

Patrick Willis
Federal Contractor

United States Department of Agriculture (USDA)
National Agricultural Statistics Service (NASS)
Research and Development Division (RDD)
Spatial Analysis Research Section (SARS)

The USDA-NASS Cropland Data Layer: Early Season Winter Wheat Identification Using Limited Ground Truth

ASPRS Annual Conference – Baltimore, 2009



NASS Overview

Provider of timely, accurate, and useful statistics in service to U.S. agriculture

NASS - Data and Statistics - Microsoft Internet Explorer

Address: http://www.nass.usda.gov/Data_and_Statistics/index.asp

USDA United States Department of Agriculture
National Agricultural Statistics Service

The 2002 Census of Agriculture is the most comprehensive source of statistics portraying our nation's agriculture

Home About NASS Newsroom Publications **Data and Statistics** Census Surveys Help Contact Us

You are here: Home / Data and Statistics

Data and Statistics

Quick Stats (Agricultural Statistics Data Base)

NASS publishes U.S., state, and county level agricultural statistics for many commodities and data series. Quick Stats offers the ability to query by commodity, state(s) and year(s), providing the most up-to-date statistics including all revisions. The query dataset can be downloaded for easy use in your database or spreadsheet.

I Want To...

- Query NASS Data from a Data Base
- Search for Data by Commodity
- Request a Special Tabulation
- Contact a Specialist
- View Data in Charts and Maps

About NASS Estimates

- Importance of Ag Estimates
- Understanding Crop Forecasts
- Foundation of Estimates
- Estimating Programs
- Citation Request

Also See

- NASS Publications
- Statistical Bulletins
- Pest Management
- Price Reactions
- State Ag Overview
- Track Records

Interactive Data

NASS provides a variety of tools for interacting with our Census datasets.

- Interactive Statistical Maps: Interactive Census Maps for 2002 Census Highlights
- Table Lens: Table Lens Application for 1997 Census Data

Last modified: 12/30/05

NASS Home | [USDA.gov](#) | [FEDSTATS](#) | [Economics Statistics System \(ESS\)](#) | [Site Map](#) | [FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [FirstGov](#) | [White House](#)

2001 Wildlife Damage Survey

7.7 Percent of Crop Value Lost to Deer and Geese

Maryland farmers lost \$17.2 million of corn, soybeans and wheat to deer and geese during 2001, translates to Maryland farmers losing 7.7 percent of the crop value to deer and geese. Soybeans account for the greatest economic loss, totaling \$9.1 million, 11 percent. Corn losses were \$6.6 million, 5.8 percent and wheat \$1.5 million, 5.6 percent. Deer damage resulted in losses of \$13.6 million, 6.1 percent, while geese losses were \$3.6 million, 1.6 percent.

Production losses totaled 6.0 million bushels. Corn losses were 3.2 million bushels, soybean losses are 2.2 million bushels and wheat accounted for 0.6 million bushels. Production losses to deer were 4.7 million bushels and geese 1.3 million bushels.

In terms of yield, losses to deer were most severe in Central and Western Maryland, while geese damage greater on the Eastern Shore. Corn yield losses of 9.6 bushels per acre and 7.4 bushels per acre were reported in Central and Western Maryland, respectively. The Lower Eastern Shore reported the highest soybean loss of 6.1 bushels per acre.

Sixty-two percent of farms reported deer or geese damage to one or more crops. Damage was reported on 27 percent of farms raising corn, 58 percent of farms growing soybeans and 27 percent of farms with wheat.

Maryland 2001 Crop Loss from Deer

Region	Crop	Acres	Harvested Yield (bushels)	Average Yield Loss (bushels)	Production Loss (bu)	Economic Loss (\$)
Western Maryland	Corn	9,500	124,9	7.4	40,100	83
	Soybeans	300	36.7	9.9	1,201,200	2,413
	Wheat	200	45.2	2.3	460	1
Central Maryland	Corn	114,200	98.4	3.9	360,750	1,479
	Soybeans	92,800	34.2	3.3	126,250	319
	Wheat	38,300	63.3	3.3	126,250	319
Southern Maryland	Corn	29,800	132.9	4.9	146,200	299
	Soybeans	43,200	39.0	3.1	142,260	334
	Wheat	16,900	57.0	0.9	14,400	36
Upper Shore	Corn	197,200	159.2	5.1	800,700	1,211
	Soybeans	232,000	39.8	2.4	186,800	2,212
	Wheat	84,800	64.0	1.1	99,150	213

USDA NEWS RELEASE

NATIONAL AGRICULTURAL STATISTICS SERVICE
United States Department of Agriculture - Washington, DC 20250
Ag Statistics Hotline: (800) 727-9540 • www.nass.usda.gov

Contact: Ellen Dougherty, (202) 690-8122
Jeff Geuder, (202) 720-2127

USDA FORECASTS RECORD-SETTING CORN CROP FOR 2007

Washington, Aug. 10, 2007 – U.S. history in 2007, according to the United States Department of Agriculture's National Agricultural Statistics Service, is that the nation's corn crop is projected to reach 13.1 billion bushels, 10.6 percent more than the 2006 record of 11.8 billion bushels. Based on conditions as of August 10, 2007, the average yield is projected to be 106.4 bushels per acre, up 3.7 bushels from last year's 102.7 bushels per acre. Behind the 160.4 bushels per acre is the 160.4 bushels per acre for grain, up 1.1 bushels from last year's 159.3 bushels per acre. Yield forecasts are high for the Corn Belt, Ohio Valley, and the Eastern Corn Belt. Meanwhile, hot, dry conditions in the Southeast and the Upper Midwest are expected to reduce yields in those areas.

WISCONSIN AGRICULTURAL STATISTICS SERVICE
P.O. Box 8034 Madison, WI 53708-8034
In cooperation with WI Department of Agriculture, Trade and Consumer Protection

2002 Dairy Producer Opinion Survey

November 2002

Wisconsin Milk Production to Recover

Milk production is expected to increase in Wisconsin during the next few years according to a survey conducted by the Wisconsin Agricultural Statistics Service. This statewide survey of producers asked for their plans with the assumption that milk prices for the next five years will be at the same level as the past five years. The survey was conducted during May and June 2002.

Based on the survey, 60 percent of producers expect to keep the same herd size, 20 percent plan to increase herd size, and 20 percent intend to discontinue milking by 2007. Actual results will depend on future milk prices, input prices, financing availability, crop yields, and other factors.

The number of herds projected for 2007 shows that the diversity of small to large herds will continue. The most prevalent herd size will remain at 50 to 99 cows.

2002 Census of Agriculture - SVG Interactive Mapping - United States - Microsoft Internet Explorer

National Agricultural Statistics Service 2002 Census of Agriculture

United States | All data items are from Chapter 2 - Table 1. Area Summary Highlights: 2002 Selected crops harvested - Land in orchards (acres)

State: United States - County Level | Data Item: Selected crops harvested - Land in orchards (acres)

United States Total: 5,330,439

State Total: _____

County Total: _____

Download data as CSV | XML | PDF

Help | Print | Return to

Legend

Scale: National | Zero or Data Withheld

(Changes the data range based on National or State level)

- <= 20,000
- 20,001 to 40,000
- 40,001 to 60,000
- 60,001 to 80,000
- 80,001 to 100,000
- 100,001 >=

Comparisons: 6 | Color: Green

Source: USDA-NASS 2002 Census of Agriculture © USDA-NASS 2005-2006

Navigate: Mouse-over a specific state/county to view the state/county level data. Right click to zoom (option-click for MAC users). Hold the Alt key and click+drag to pan. For additional assistance with this application, [click here to view the support page.](#)

All Milk Price, Wisconsin Annual Average, 1985 - 2002 1/

Wisconsin Dairy Herds by Herd Size

Milk cow herd size	May 2002 herds	May 2007 herds (projected) 1/	Change 2007/2002
1 - 29	2,800	1,440	-45
30 - 49	4,700	3,440	-27
50 - 99	7,400	5,600	-24
100 - 199	1,900	2,080	+10
200 - 499	700	600	-29
500+	200	440	+120
Total	17,500	15,900	-20

1/ The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

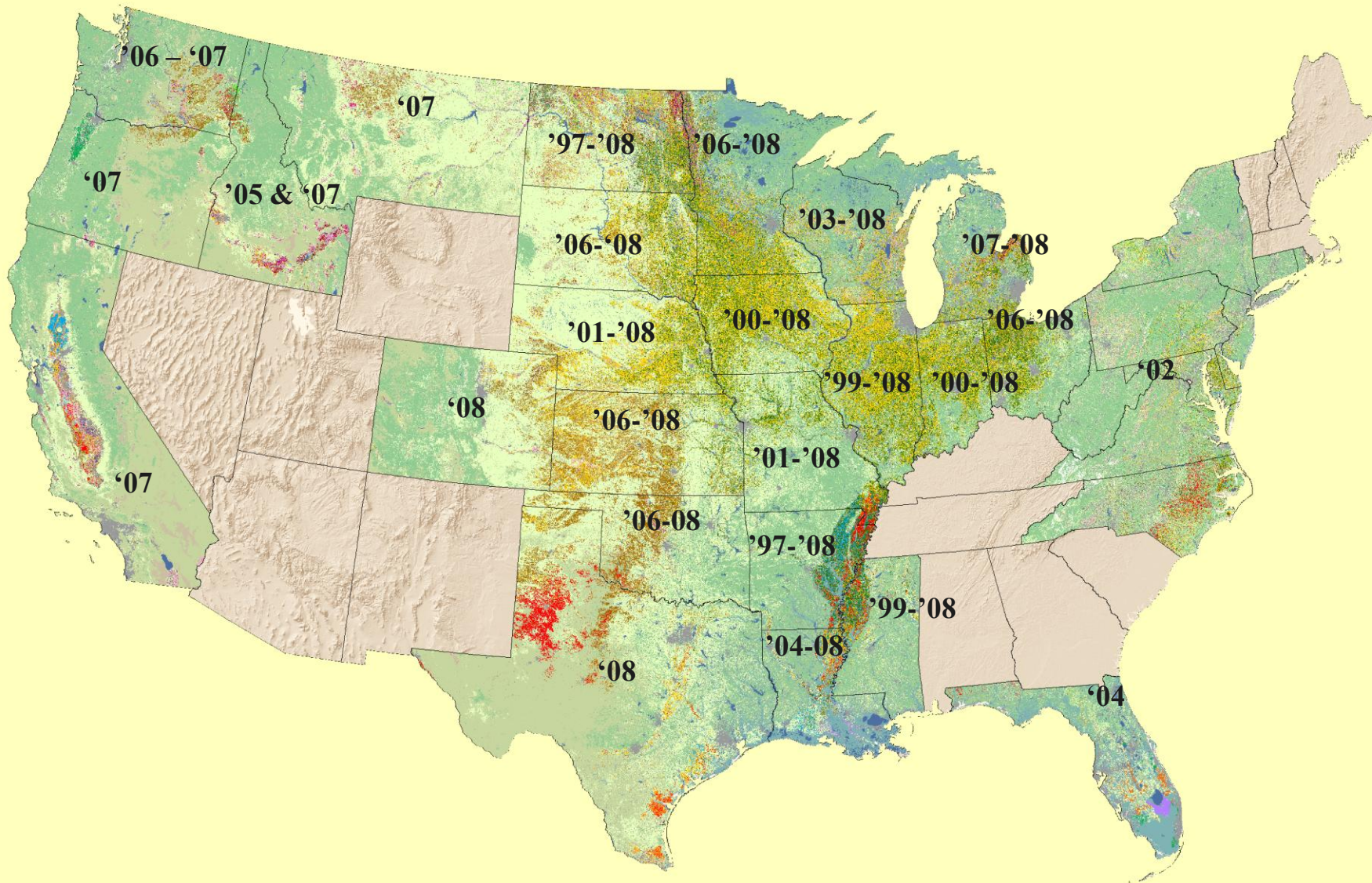
Percent of Herds by Size Group 2007 Projection

Wisconsin Dairy Farmer Plans for May 2007 1/ by Herd Size

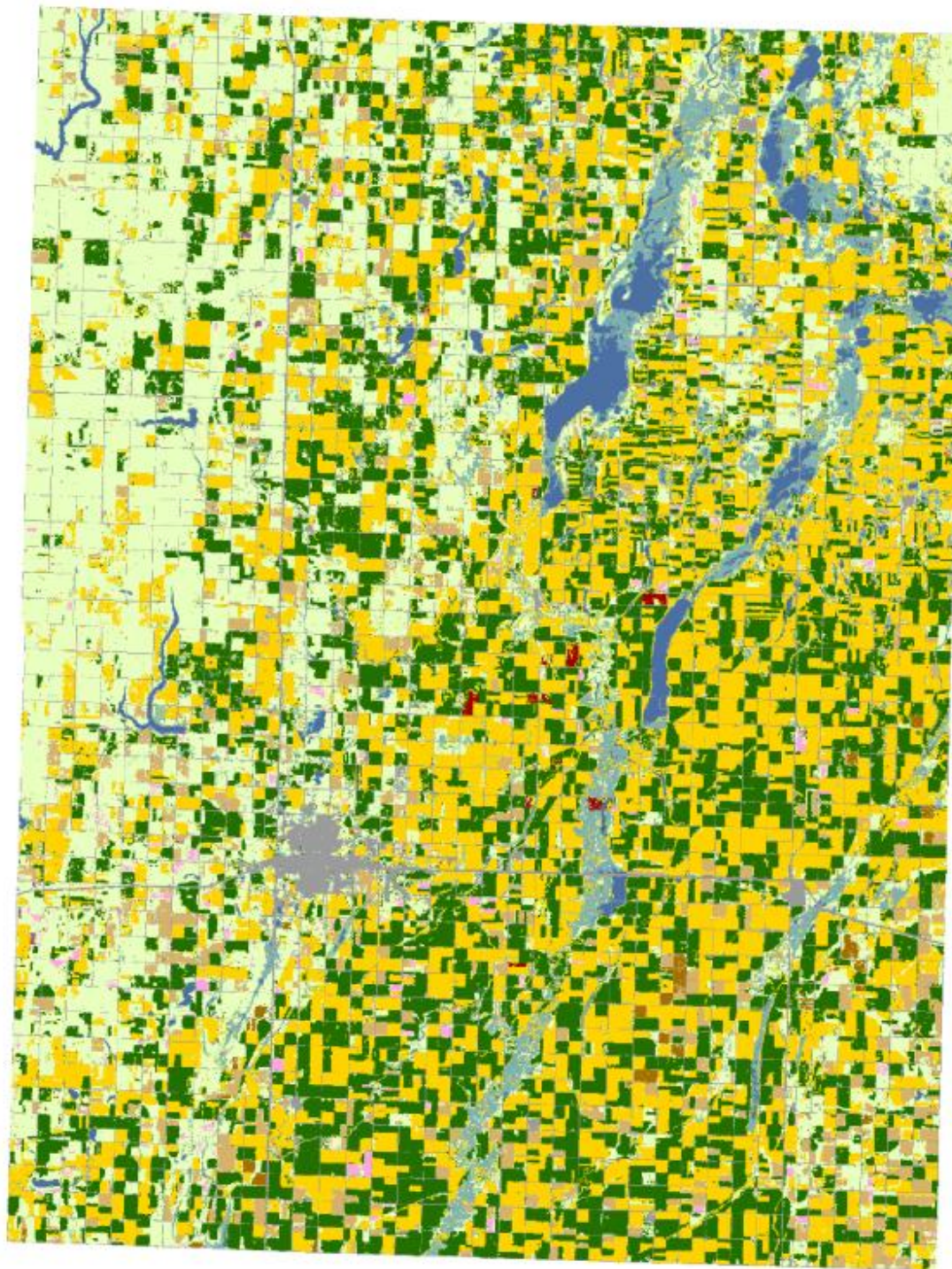
Herds	Keep same herd size	Increase herd size	Discontinue milking
2,800	47	17	36
4,700	71	9	20
7,400	63	19	18
1,900	53	37	10
700	33	59	8
200	22	78	0
17,500	62	29	20

1/ The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

Cropland Data Layers 1997 - 2008



Brown County, SD '08



Land Cover Categories (Ordered by Decreasing Acreage)

Agricultural

- Corn
- Soybeans
- Spring Wheat
- Alfalfa
- Winter Wheat
- Dry Beans
- Sunflowers
- Oats
- Millet
- Sorghum
- Barley
- Rye
- Other Crops

Non-Agricultural

- Grass/Pasture/Non-Ag
- Urban/Developed
- Wetlands
- Water
- Woodland
- Fallow/Idle Cropland
- Barren
- Shrubland

Purpose of the Cropland Data Layer (CDL) Program

Typically, the CDL program goals are:

- 1) Combine remote sensing imagery, USDA/Farm Service Agency reported data and NASS survey data to produce supplemental, unbiased independent acreage estimates for the state's major commodities.
- 2) Production of a crop-specific digital land cover data layer for distribution in industry standard formats.

Annual CDL states traditionally focused in the Midwest and Mississippi Delta States

- Corn, Cotton, Rice, Soybeans, Winter Wheat



Corn



Soybeans

Methodology

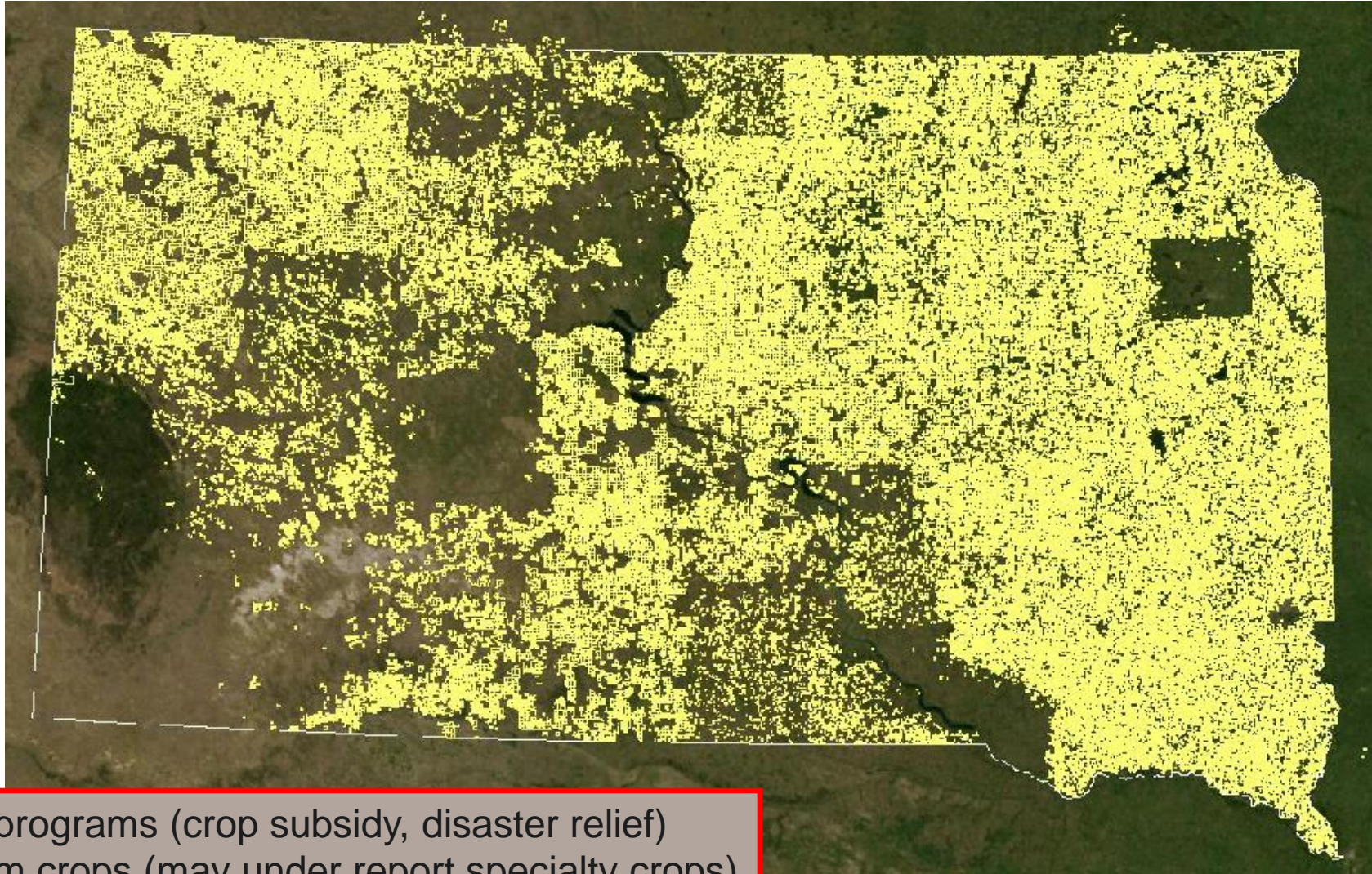
- “Stack” satellite imagery and ancillary data layers within a raster GIS
 - 56 meter grid cells, Albers Conic Equal Area projection
- Sample spatially from stack within known ground truth from FSA and NLCD
- Data-mine samples using Boosted Classification Tree Analysis to derive best fitting decision rules
- Apply derived decision rules back to input data stack
- Create land cover map
- Create probability map
- Assess map accuracy
- Derive acreage estimates

Methodology

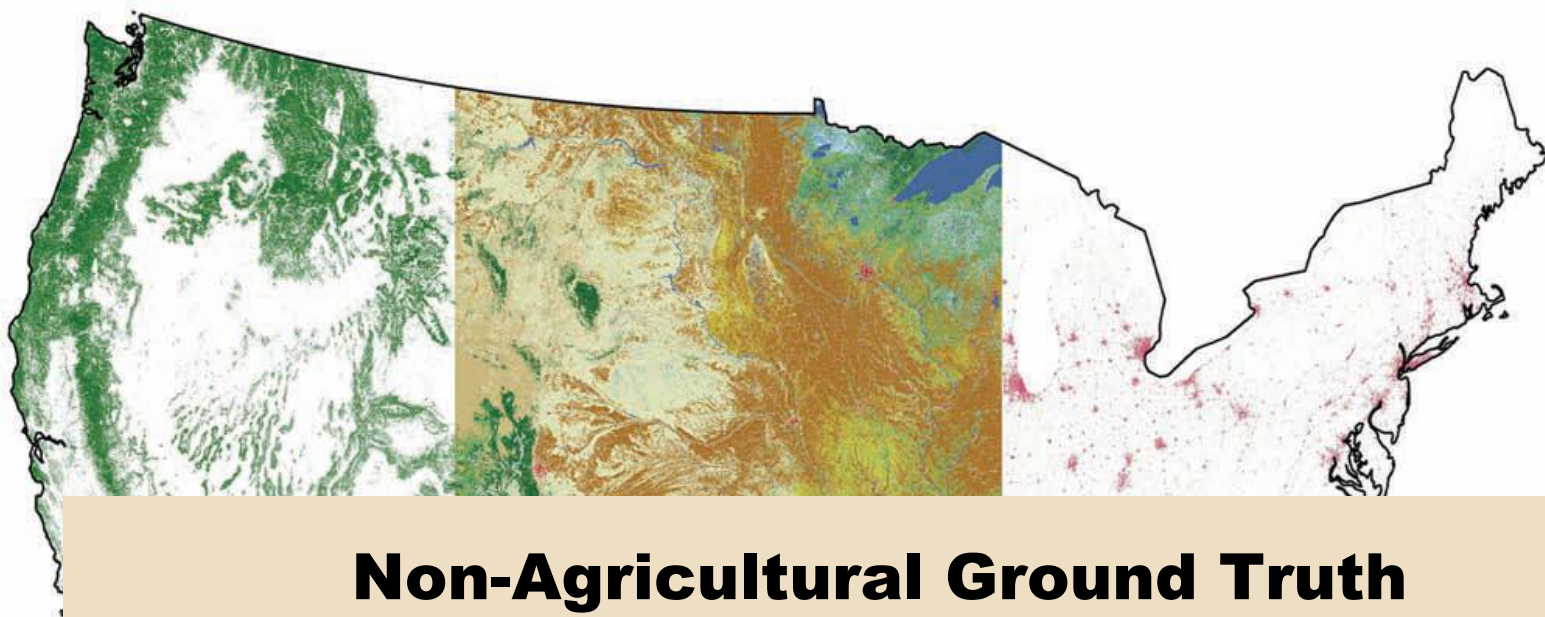
- Ground Truth
 - Agricultural training & validation
 - Farm Service Agency (FSA) Common Land Unit (CLU)
 - Non-Agricultural training & validation
 - USGS 2001 National Land Cover Dataset (NLCD)
- Satellite Imagery
 - IRS Resourcesat-1 AWiFS
 - NASA Terra MODIS 16-day composite NDVI
 - Landsat 5
- Ancillary data layers
 - USGS National Elevation Dataset (NED)
 - USGS NLCD 2001 Impervious and Tree Canopy layers
- Software
 - Ground Truth Preparation: ESRI ArcGIS 9.2
 - Imagery Preparation: Leica Geosystems ERDAS Imagine 9.1
 - Decision-Tree Software: Rulequest See 5.0
 - Classification: NLCD Mapping Toolkit
 - Acreage Estimation: SAS

Agricultural Ground Truth

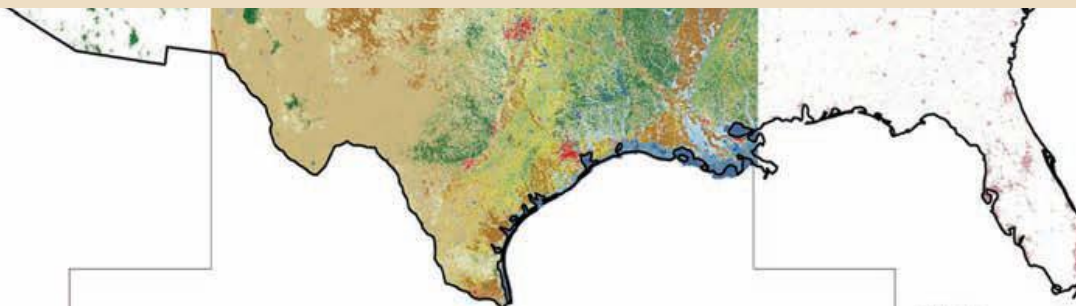
FSA Common Land Unit



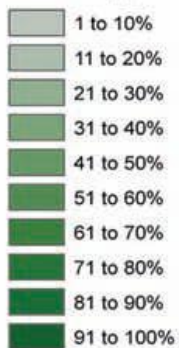
- USDA programs (crop subsidy, disaster relief)
- Program crops (may under report specialty crops)
- GIS-ready (less labor intensive for NASS)



Non-Agricultural Ground Truth USGS, National Land Cover Dataset 2001



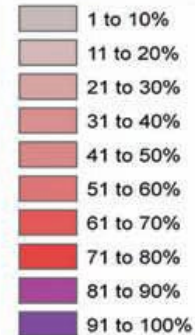
Tree canopy



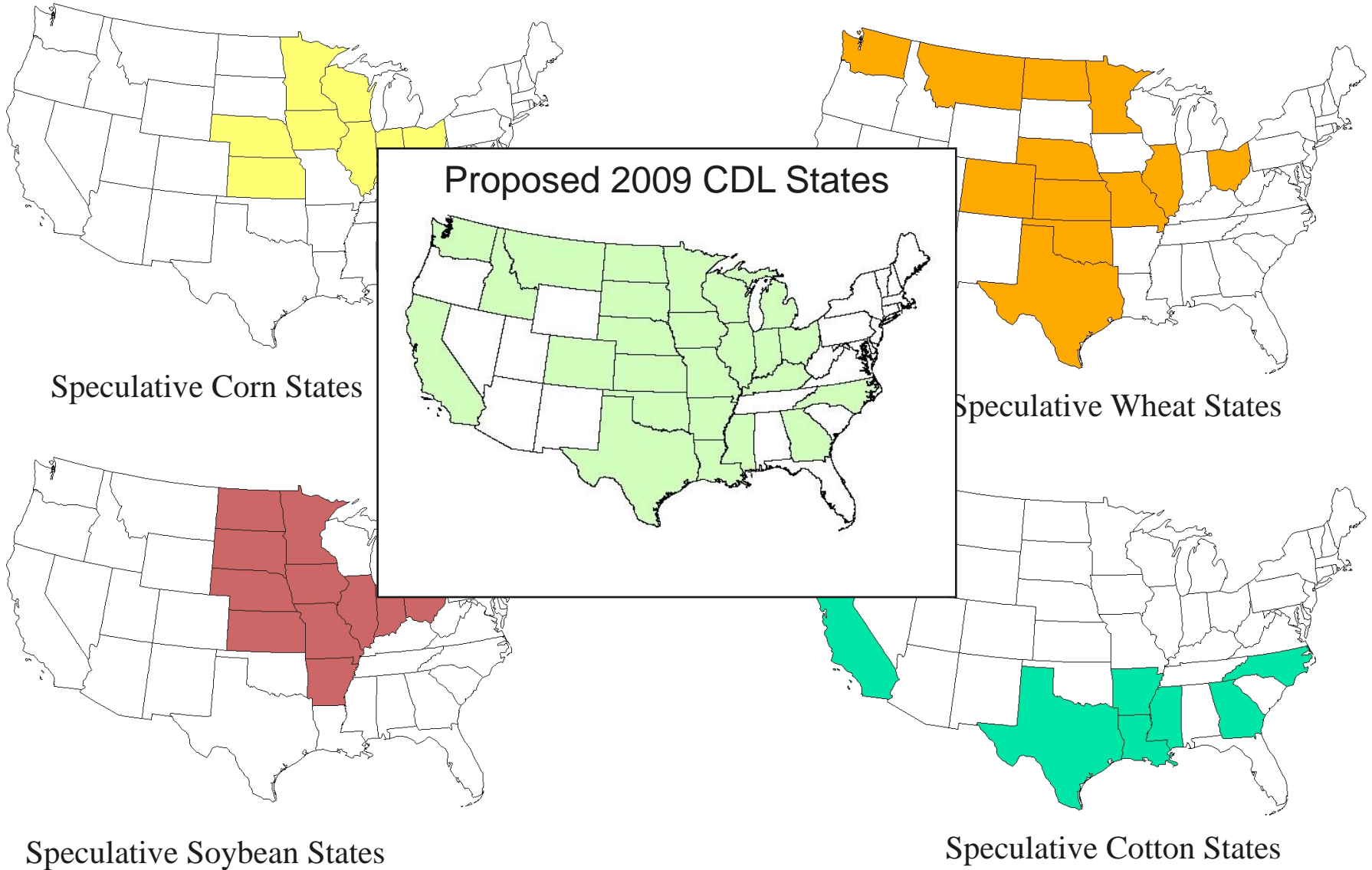
Land Cover Class Value and Description



Urban Imperviousness



Expanding CDL Program Priorities



New Objective: Early Season Winter Wheat Acreage Estimation

13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		
8:●	15:○	22:○	30:○			

10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	
6:●	13:○	20:○	28:○			

9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					
7:●	14:○	21:○	29:○			

April						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			
5:●	12:○	20:○	28:○			

May						
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
5:●	11:○	19:○	27:○			

June						
Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24				
29	30					
3:●	10:○					

2007 Crop Acreage Report
CDL winter wheat

July						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		
2:●	10:○	18:○	25:○			

August						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						
1:●	8:○	16:○	23:○	30:○		

September						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				
7:○	15:○	22:○	29:○			

October						
Su	Mo	Tu	We	Th	Fr	Sa
5	6	7				
12	13	14				
19	20	21				
26	27	28				
7:○	14:○	21:○	28:○			

November						
Su	Mo	Tu	We	Th	Fr	Sa
5:○	13:○	19:○	27:○			

December						
Su	Mo	Tu	We	Th	Fr	Sa
				4	5	6
				11	12	13
				18	19	20
				25	26	27
5:○	12:○	19:○	27:○			

Historical:
Crop Production Annual Summary
CDL all crops/county estimates



The Challenge:

Classification with Partial Ground Truth

FSA reporting deadlines

- Different reporting dates for different crops
- State dependent

Illinois example - early June 2008:

Available FSA data: ~ 14% of winter wheat reported
 < 1% of any other crop

Classification inputs: AWiFS scenes
 080405, 080406, 080415, 080420, 080430, 080504
 MODIS 16 day NDVI composites
 071016, 071101, 071117, 080406, 080422, 080508
 Ancillary data
 Elevation, NLCD Canopy, NLCD Imperviousness

The Challenge: Classification with Partial Ground Truth

June



September

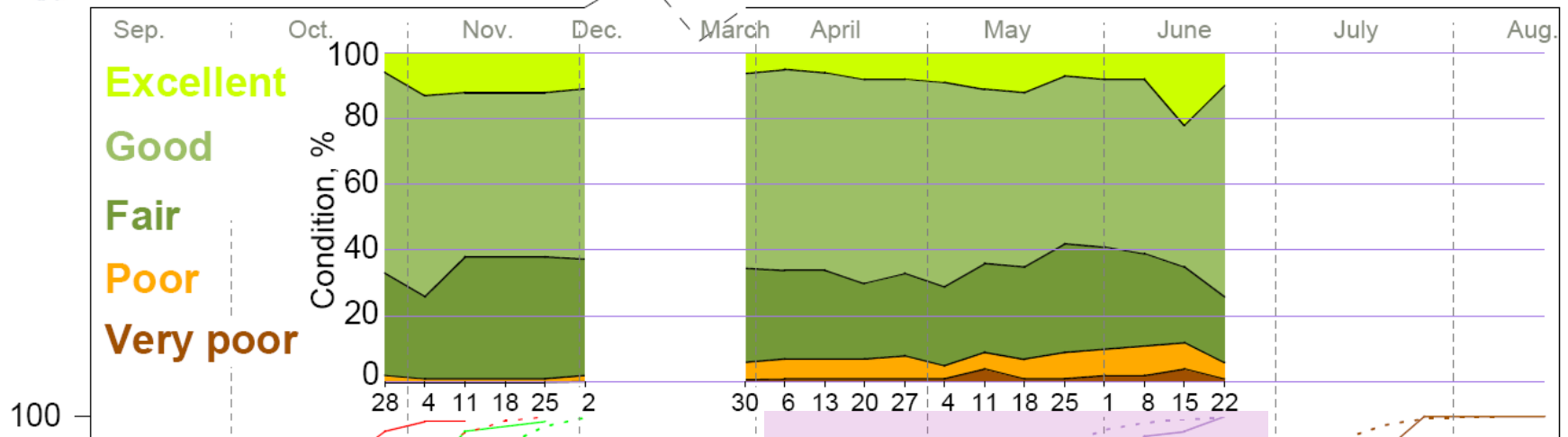




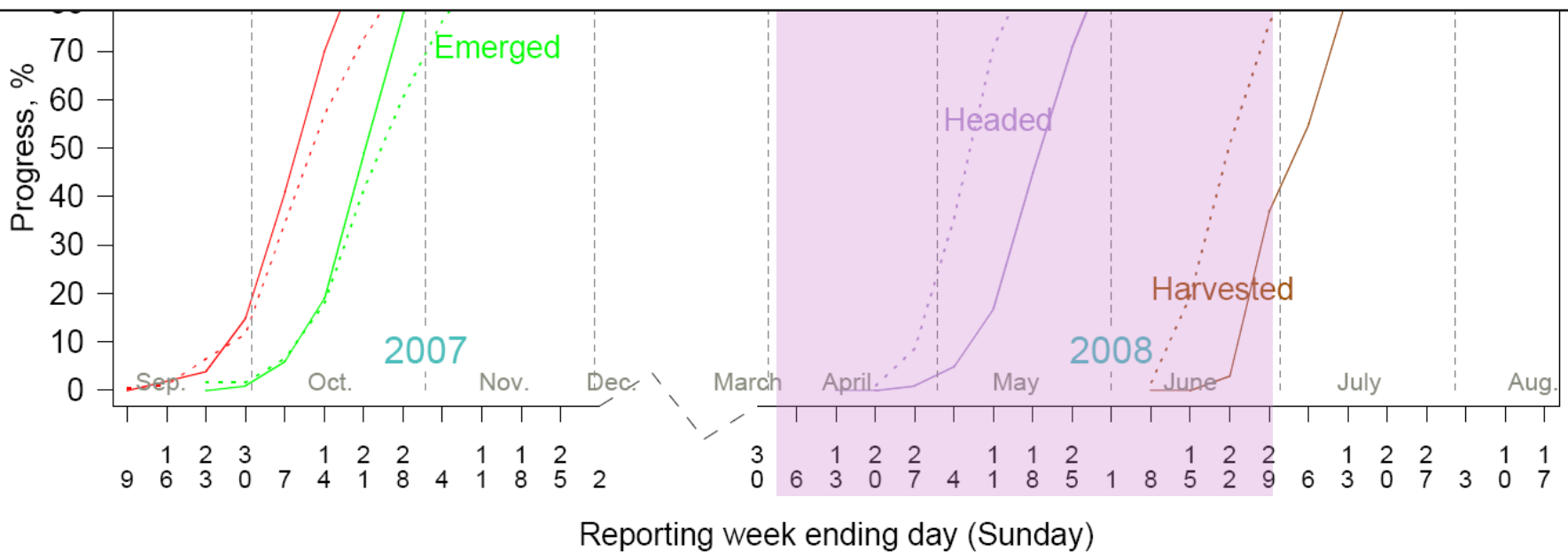
Crop Progress: Winter Wheat in Illinois, 2008



2008, 2003-2007 Average



http://www.nass.usda.gov/Charts_and_Maps/Crop_Progress_&_Condition/



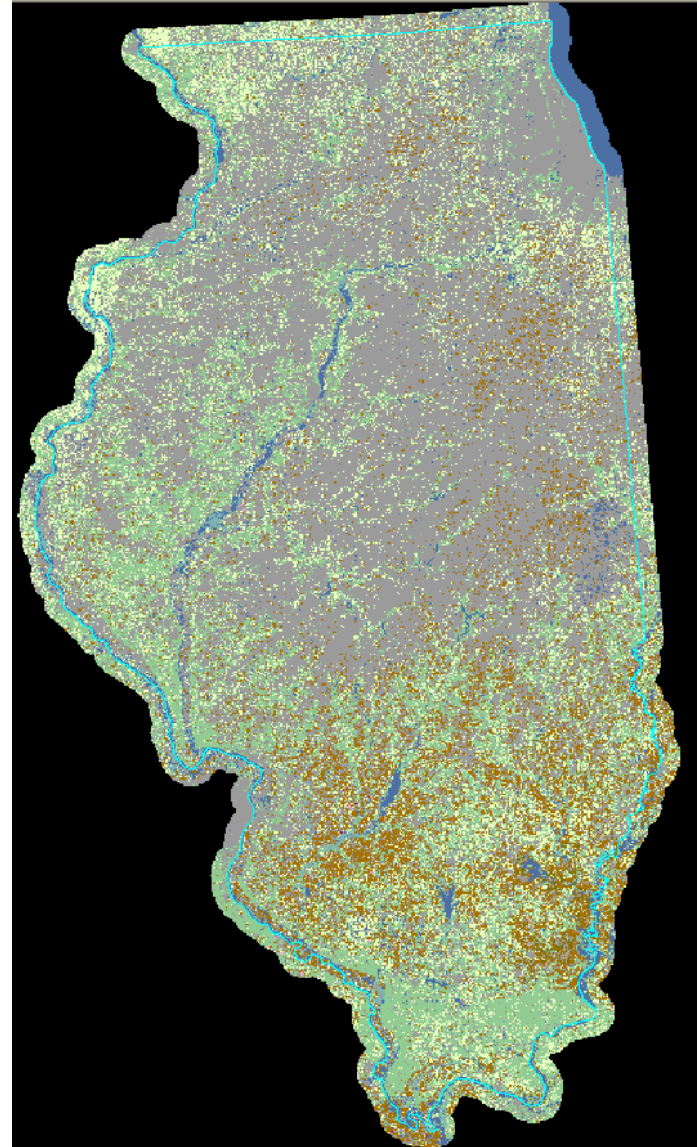
Initial Classification

Normal CDL methodology

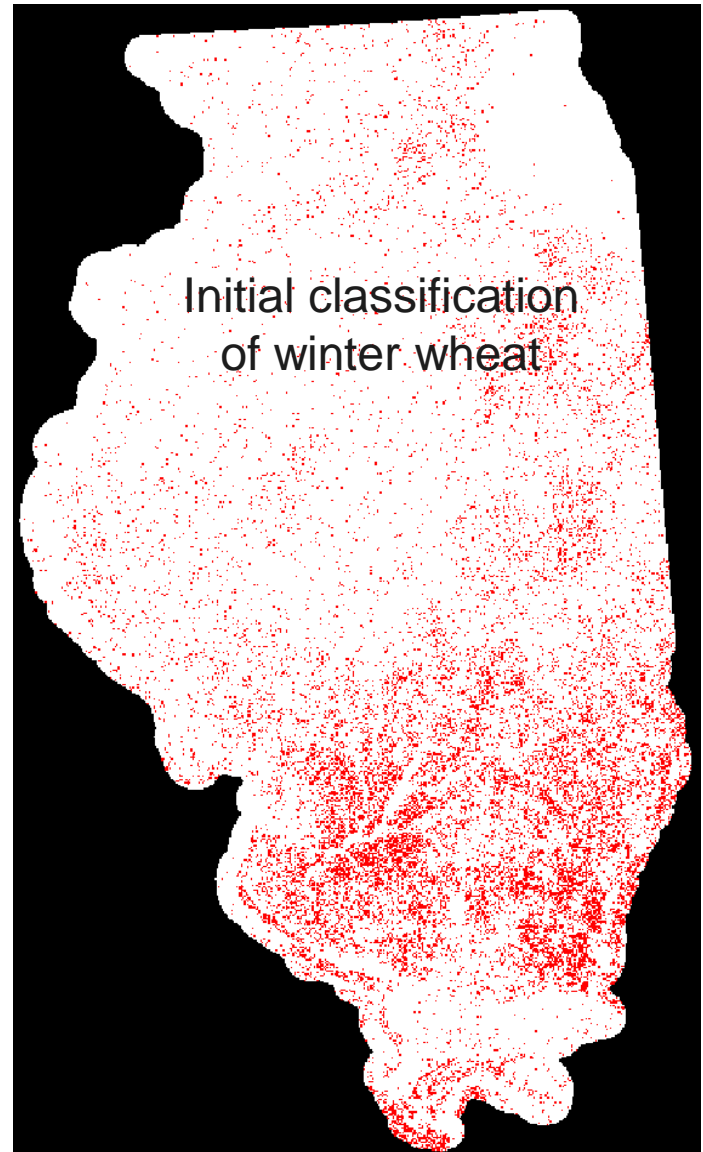
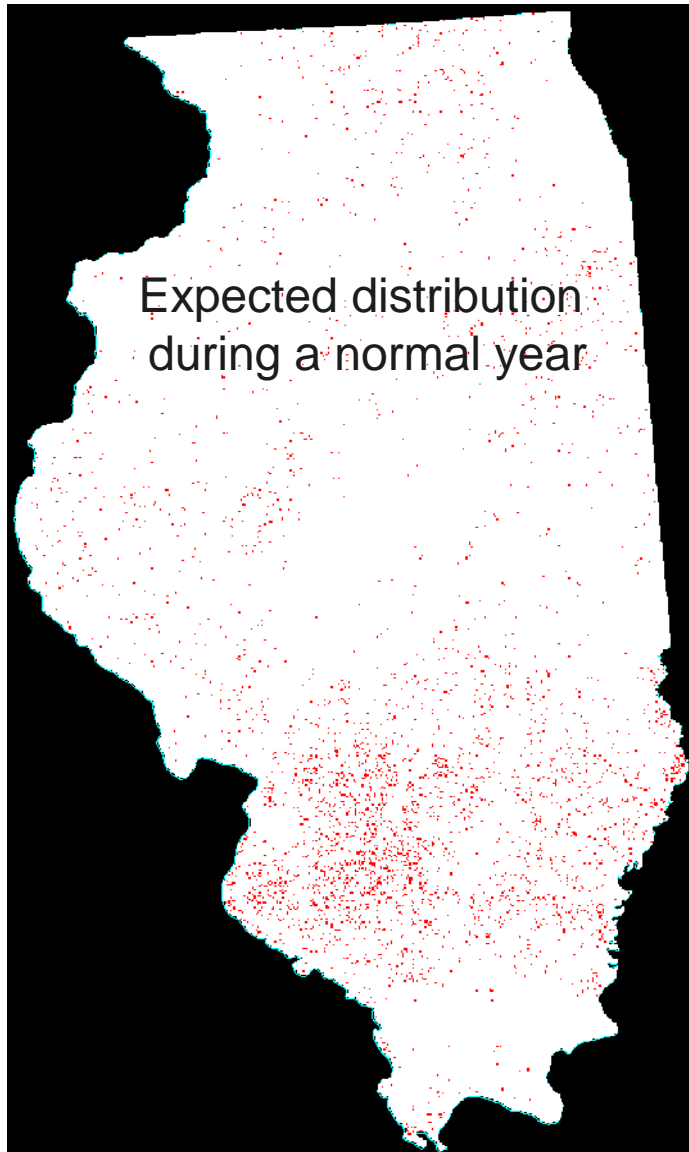
50% of the FSA data
(almost entirely winter wheat)

Proportionately sampled NLCD

Drastic winter wheat over classification



Initial Classification



Goal: Create a Historical 'Other Crops' Data Layer for Training

- Identify areas where:
 - All past CDL's were cultivated crops
 - Exclude winter wheat
- Logic problem
 - Recode the cultivated 'other crops' to 1
 - Recode winter wheat and non-ag to 0
 - Multiply the layers together

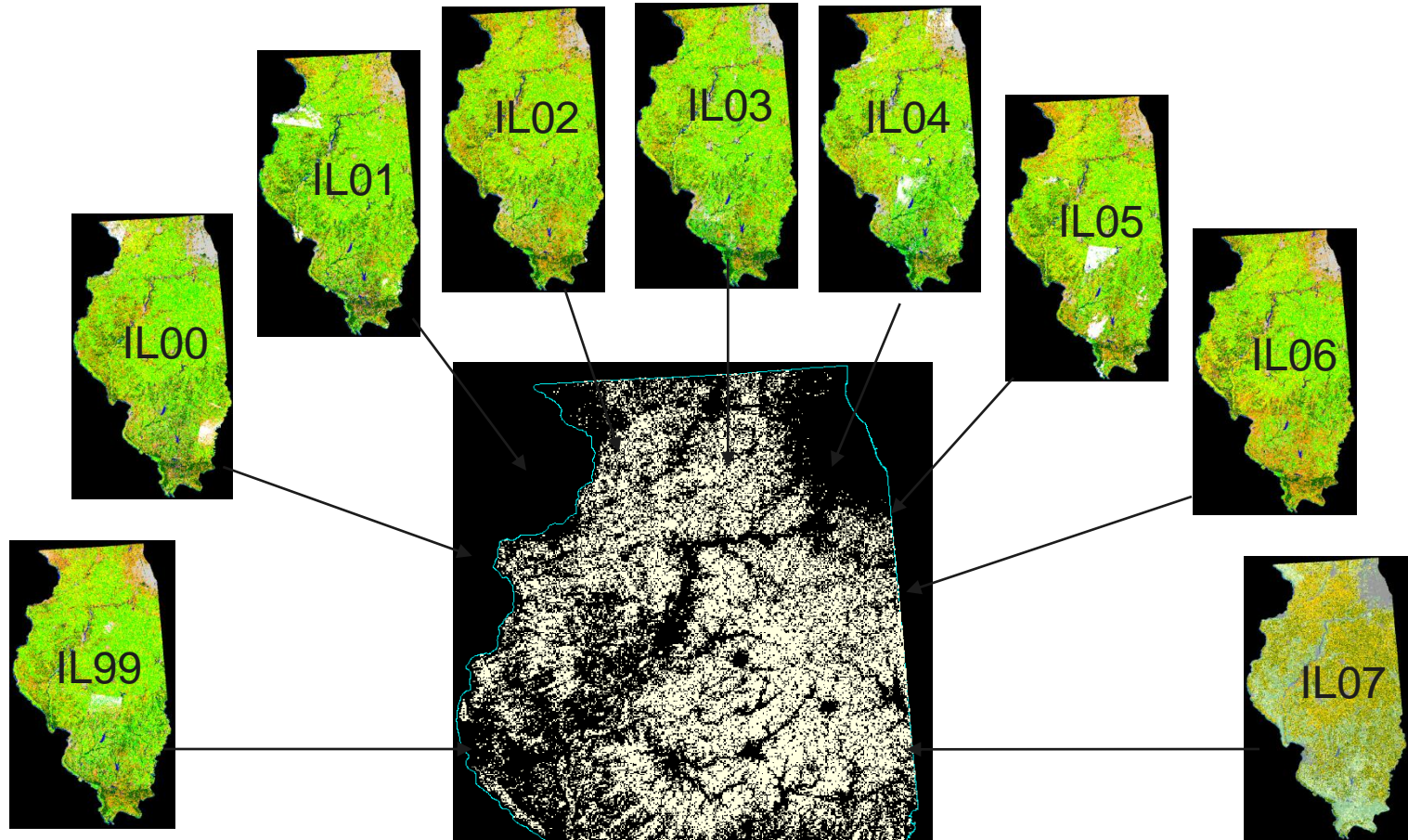
Goal: Create a Historical 'Other Crops' Data Layer for Training

- Model created using Erdas Imagine Spatial Modeler
- Example for Illinois 1999-2007

The screenshot displays the Erdas Imagine Spatial Modeler interface. On the left, a workflow diagram shows several input rasters (n1_089, n2_100, n3_101, n4_102, n5_103, n6_104) feeding into a central circular process node labeled 'n9_107_owifs_albers_se13_RC'. Below this node, an output raster 'n10_189' is shown. A dialog box titled 'Rasters: n9_107_owifs_albers_se13_RC' is open, showing the 'File Name' as 'i07_owifs_albers_se13.img', 'Number of Rows' as 11175, and 'Number of Columns' as 6293. The 'Interpolation' is set to 'Nearest Neighbor'. The 'Output' section shows 'Data Type' as 'Unsigned 8-bit' and 'File Type' as 'Thematic'. The 'Recode' dialog box is also open, showing a table of values and their corresponding new values, red, green, and blue components, and opacity. The 'New Value' is set to 1.

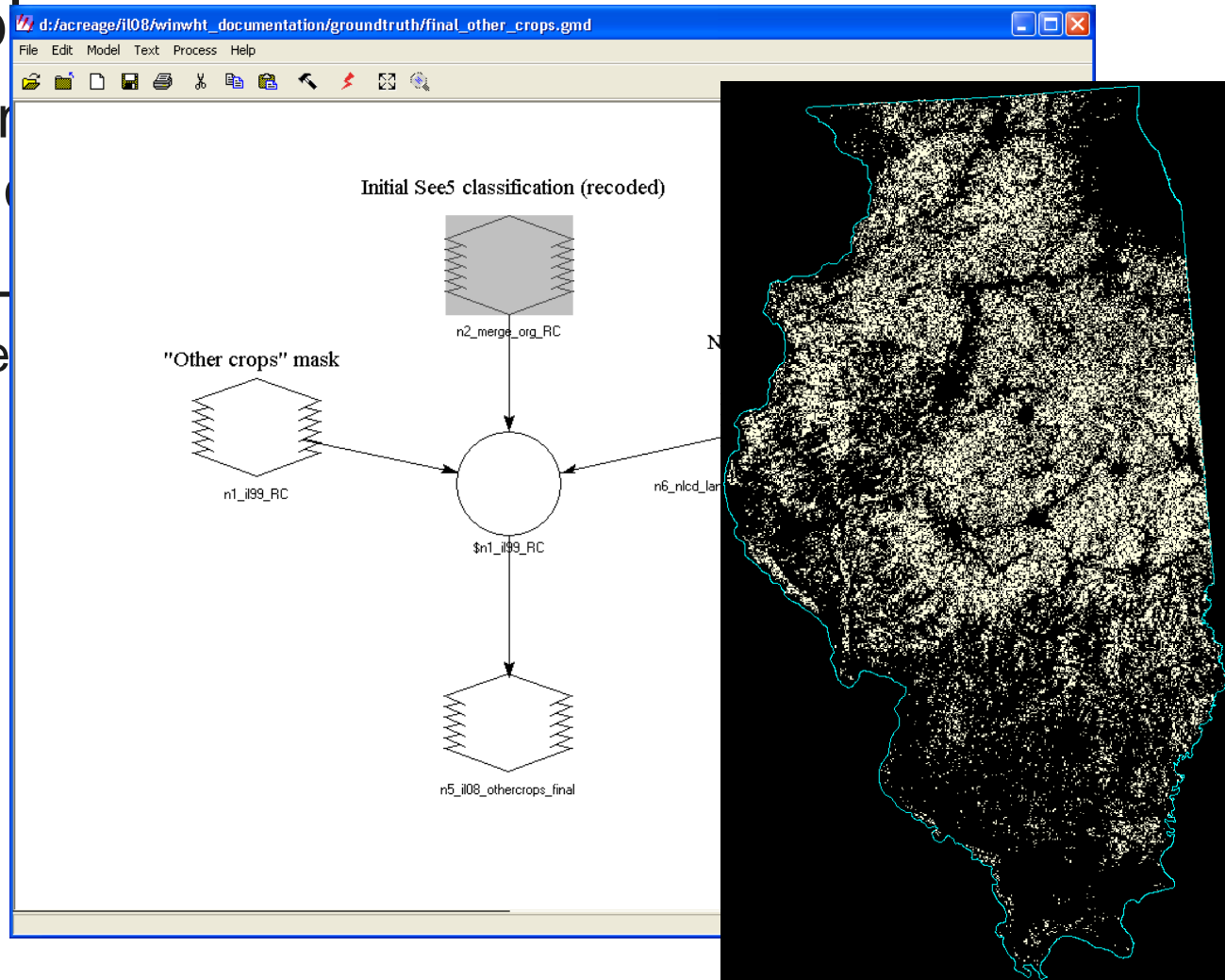
Value	New Value	Red	Green	Blue	Opacity	Histogram
0	1	0.000	0.000	0.000	0.0	2359308 0 Background
1	1	1.000	0.030	0.000	1.0	16074478 0 Corn
2	1	1.000	0.000	0.000	1.0	0 0 Cotton
3	1	0.000	0.000	0.000	1.0	855 0 Rice
4	1	1.000	0.520	0.050	1.0	2335 0 Sorghum
5	1	0.140	0.440	0.000	1.0	5267196 0 Soybeans
6	1	1.000	1.000	0.000	1.0	300 0 Sunflowers
7	1	0.000	0.000	0.000	1.0	0 0
8	1	0.000	0.000	0.000	1.0	0 0
9	1	0.000	0.000	0.000	1.0	0 0
10	1	0.800	0.400	0.400	1.0	0 0 Peanuts
11	1	0.400	0.380	0.200	1.0	0 0 Tobacco
12	1	1.000	0.020	0.000	1.0	0 0 Sweet Corn
13	1	1.000	0.030	0.000	1.0	0 0 Pop. or Grn. Corn
14	1	0.000	0.000	0.000	1.0	0 0
15	1	0.000	0.000	0.000	1.0	0 0
16	1	0.000	0.000	0.000	1.0	0 0
17	1	0.000	0.000	0.000	1.0	0 0
18	1	0.000	0.000	0.000	1.0	0 0
19	1	0.000	0.000	0.000	1.0	0 0
20	1	0.000	0.000	0.000	1.0	0 0
21	1	0.950	0.000	0.450	1.0	138 0 Barley
22	0	0.540	0.390	0.330	1.0	0 0 Durum Wheat
23	0	0.850	0.700	0.420	1.0	119 0 Spring Wheat
24	0	0.650	0.440	0.000	1.0	258342 0 Winter Wheat
25	1	0.840	0.620	0.740	1.0	0 0 Other Small Grains
26	0	0.440	0.440	0.000	1.0	619346 0 Wm. Wht. Soyb. Dbl. Crop
27	1	0.680	0.000	0.450	1.0	286 0 Rye
28	1	0.630	0.350	0.540	1.0	398 0 Oats
29	1	0.440	0.000	0.290	1.0	53 0 Millet
30	1	0.520	0.640	0.630	1.0	0 0 Speltz
31	1	0.820	1.000	0.000	1.0	0 0 Canola
32	1	0.500	0.600	1.000	1.0	0 0 Flaxseed
33	1	0.840	0.840	0.000	1.0	0 0 Safflower
34	1	0.000	0.690	0.300	1.0	0 0 Rape Seed
35	1	0.000	0.690	0.300	1.0	0 0 Mustard
36	1	1.000	0.650	0.690	1.0	30037 0 Alfalfa
37	1	0.650	0.950	0.550	1.0	0 0 Other Hays
38	1	0.000	0.690	0.300	1.0	0 0 Canelina
39	1	0.000	0.000	0.000	1.0	0 0
40	1	0.000	0.000	0.000	1.0	0 0
41	1	0.660	0.000	0.900	1.0	0 0 Sugarbeets
42	1	0.650	0.000	0.000	1.0	7682 0 Dry Beans
43	1	0.440	0.140	0.000	1.0	3550 0 Potatoes
44	1	0.000	0.690	0.300	1.0	4599 0 Other Crops
45	1	0.700	0.500	1.000	1.0	0 0 Sugarcane
46	1	1.000	0.800	0.400	1.0	0 0 Sweet Potatoes
47	1	1.000	0.400	0.400	1.0	44140 0 Misc. Vegt. & Fruits
48	1	1.000	0.750	0.750	1.0	0 0 Watermelon
49	1	1.000	0.400	0.400	1.0	0 0 Onions
50	1	0.000	0.690	0.300	1.0	0 0 Pickles
51	1	0.000	0.690	0.300	1.0	0 0 Chick Peas
52	1	0.000	0.870	0.630	1.0	0 0 Lentils
53	1	0.330	1.000	0.000	1.0	2700 0 Peas

'Other Crops' Mask



Further refinements to the 'Other Crops' Mask

- More logic problem
 - Mask out all winter wheat only classification
 - Mask out all NL
 - Applies to older ag training



Add 'Other Crops' as Training

- Sample proportionately from:
 - The refined 'other crops' data layer
 - Available FSA data
 - Non-ag NLCD

2008 Illinois expected statewide proportions:

3.5% winter wheat

56.5% other crops

40% NLCD non-ag

Sample all of the early season FSA data

104,000 pixels of winter wheat

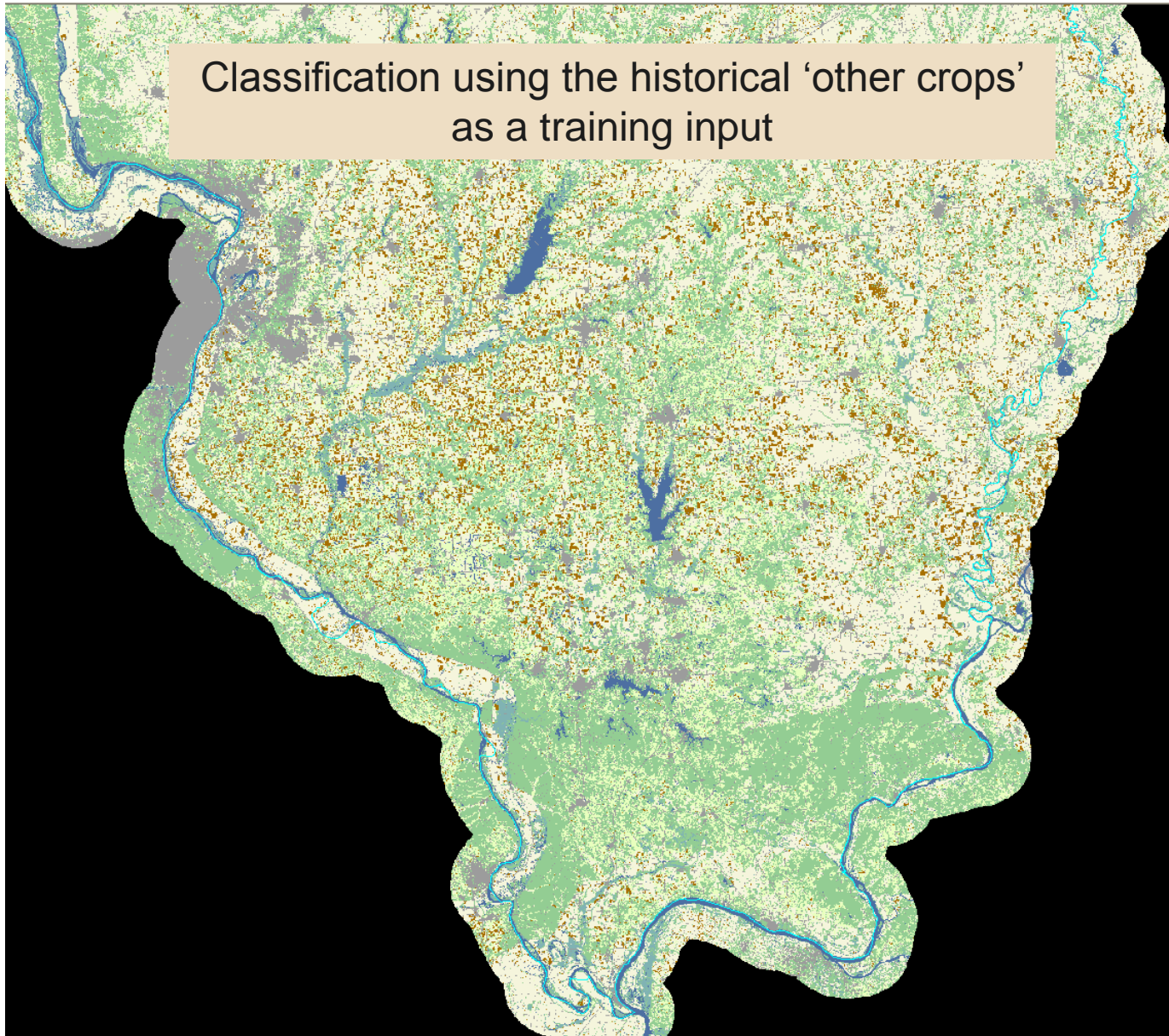
Sample the corresponding proportion of the 'other crops' mask

1,670,000 pixels of other crops

Sample the corresponding NLCD non-ag

1,180,000 pixels of NLCD non-ag

Resulting Classification



Results: Improved Acreage Estimation

- Compared to the official NASS 2008 Illinois harvested winter wheat estimate:
 - The initial classification using normal methodology over classified by **127,000 acres (+ 10%)**
 - Using the historical 'other crops' technique under classified by **10,000 acres (- 1%)**
- Acreage NOT just about counting pixels, regression based estimator

Regression-based Acreage Estimator

- June Survey summaries
- Area Sampling Frame
- CDLs

SAS/IML Workshop - SegMrg_Zone_Segs_Class (ActionMenuScatterPlot_5)

```

/*
 Import the NBSTAB.lst files across districts using
 Import_NBS-TAB.sas

*/
/*- TO DO

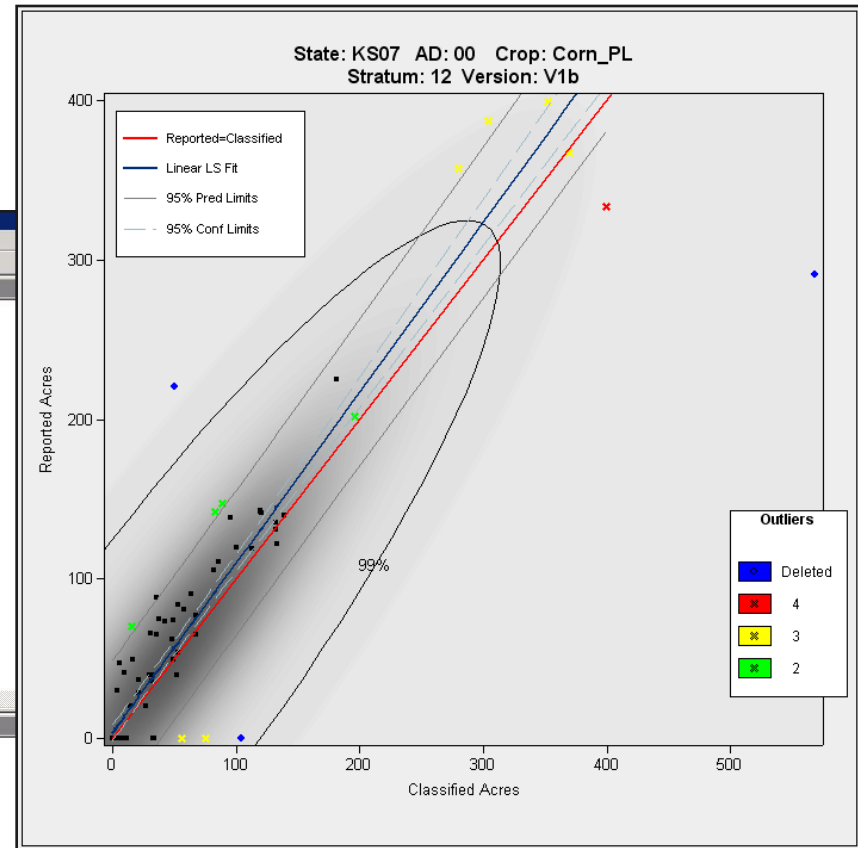
How to set State, Year, LibDir? : IML input statement
Add columns to DoDialogGetListItems (Strata) of seg. counts, ...?
Regression of multiple strata does not work
Brush scatterplot by % good ground truth
Save SegDropAccum list of dropped segment to a file
Print state, year, district, strata, cover to log/output
*/

Year = '06';
State = 'IA';
    
```

output

Source	DF	Sum of Squares	Mean Square	F Value
Model	1	4991716	4991716	2785.56
Error	373	668415	1791.99648	<.0001
Corrected Total	374	5660131		

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t	95% Confidence Limits
Intercept	1	24.01235	5.16370	4.65	<.0001	13.85874 34.16595
Pixels	1	0.68913	0.01306	52.78	<.0001	0.66346 0.71481



116	IA	06	01	Soybeans	13
445	IA	06	01	Soybeans	13
101	IA	06	01	Soybeans	13
181	IA	06	01	Soybeans	13
287	IA	06	01	Soybeans	13
117	IA	06	01	Soybeans	13
70	IA	06	01	Soybeans	13

Improvements / Limitations

- Better understanding of crop rotation patterns
 - Claire Boryan, 9:15am Thursday, TS34 Session
- Limitations
 - Requires reliable historical data
 - Some knowledge of expected output
- Future testing:
 - Iterative classification approach for states with no historical data

