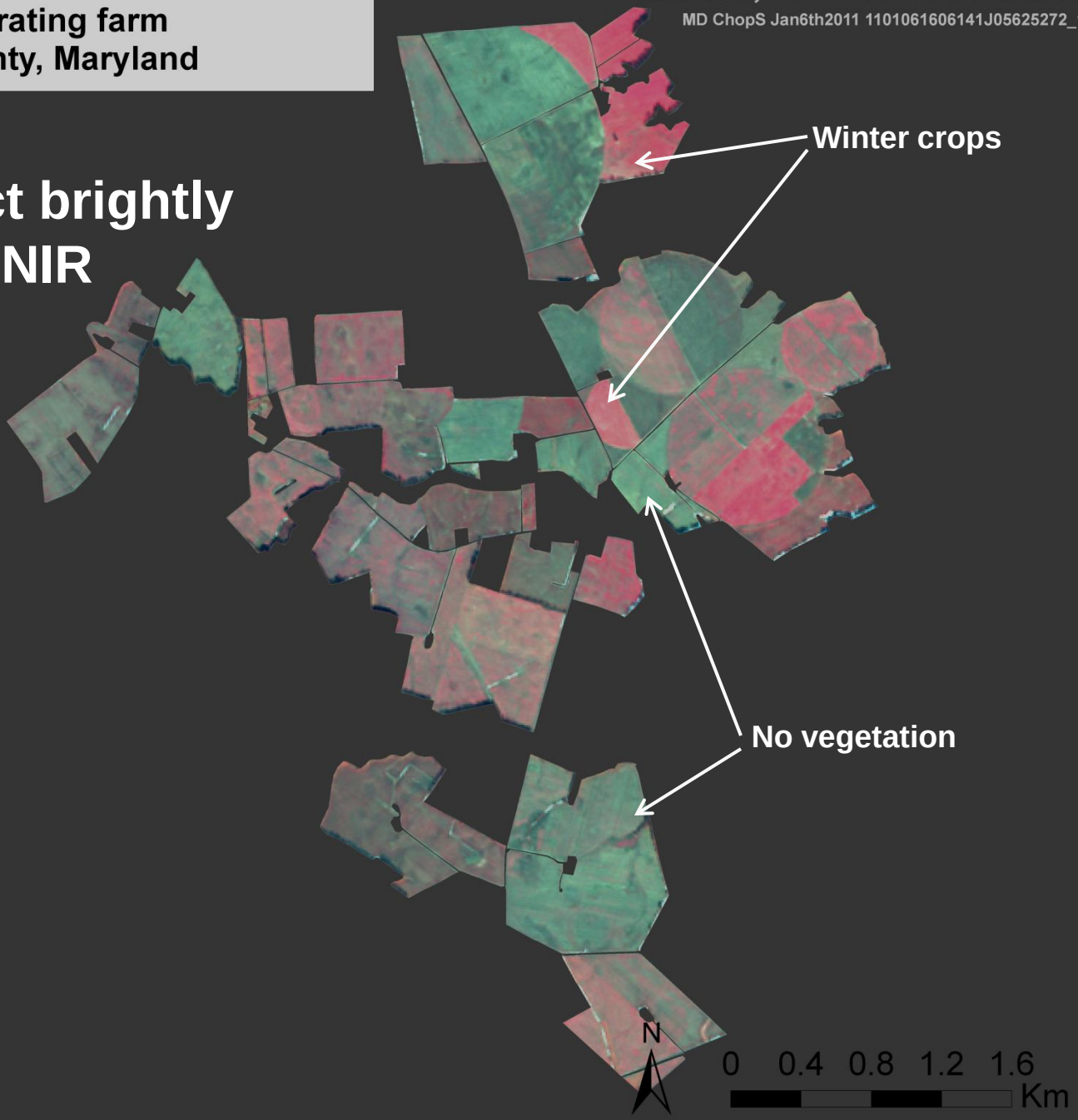
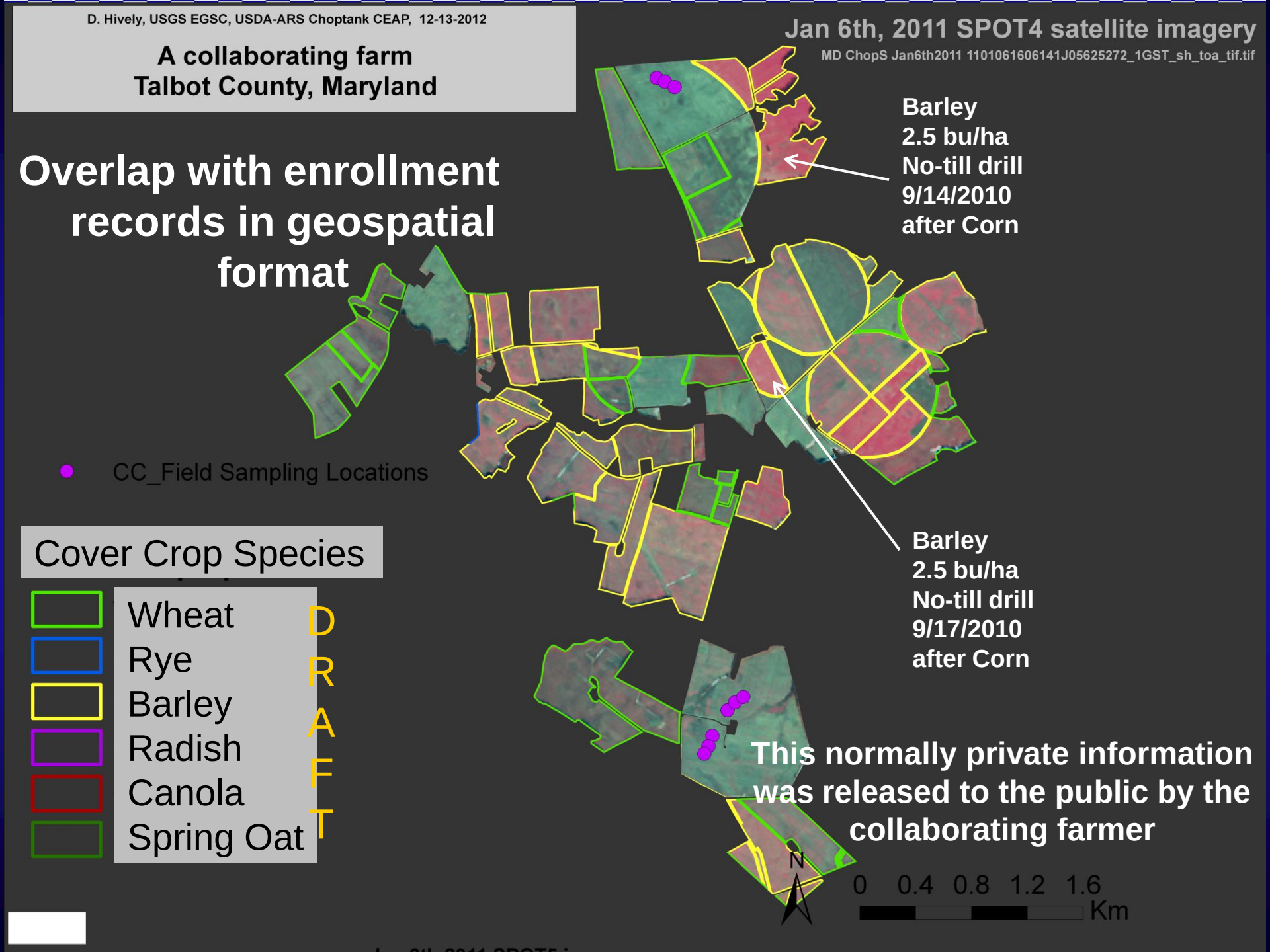
A collaborating farm
Talbot County, Maryland

Jan 6th, 2011 SPOT4 satellite imagery

MD ChopS Jan6th2011 1101061606141J05625272_1GST_sh_toa_tif.tif

Plants reflect brightly in the NIR




D. Hively, USGS EGSC, USDA-ARS Choptank CEAP, 12-13-2012
A collaborating farm
Talbot County, Maryland
Jan 6th, 2011 SPOT4 satellite imagery
MD ChopS Jan6th2011 1101061606141J05625272_1GST_sh_toa_tif.tif
Overlap with enrollment records in geospatial format
Barley
2.5 bu/ha
No-till drill
9/14/2010
after Corn
CC_Field Sampling Locations
Barley
2.5 bu/ha
No-till drill
9/17/2010
after Corn
Cover Crop Species
Wheat
Rye
Barley
Radish
Canola
Spring Oat
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This normally private information was released to the public by the collaborating farmer
N
0 0.4 0.8 1.2 1.6
Km

D. Hively, USGS EGSC, USDA-ARS Choptank CEAP, 12-13-2012

A collaborating farm
Talbot County, Maryland

Jan 6th, 2011 SPOT4 satellite imagery

MD ChopS Jan6th2011 1101061606141J05625272_1GST_sh_toa_tif.tif

CC_Field Sampling Locations

Cover Crop Species

- Wheat
- Rye
- Barley
- Radish
- Canola
- Spring Oat

Barley
2.5 bu/ha
No-till drill
9/14/2010
after Corn

avg NDVI 0.53
est Biomass 603 kg/ha
est N content 12 kg/ha

Barley
2.5 bu/ha
No-till drill
9/17/2010
after Corn

avg NDVI 0.57
est Biomass 815 kg/ha
est N content 16 kg/ha

Vegetation Thresholds

NDVI

- Water -1.0-0.1
- Minimal biomass 0.1-0.3
- Low biomass 0.3-0.45
- Med biomass 0.45-0.6
- High biomass 0.6-1.0

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N

0 0.4 0.8 1.2 1.6 Km

Biomass Thresholds

Minimal

Low

Medium

Biomass categories:

Min = no cover crop; up to 10% light weed cover

Low = cover crop early growth; groundcover <25%

Med = good cover crop growth; groundcover >25%

High = lush cover crop growth; groundcover >60%

High

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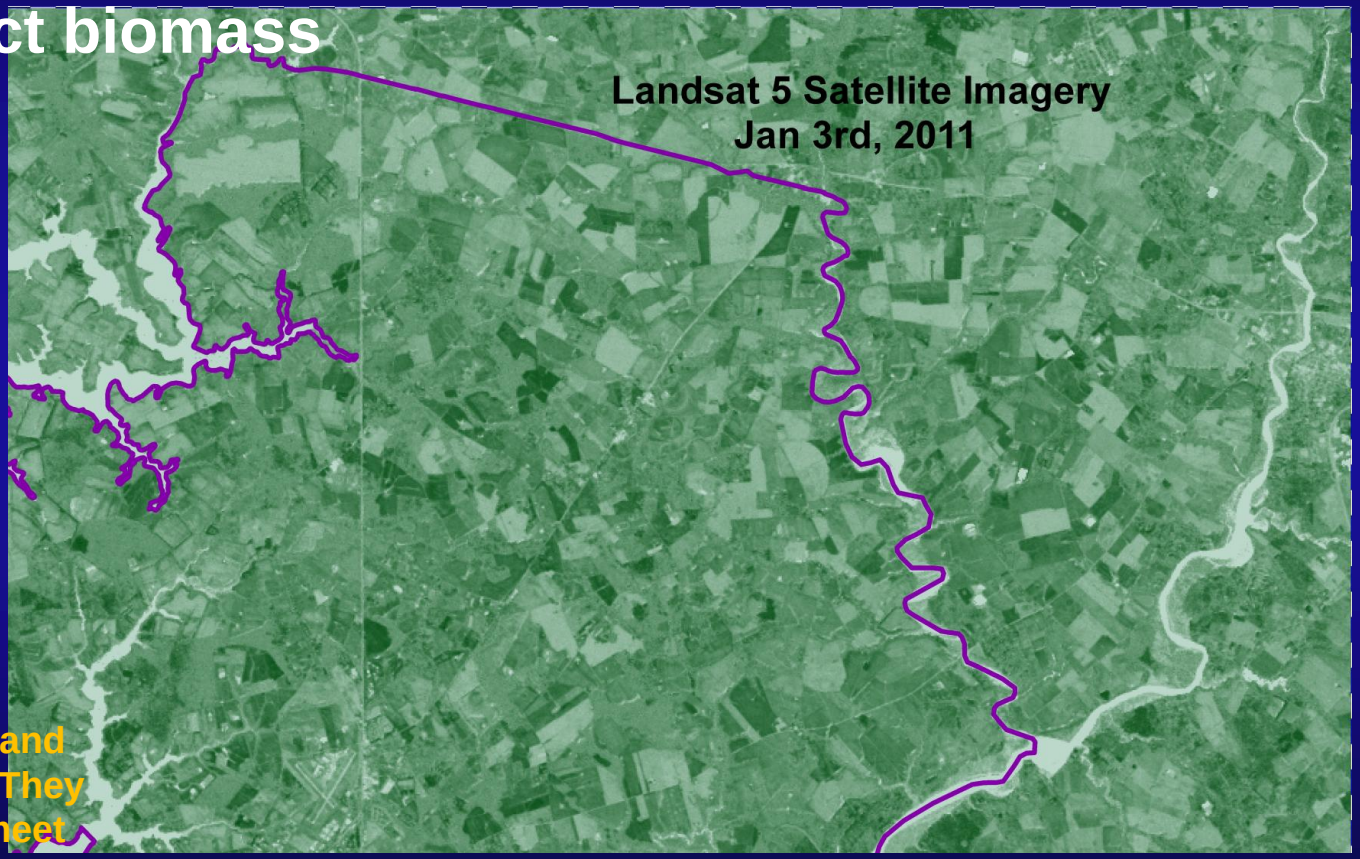
Satellite vegetation indices

- Very accurate for within-image comparison
- Some between-image calibration issues
- Used to predict biomass

The second tool



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Each image is a snapshot in time

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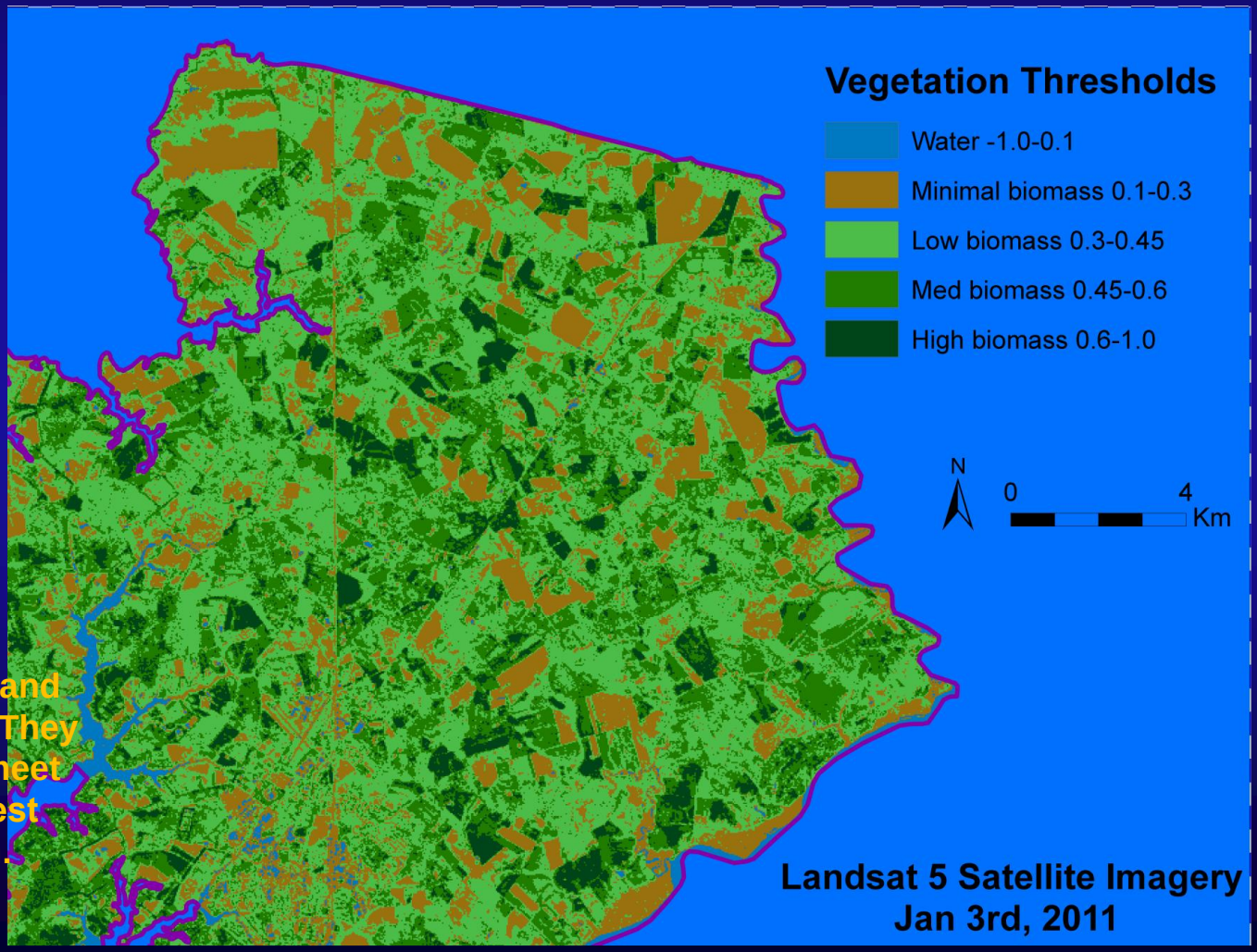
Satellite vegetation thresholds

- Classification of satellite vegetation indices
- Fairly accurate but some calibration issues remains



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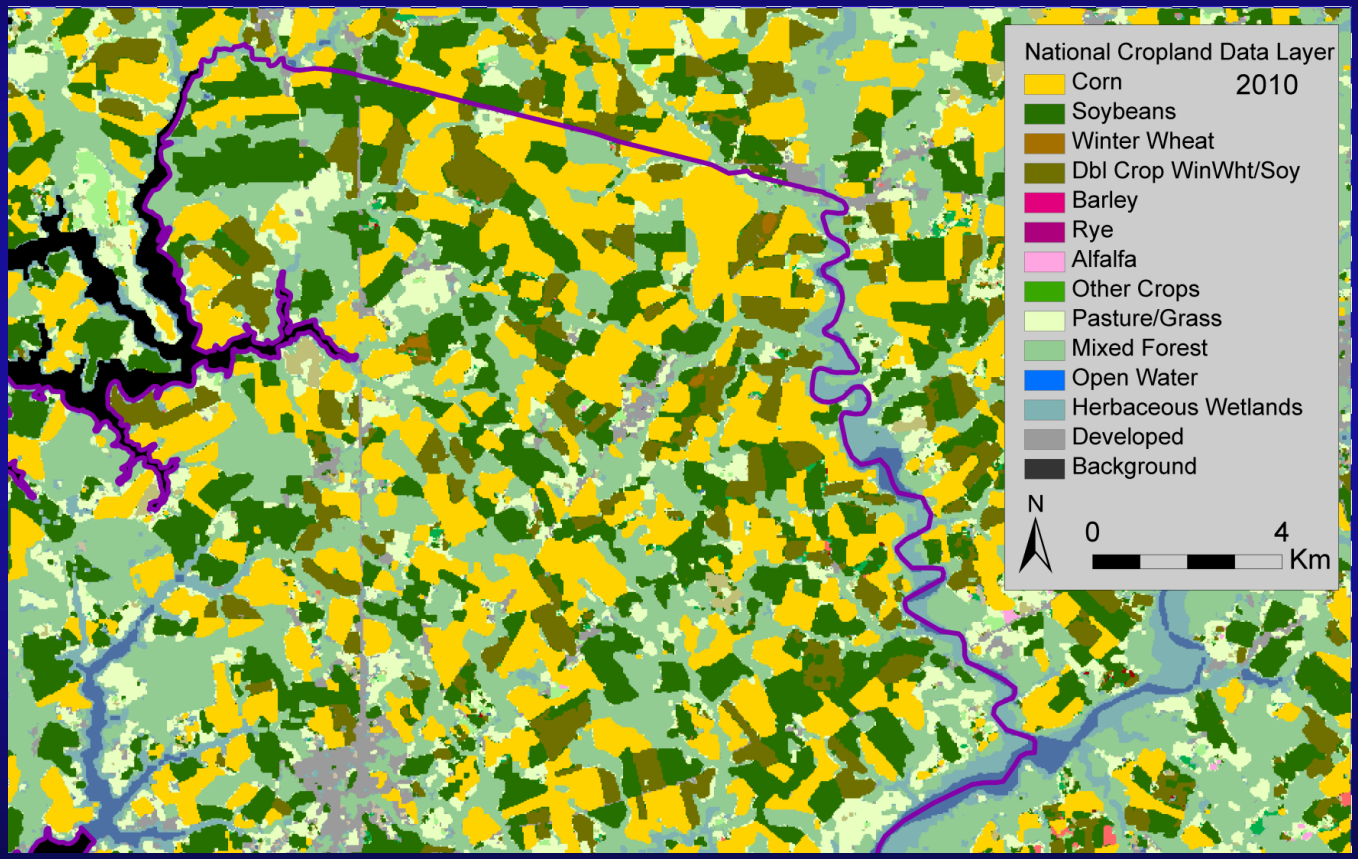
National Cropland Data Layer (NCDL)

- Satellite-based mapping of crop type by USDA-NASS
- Fairly accurate for large fields
- 2008-2012

The third tool



This public dataset allows us to measure winter ground cover by crop type

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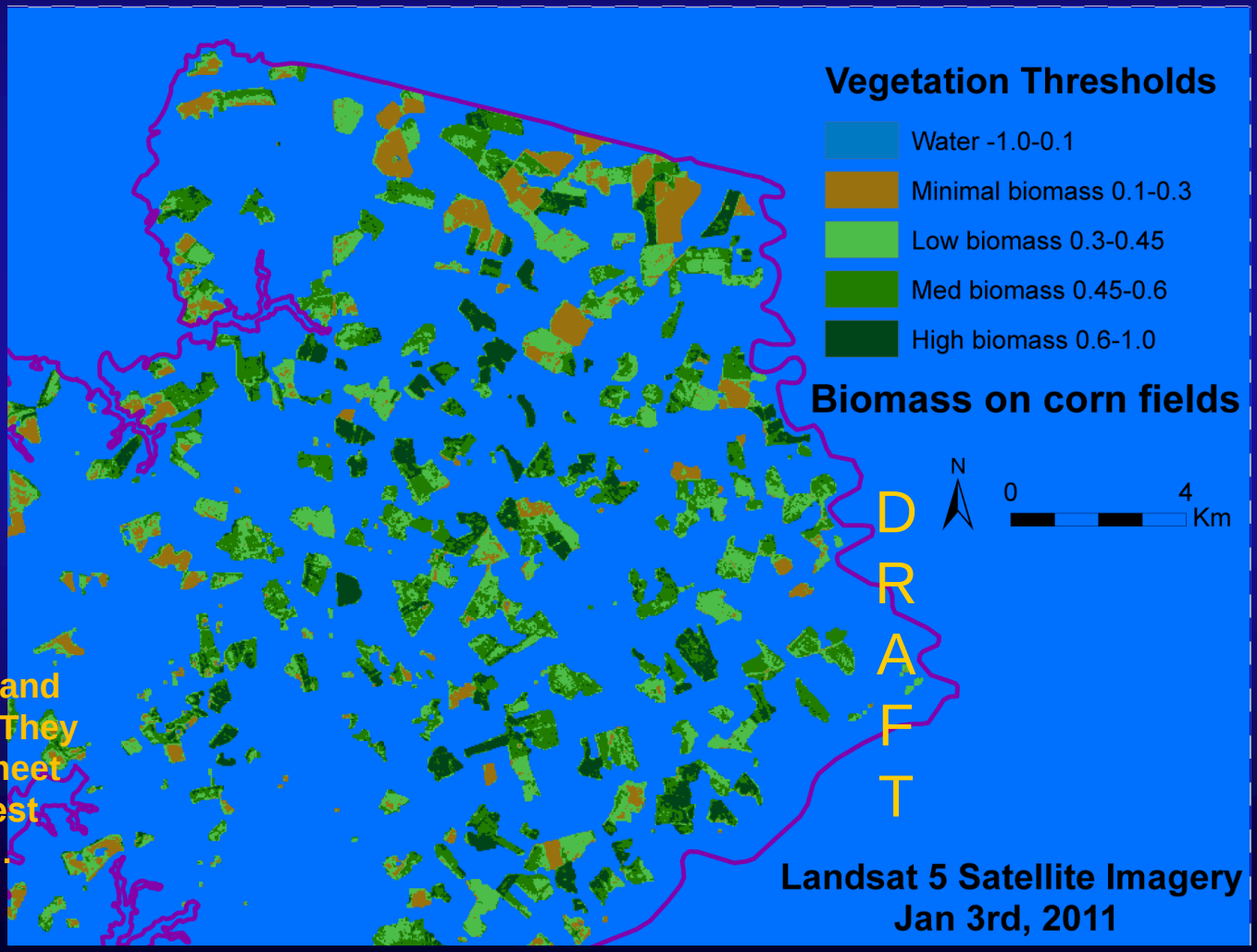
Winter vegetation by cropland type

- Combination of satellite vegetation index and crop map
- Uses only public data sources
- 2008-2012



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Synthesis

NCDL → Corn fields

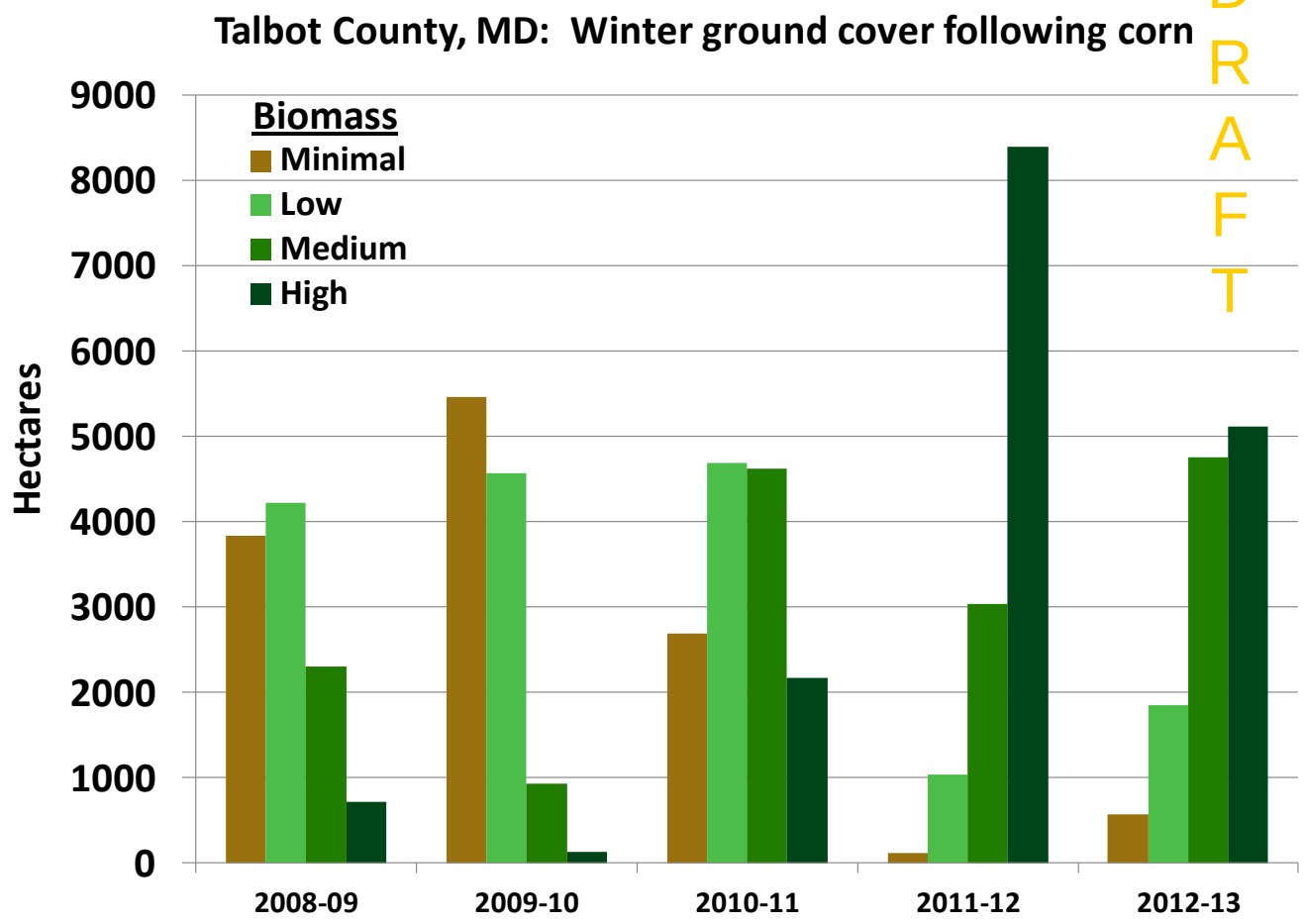
Records → Cover crop following corn

NCDL + Records → Corn fields in cover crop (%)

Satellite + NCDL

Area (ha) of corn fields and cover crops in Talbot County

	2008-09	2009-10	2010-11	2011-12	2012-13
Corn fields	11079	11113	14205	12585	12292
Cover crop following corn	6091	5824	9393	10546	9710
Corn fields in cover crop (%)	55.0	52.4	66.1	83.8	79.0



Based on analysis of Landsat imagery collected in Dec-Jan of each year
These data are preliminary and are subject to revision. They are being provided to meet the need for timely 'best science' information.

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What factors affect cover crop success?

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Planting date

Species choice


Planting method
previous crop
USGS
nitrogen, soils, weather

Analysis (example data for Jan 6th, 2011)

Satellite + NCDL + Records →

	Cover Crop Enrolled Fields		Observed NDVI	Predicted Biomass	Predicted N Content
	#	ha	NDVI	kg ha^{-1}	kg ha^{-1}
Species					
Wheat	1726	15039	0.36	224	4.5
Rye	123	878	0.35	226	4.5
Barley	236	2761	0.36	248	5.0
Planting Date					
Early < Oct 1	1050	8492	0.38	279	5.6
Standard Oct 1-15	630	6183	0.36	206	4.1
Late > Oct15	487	4713	0.30	128	2.6
Planting method					
Aerial	242	1404	0.31	139	2.8
Broadcast	100	651	0.32	155	3.1
Broadcast Stalk Chop	38	185	0.34	195	3.9
Broadcast Light Disk	659	5524	0.36	255	5.1
Conventional Drill	50	702	0.40	272	5.4
No-Till Drill	1078	10922	0.36	230	4.6

Assuming 2% N content for all cover crops. Data for use as example only. These data are preliminary and are subject to revision. They are being provided to meet the need for timely 'best science' information.

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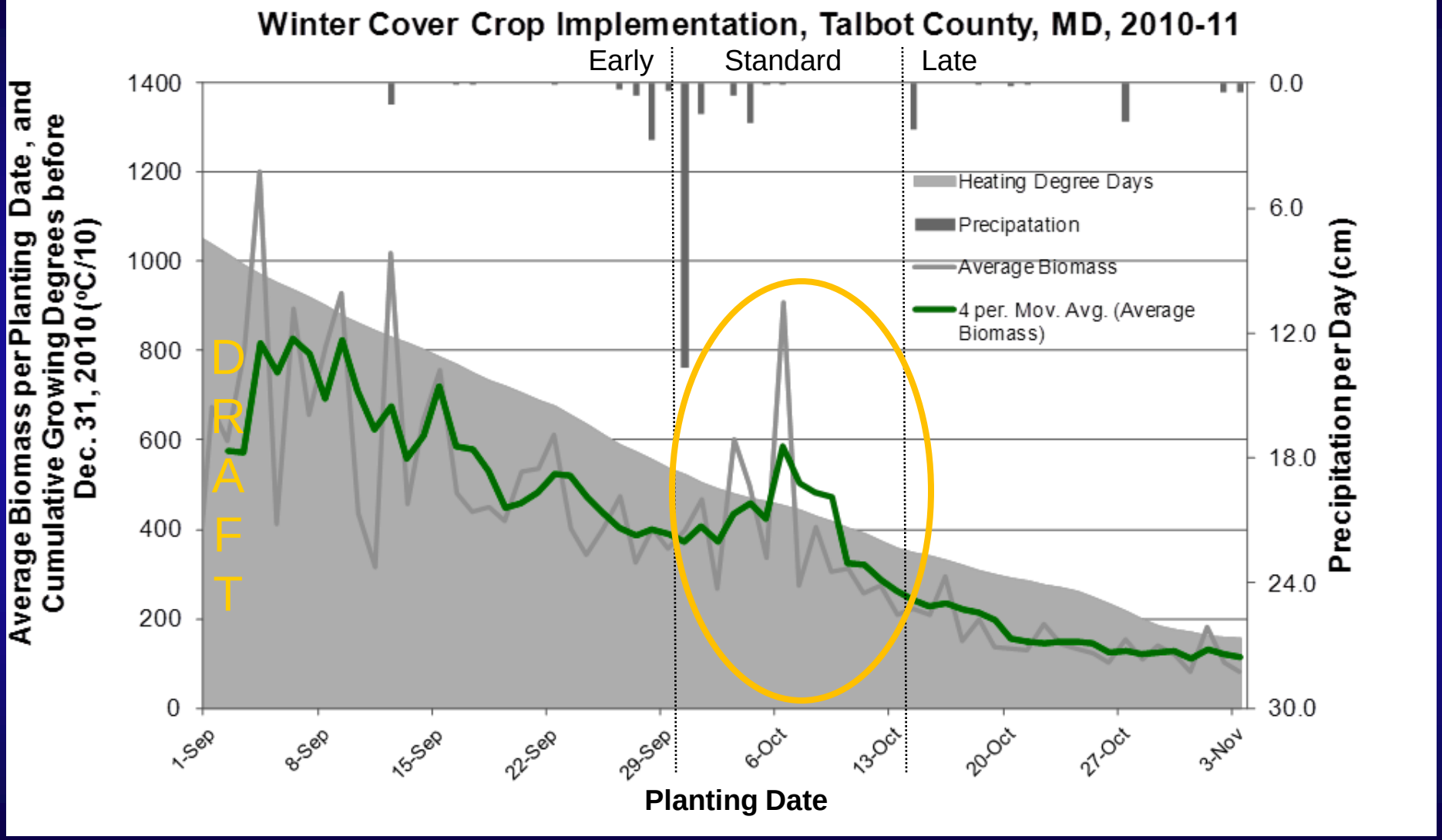
Linking performance to climate



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Cover crops and farming systems

Farmer innovation is yielding some good strategies

- **Rye after corn silage harvest grown for silage**
- **Barley and wheat planted after corn and soybeans**
- **Clover after winter wheat**
- **Cover crop mixes**
- **Linked to crop rotation and nutrient management**

What is succeeding, and how can we help it grow?

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Green is good

But is greener always better?

- **Our field data shows that cover crops scavenge about half of available nitrogen**
- **Some cover crops grow poorly from N limitation**
- **Some field receive too much manure and nutrients**

USGS

Green is good

But is greener always better?

Is there a lower threshold for cover crop success?

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How do we define success?

- Successful strategies fit in with climate and farming systems
- Economical practices, nutrient retention, soil health, recyclical agricultural systems
- Awareness of constraints and opportunities
- Experimentation and sustainability

Carrots, sticks, knowledge, and experience

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Discussion points

- Is it about cover crops, farming systems, or both?
- How can we foster successful cover crop techniques?
- How do we define success?
- Where do we want to be in ten years?

Keep it green – feed the soil

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Thank you! ~ Questions?

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For further details see Hively et al., 2009 - open access articles available online in Sept-Oct 2009 Journal of Soil and Water Conservation
http://www.jswconline.org/content/64/5/ 154A.full.pdf+html
http://www.jswconline.org/content/64/5/ 303.full.pdf+html

Report to farmers (example)

2007-8 Cover Crop Performance Report
USDA-ARS Field Sampling Results

Farmer: [redacted]
Field ID:
ARS ID:
Cover crop species: wheat
Previous crop: Corn
Planting method: no-till
Planting date: 9/29/2007
Comments:
Previous fertility?
Previous crop yield?
Irrigated ?

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Sampling Date	Soil Nitrogen (lb/ac)	Cover Crop Nitrogen (lb/ac)	Biomass (lb/ac)
October 3rd, 2007	50.7	na	na
December 17th, 2007	8.6	22	785
March 26th, 2008	2.0	29	1367

Thank you for participating in the cover crop program, and for allowing us access to your fields.
If you have questions, please contact Dr. Dean Hively, USDA-ARS, 301-504-9031

2007-8 Cover Crop Performance Report
USDA-ARS Field Sampling Results

Farmer: [redacted]
Field ID:
ARS ID:
Cover crop species: Wheat
Previous crop: Soy
Planting method: Conventional
Planting date: 9/28/2007
Comments:
Previous fertility?
Previous crop yield?
Irrigated ?

DRAFT

Sampling Date	Soil Nitrogen (lb/ac)	Cover Crop Nitrogen (lb/ac)	Biomass (lb/ac)
October 3rd, 2007	18.8	na	na
December 17th, 2007	6.4	8	233
March 28th, 2008	3.4	8	312

Thank you for participating in the cover crop program, and for allowing us access to your fields.
If you have questions, please contact Dr. Dean Hively, USDA-ARS, 301-504-9031

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Winter cover crop remote sensing

Understanding Agricultural Conservation Practices – Collaborators

- **USGS Priority Ecosystems Services, Chesapeake Bay Science Plan**
- **USDA Agricultural Research Service**
- **Maryland Department of Agriculture**
- **Soil Conservation Districts in four Eastern Shore counties**
- **University of Maryland (Geography, Plant Science, Economics)**
- **National Fish and Wildlife Foundation**
- **USDA-NRCS, USDA-FSA, Farmers**
- **EPA Chesapeake bay Program**
- **USDA Choptank River Conservation Effects Assessment Project**

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