

Feasibility of spatial resolution and herbaceous category improvements to the Cropland Data Layer

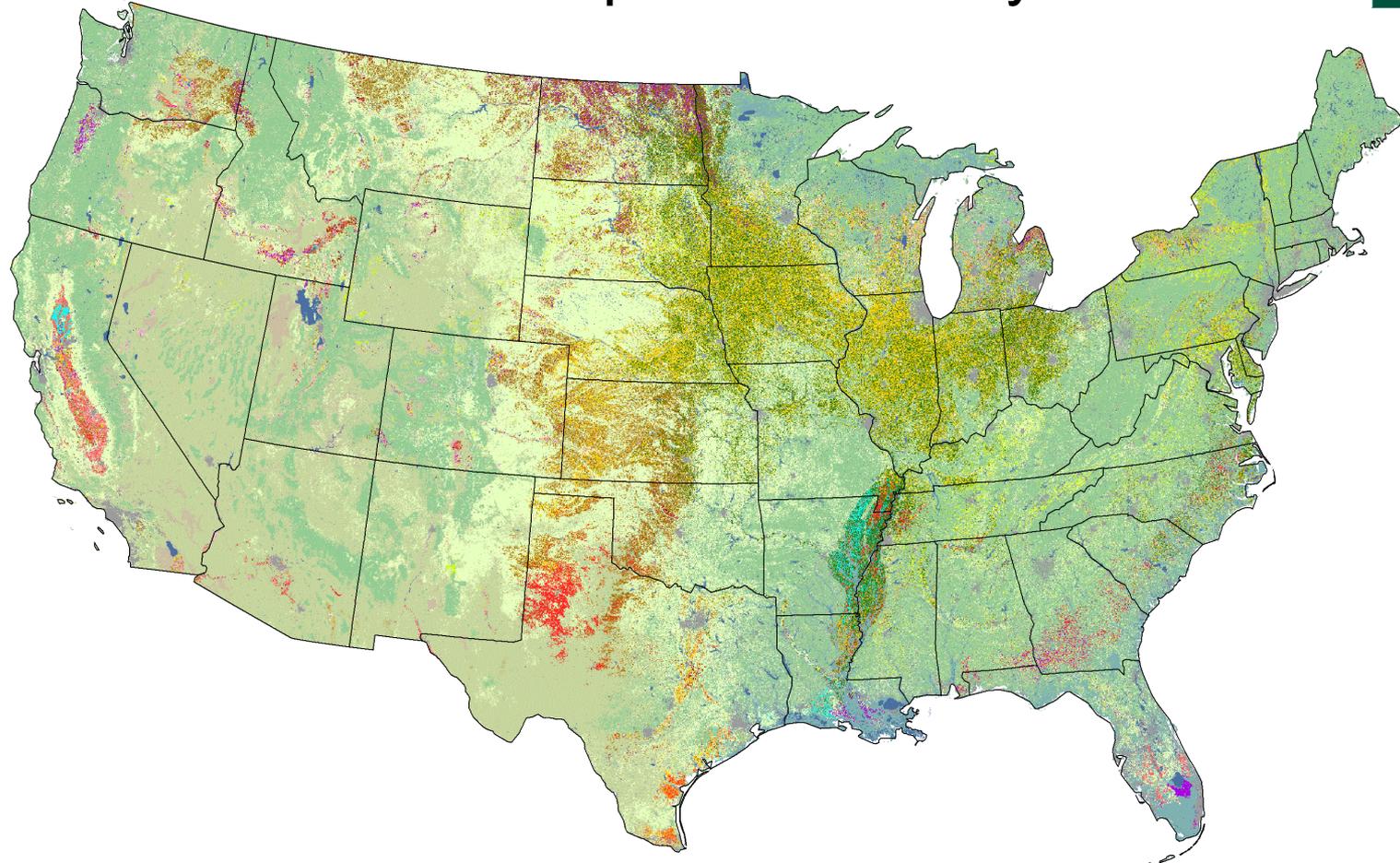


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National Agricultural Statistics Service
United States Department of Agriculture

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ASPRS Annual Conference
Milwaukee, Wisconsin

2010 Cropland Data Layers



Major Land Cover Categories

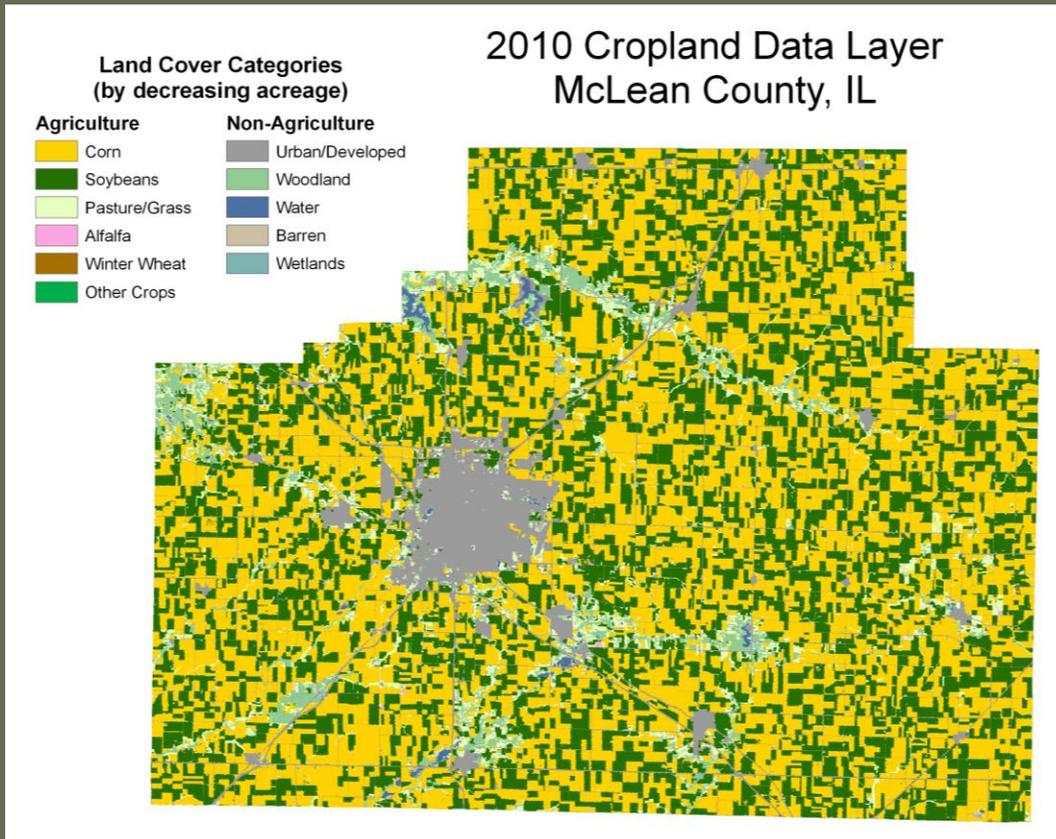
Agriculture

- Pasture/Grass
- Corn
- Soybeans
- All Wheat
- Other Hay
- Fallow/Idle Cropland
- Alfalfa
- Cotton
- Other Crops
- Vegetables/Fruits/Nuts

Non-Agriculture

- Sorghum
- Other Small Grains
- Rice
- Woodland
- Shrubland
- Urban/Developed
- Wetlands
- Water
- Barren
- Perennial Ice/Snow

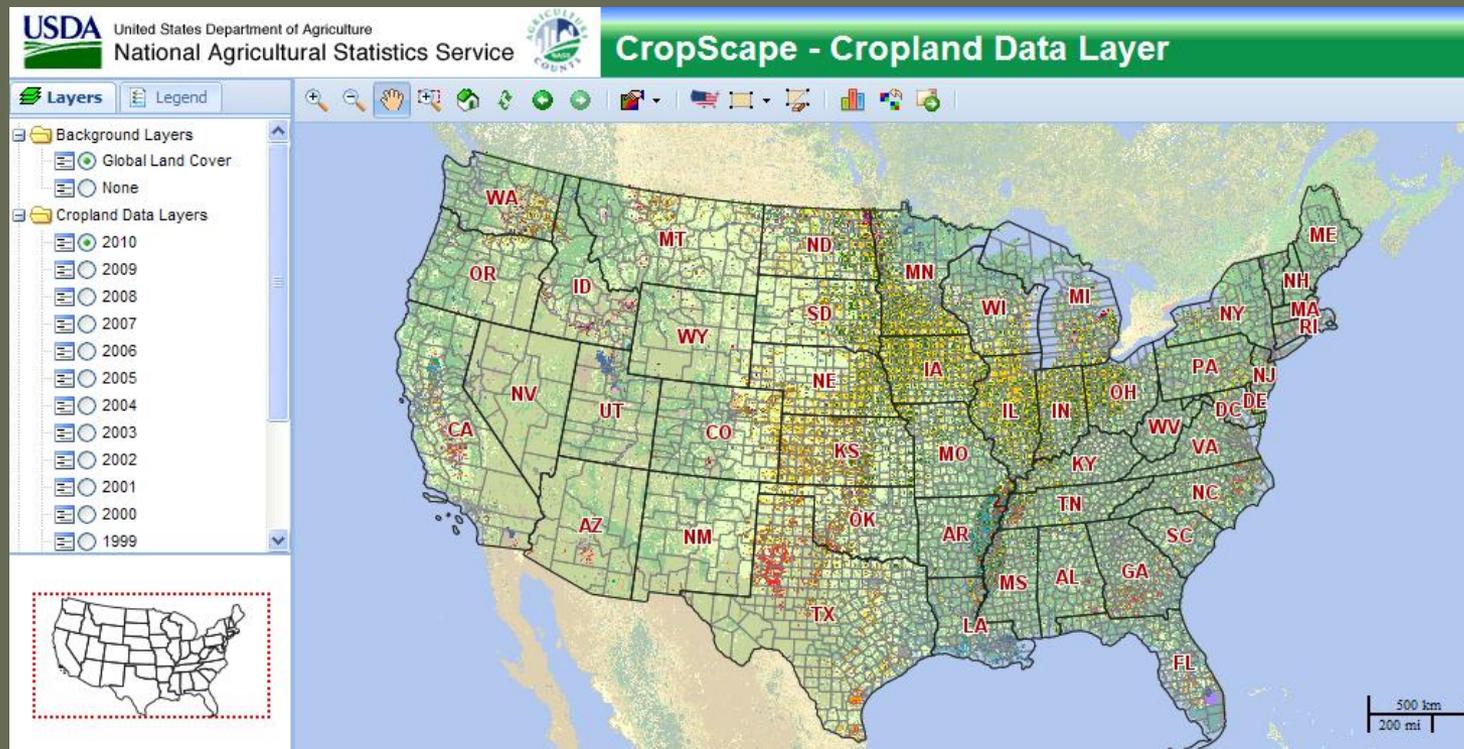
CDL generalities



- Annual land cover classification targeted to identifying *circa* summer cultivated crops
- Encompasses (since 2009) all of conterminous USA
- 56m or 30m resolution
 - Depending on year
- Derived primarily from
 - Landsat-5 TM
 - Resourcesat-1 AWiFS
- Built with a supervised classification tree methodology
 - Implemented with See 5.0 via ERDAS Imagine
- Utilizes ground/training data from USDA Farm Service Agency and ancillary data from National Land Cover Database
- Highly robust for dominant crop types
 - corn, soybeans, wheat, rice, cotton, etc.
- Used internally by NASS to estimate state and county-level acreage

CDL access

- Traditionally through DVD, FTP, or the USDA Geospatial Data Gateway
- Now easiest is the “CropScape” portal
 - nassgeodata.gmu.edu/CropScape
 - or just Google “CropScape”

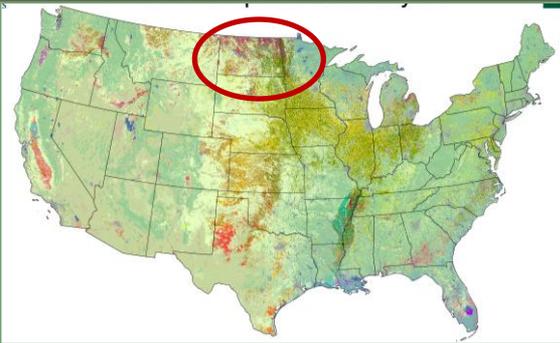


Two of the bigger user questions about CDL

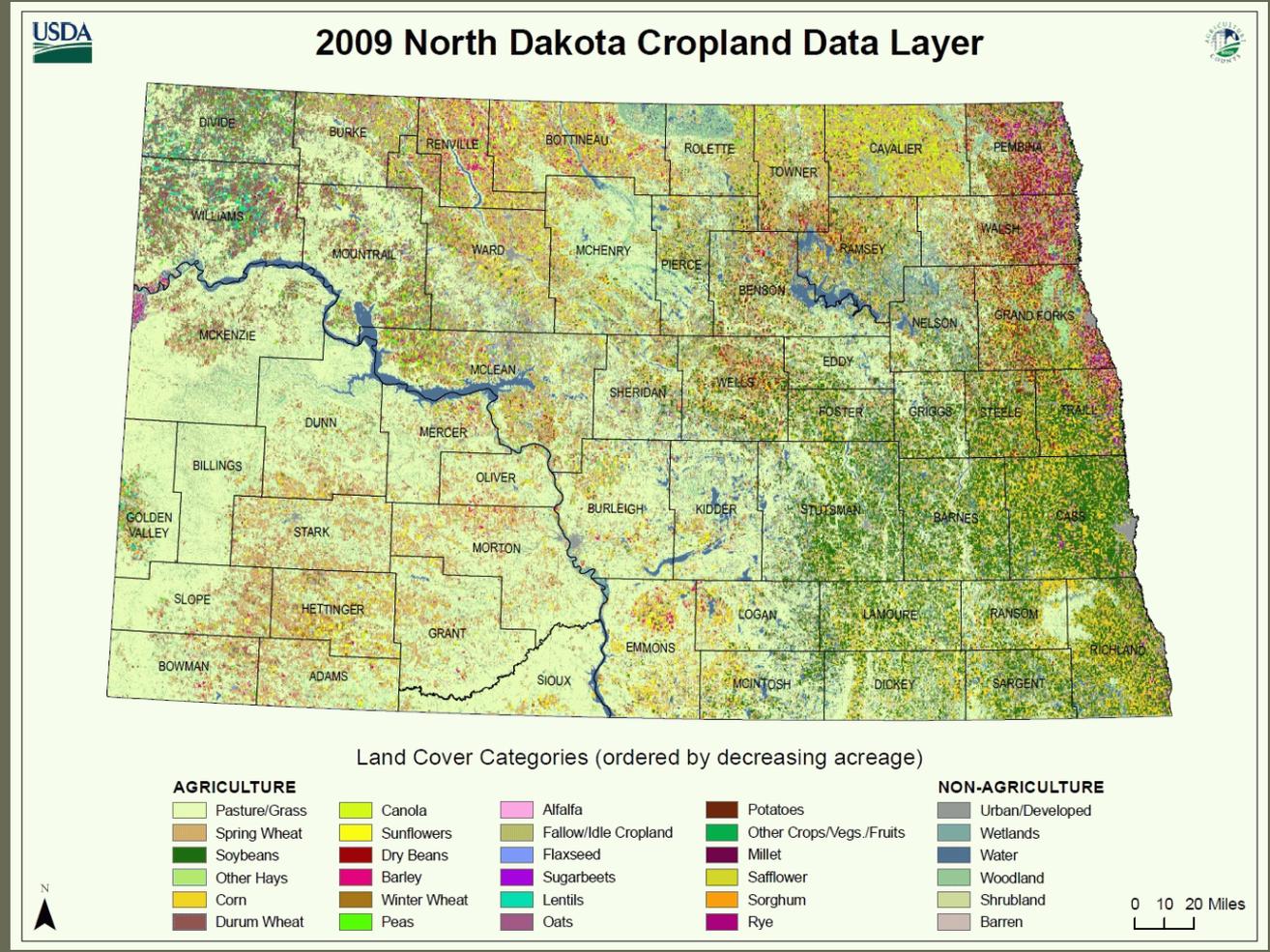
- Can you improve the spatial resolution?
 - 56m is too coarse
 - 56m is not “standard”
- Can you better define and accurately map herbaceous categories?
 - Pasture, hay, grasslands, Cropland Reserve Program (CRP), native grasses, rangeland, etc...



North Dakota as a study area

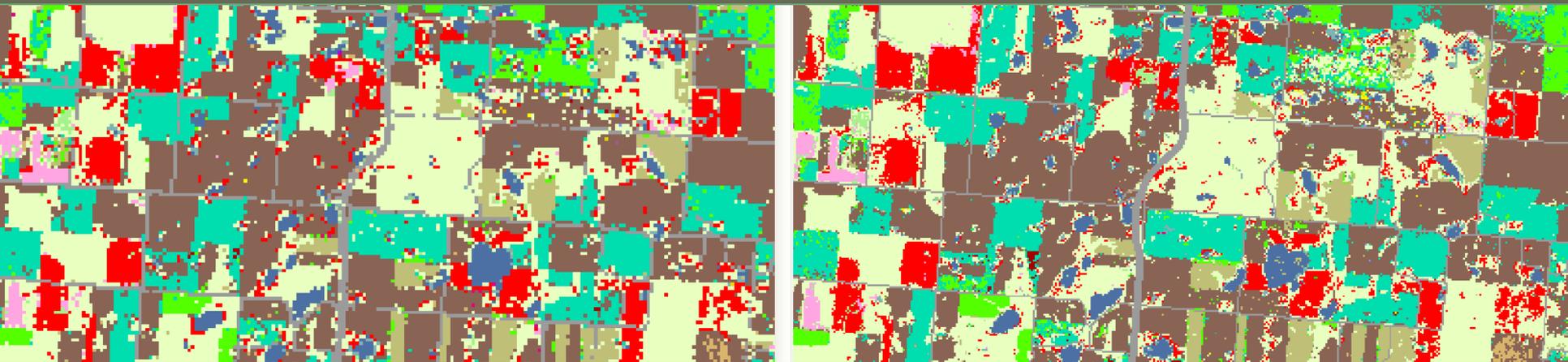


- ND is nice to analyze because
 - Large diversity of major commodity crops
 - Large diversity of grassland usages



Question #1: Finer spatial resolution?

- All CDLs, to date, are either 30m or 56m resolution
 - Based on the primary data source
 - If Landsat TM, or ETM, then 30m
 - If Resourcesat AWiFS then 56m
 - Earlier CDLs (early 2000s) were 30m
 - More recent CDLs (late 2000s) were 56m



56m

NW North Dakota

30m

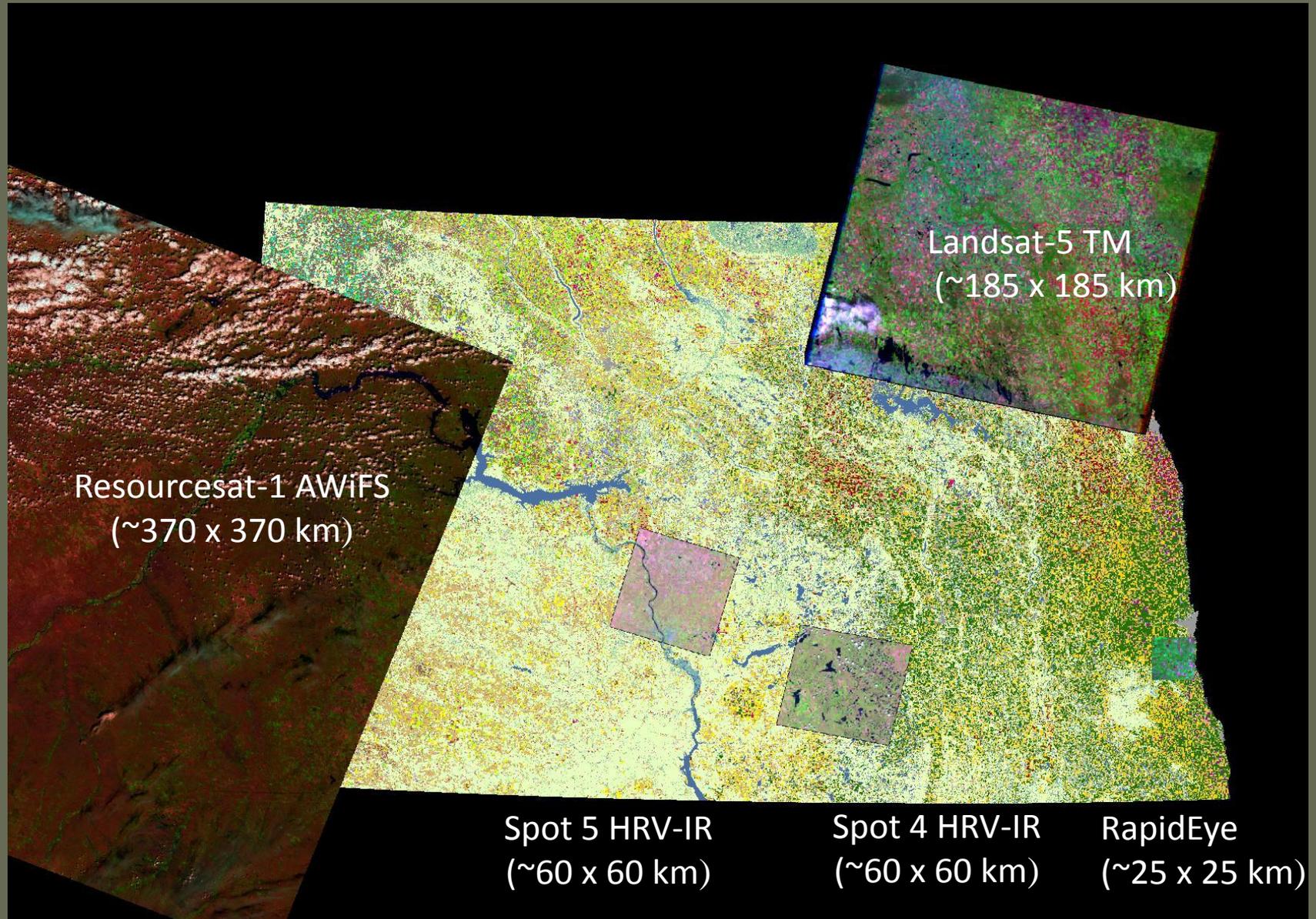
- **2010 originally planned and processed at 56m but ultimately reprocessed and released at 30m!**
- Accuracy (pixel level) of cropped areas: 56m = 78.1%, 30m = 80.5%
- In terms of NASS derived area estimates 56m v. 30m perform about the same

Finer than 30m resolution?

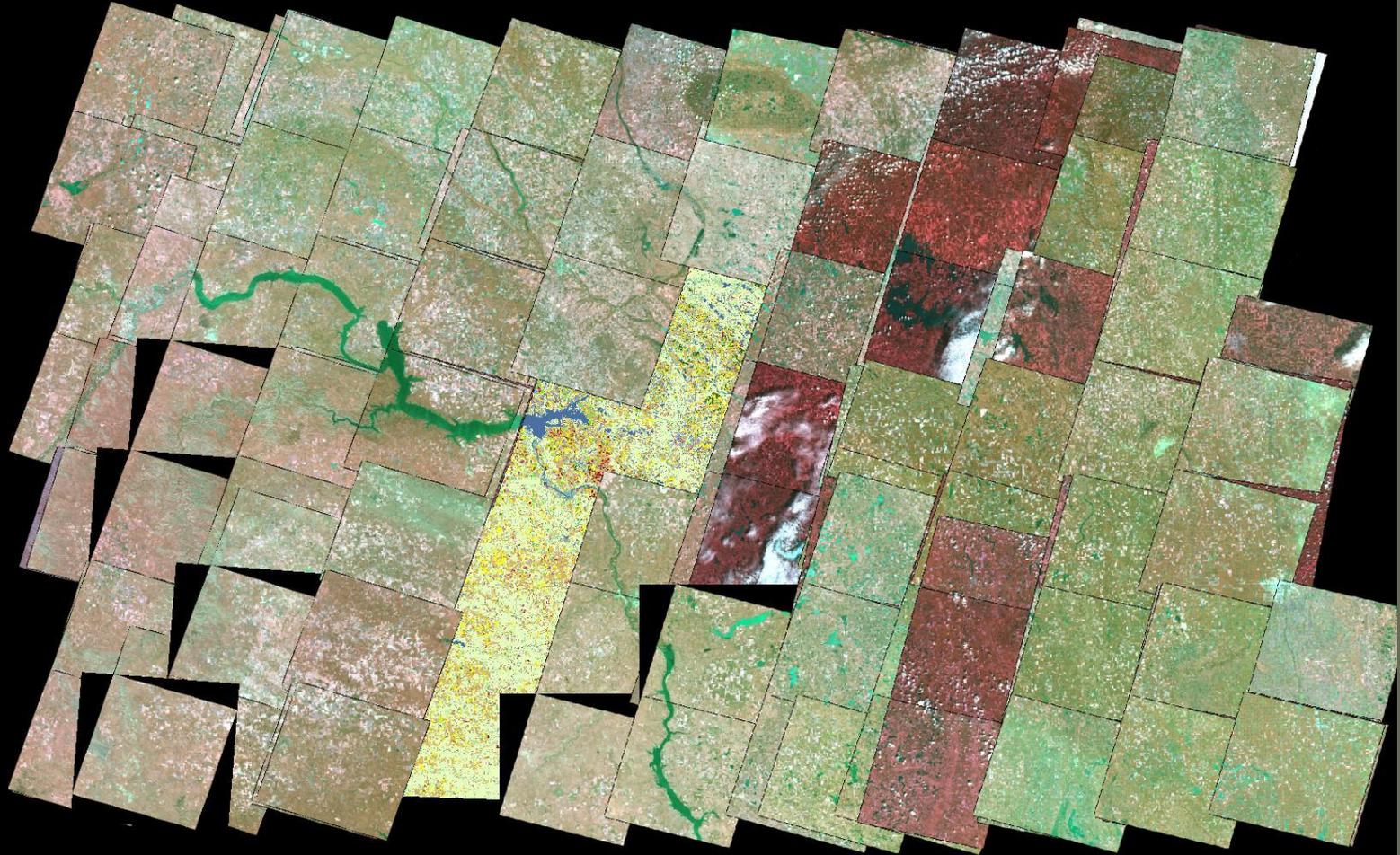
- What about 20m, or 10m, or 5m resolution?
 - Number of sensors currently producing finer resolution data with multispectral capability
 - SPOT, LISS-III, DMCii, DEIMOS, RapidEye etc...
- For 2010 large US Federal data buy of SPOT imagery
 - Targeted over growing areas but covering most of US.
 - Freely distributable to Federal agencies via USGS EarthExplorer
 - Imagery not ortho-rectified but reasonably well geo-registered
- So SPOT best candidate for higher resolution land cover mapping...



Areal comparison



SPOT 4 North Dakota 2010 summer collects



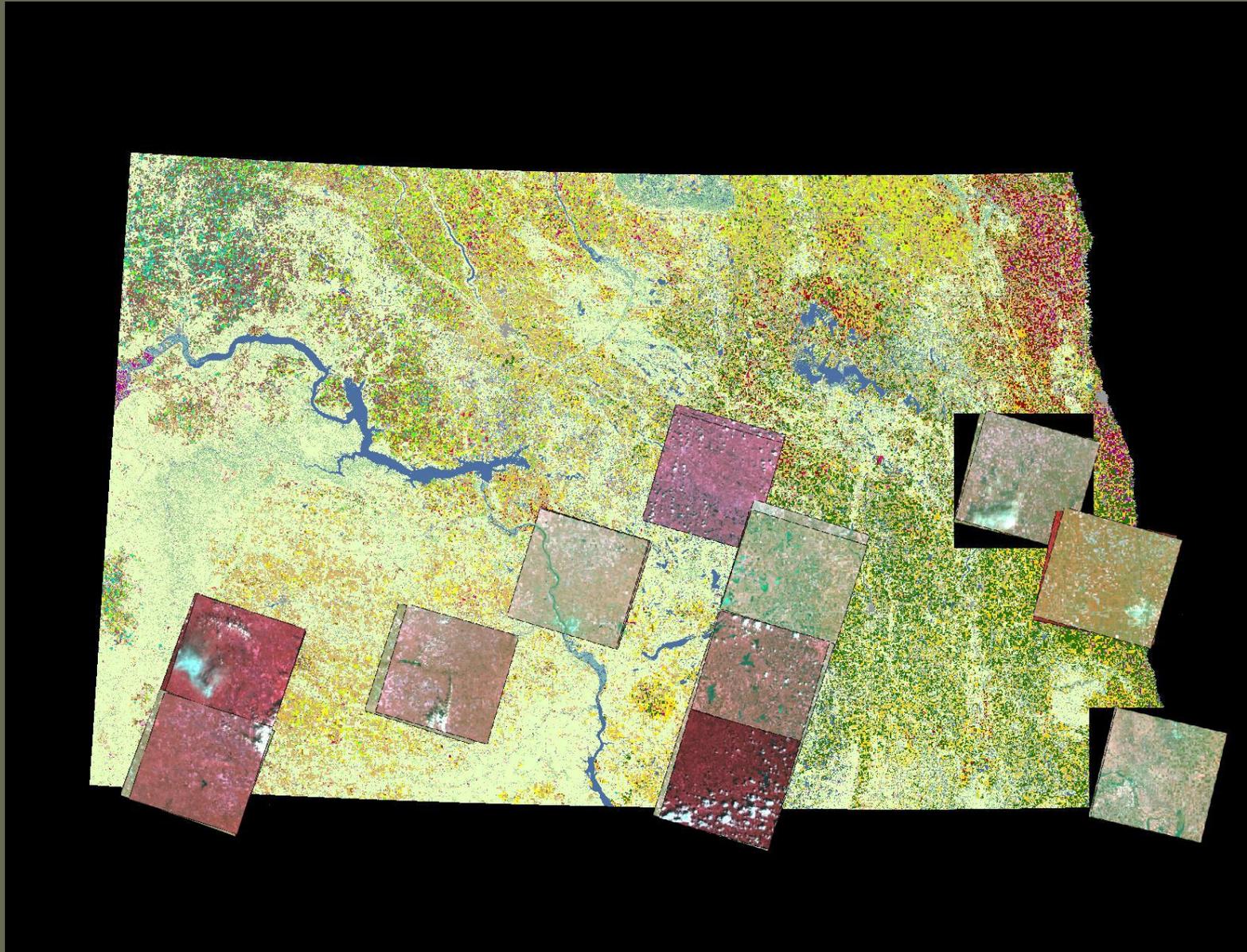
149 scenes (20m resolution)

SPOT 5 North Dakota 2010 summer collects

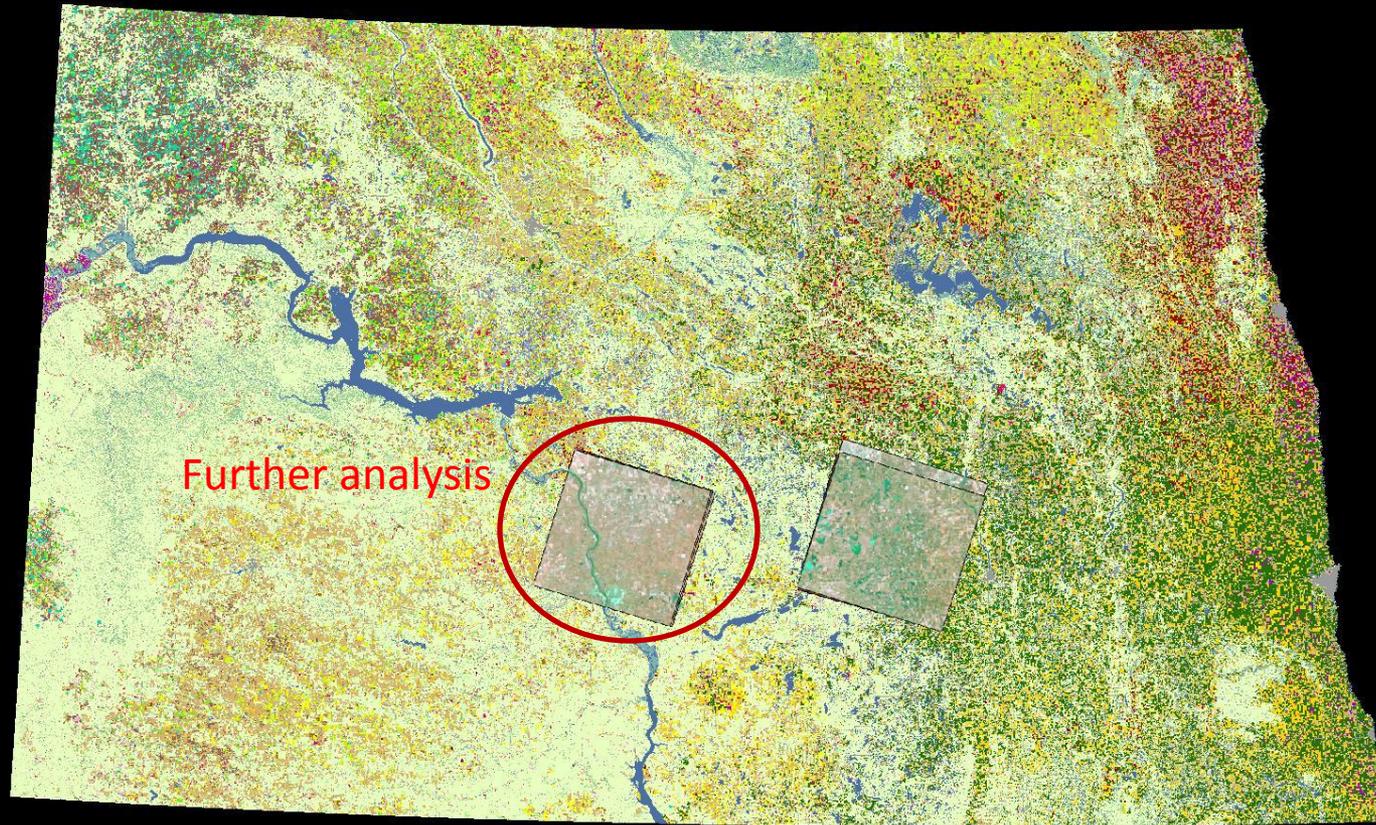
52 scenes (10m resolution)



Areas with at least two SPOT 5 scenes



Areas with at least three SPOT 5 scenes



Visual comparison (“false natural color”)

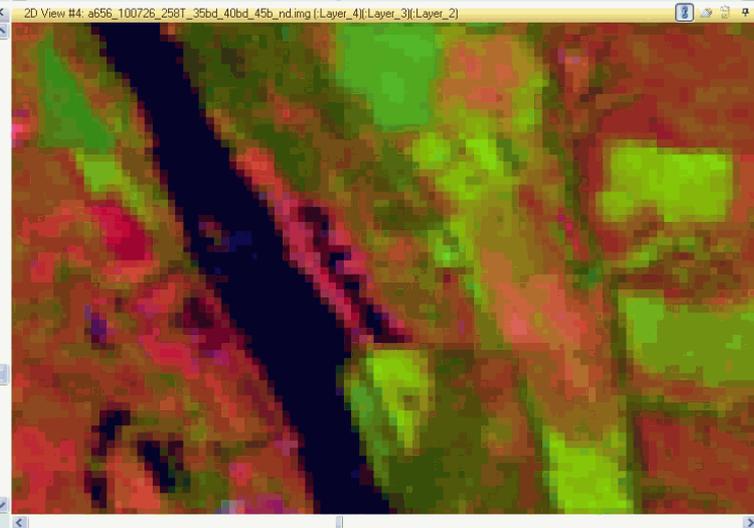
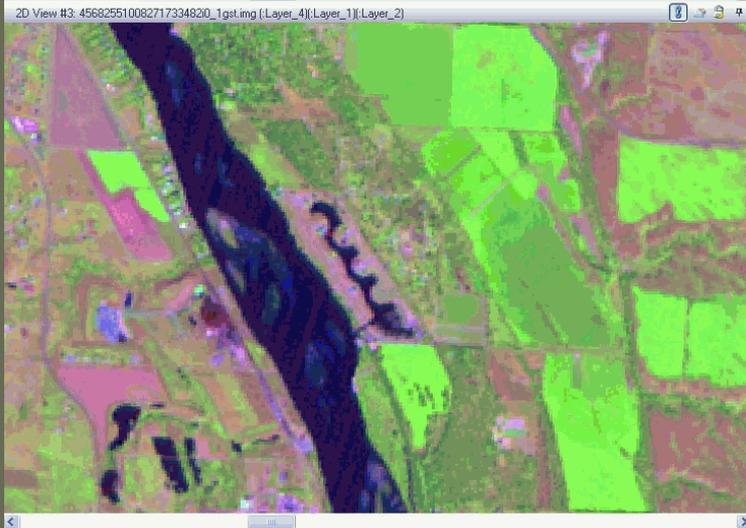
SPOT 5

Landsat TM

July 18



Aug. 27



July 26

SPOT 4

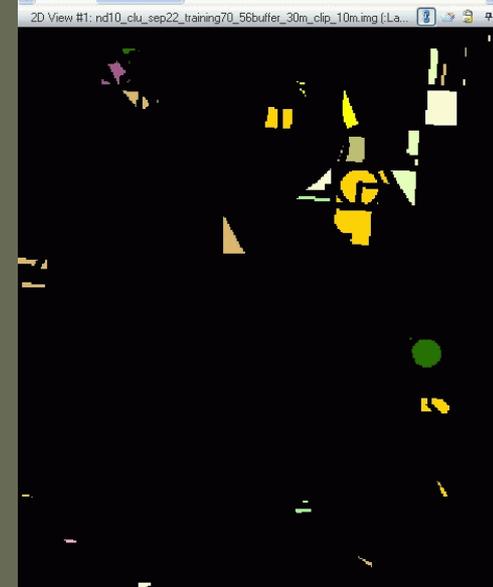
Resourcesat-1 AWiFS

Notes about ground data

- Agricultural categories
 - Use Farm Service Agency farmer reported “578” program crop tied to Common Land Unit (CLU) polygon data
 - Early in the season this information is thin
- Non-agricultural categories
 - Draw samples from the NLCD to act as proxy ground truth
- Ultimately draw hundreds of thousands of sample from both across a state and use in supervised decision tree type classification
 - Perhaps 1 – 10 % agricultural ground truth coverage early in the season
 - Grows to 20, 30, 40%, or more, as season evolves
- Made even more robust with knowledge that classifier is tolerant of outliers/errors



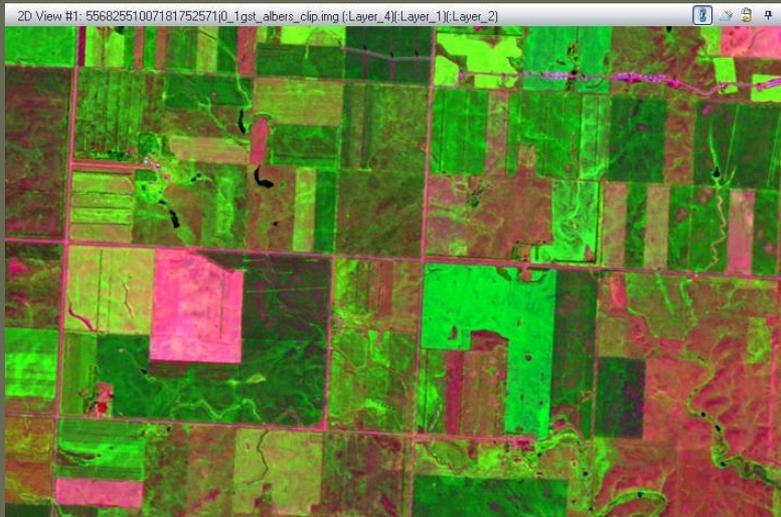
NLCD



FSA

Three SPOT scenes and output classification

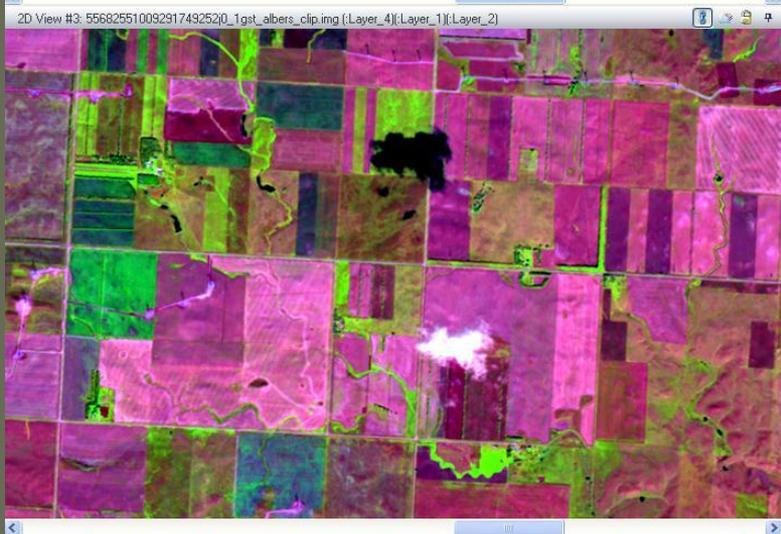
July 18



Aug 17



Sep 29



Pasture/Grass	Canola	Alfalfa
Spring Wheat	Sunflowers	Fallow/Idle Cropland
Soybeans	Dry Beans	Flaxseed
Other Hays	Barley	Sugarbeets
Corn	Winter Wheat	Lentils
Durum Wheat	Peas	Oats

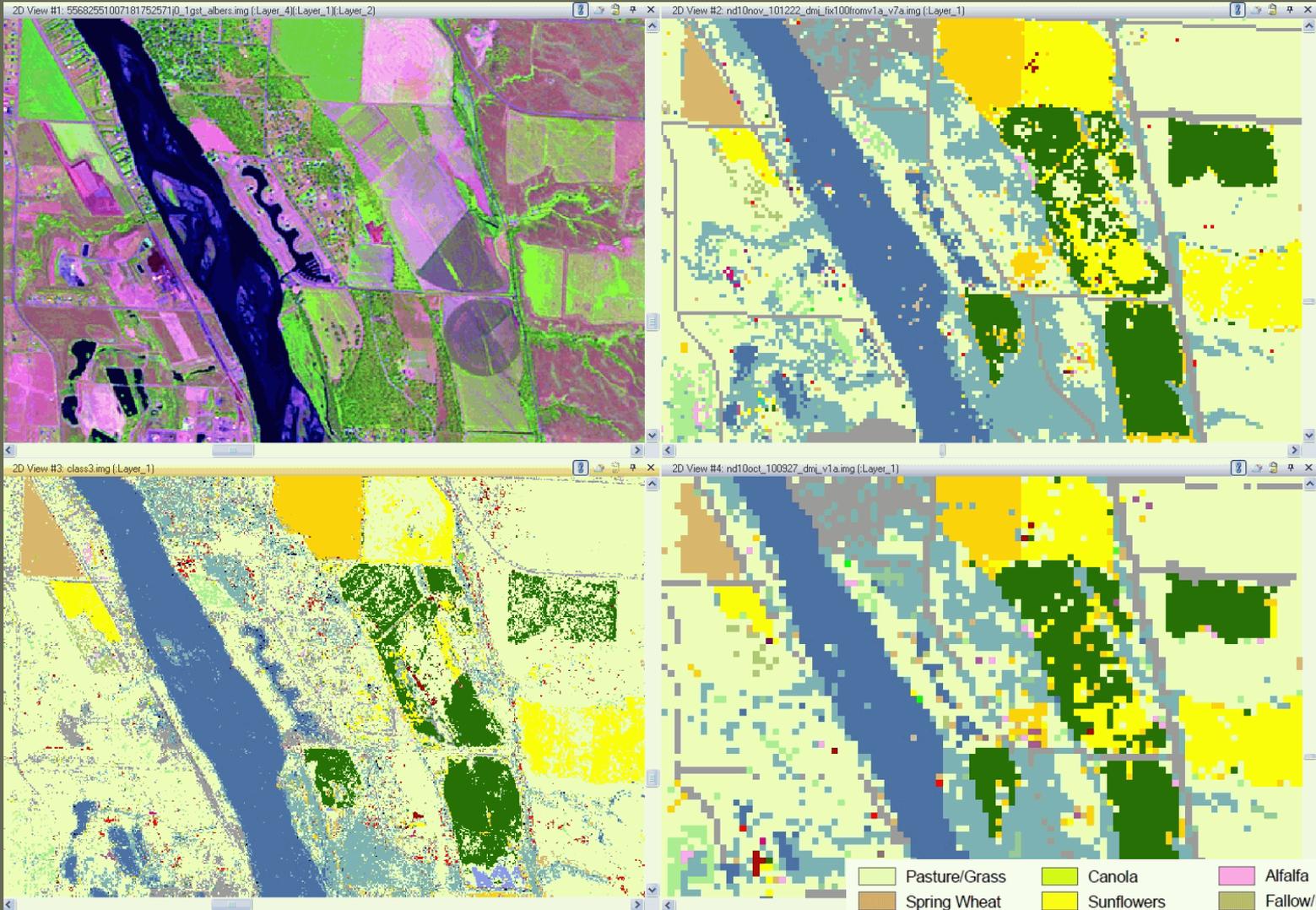
Classifications compared

Raw
10m

30m

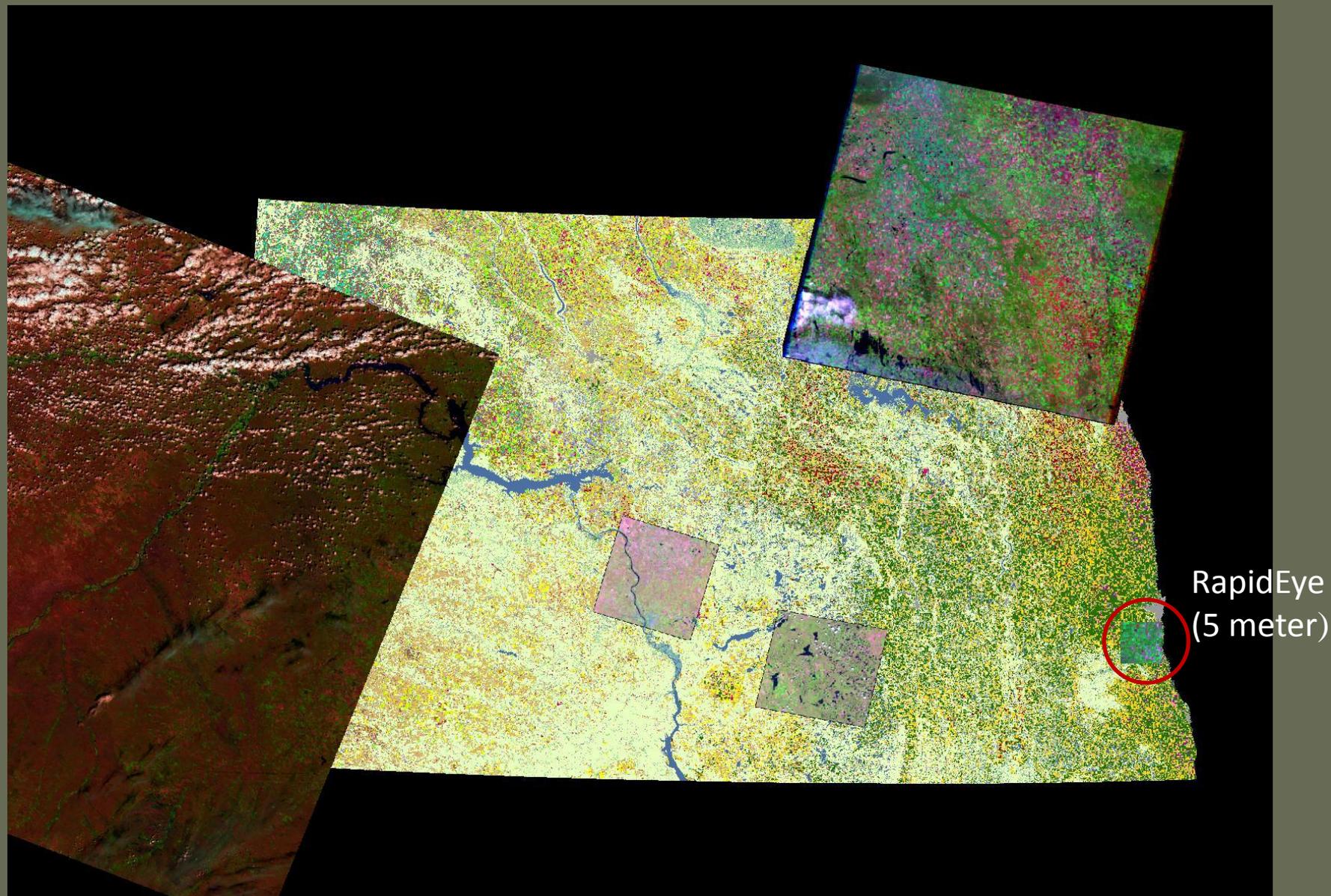
10m

56m



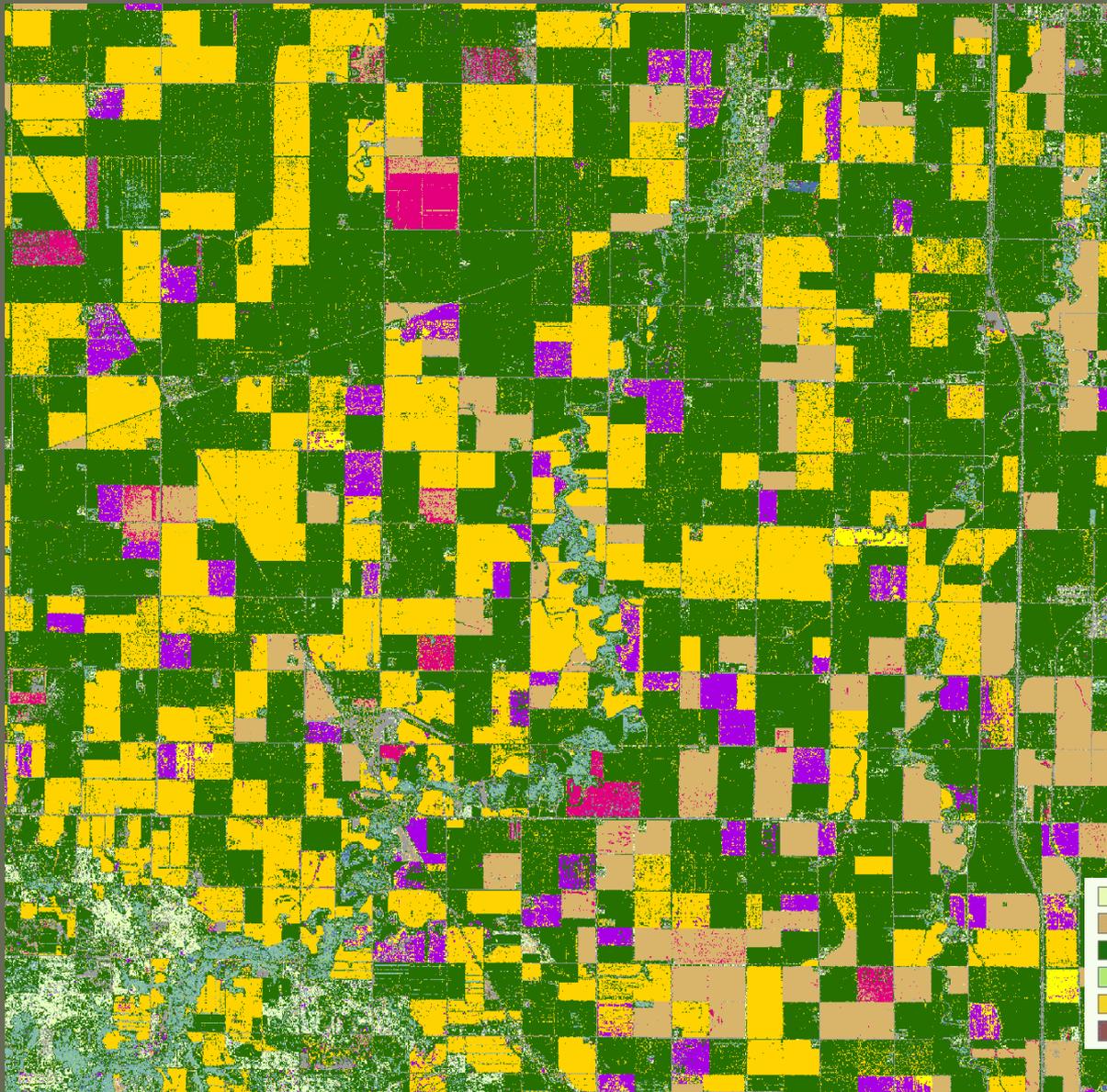
Pasture/Grass	Canola	Alfalfa
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Second area - RapidEye analysis



RapidEye
(5 meter)

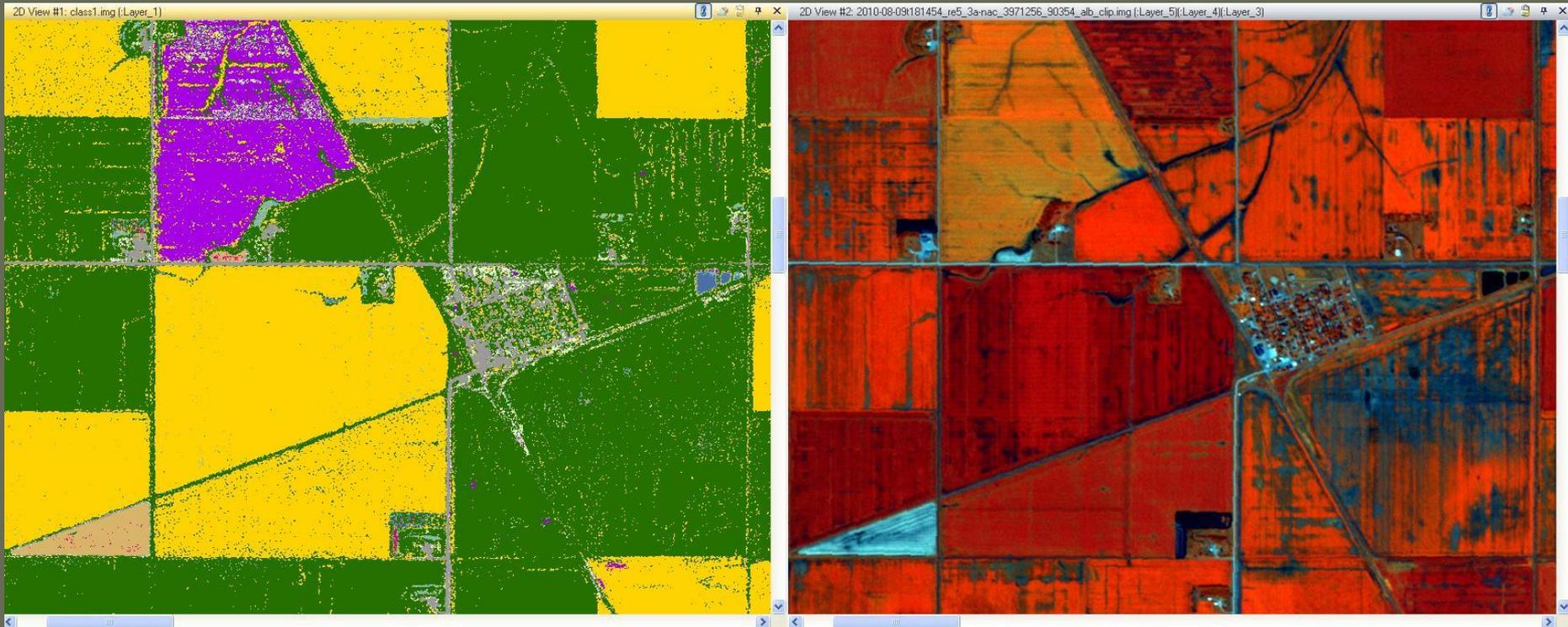
RapidEye classification



- Single scene
 - August 9th
 - not “multi-temporal”
 - Reasonable nonetheless

Pasture/Grass	Canola	Alfalfa
Spring Wheat	Sunflowers	Fallow/Idle Cropland
Soybeans	Dry Beans	Flaxseed
Other Hays	Barley	Sugarbeets
Corn	Winter Wheat	Lentils
Durum Wheat	Peas	Oats

RapidEye 5m classification versus raw



Pasture/Grass	Canola	Alfalfa
Spring Wheat	Sunflowers	Fallow/Idle Cropland
Soybeans	Dry Beans	Flaxseed
Other Hays	Barley	Sugarbeets
Corn	Winter Wheat	Lentils
Durum Wheat	Peas	Oats

R = NIR band
 G= "red edge" band
 B= red band

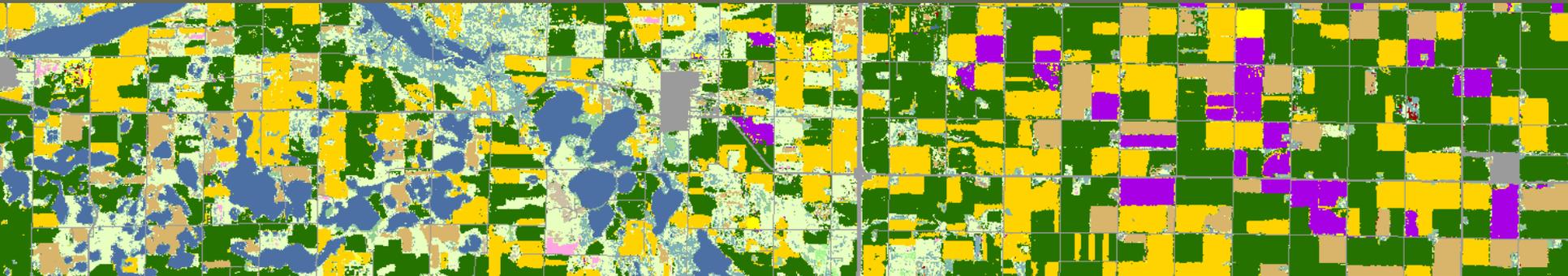
RapidEye classification versus 30m CDL

- Single date of 5m data seems to perform well
- Obvious improvements with detail
- “Red-edge” band may indeed be yielding additional information



Spatial resolution improvements conclusions

- National 30m, the new NASS standard
- May be possible to go finer but unlikely in the near future
 - Incomplete multi-temporal coverage
 - Exponential data handling needs
 - downloading, storage, and processing
 - Little to gain in area statistics improvement
 - Lack of ortho-registration with US SPOT data buy
 - Albeit SPOT 5 is probably close enough, especially if used in conjunction with coarser (e.g. Landsat) data.
 - Hindrance with no “bulk download” capability at USGS like for Landsat data



Question 2: Herbaceous classification

- NASS CDL nomenclature would generally call these
 1. Hay (excluding alfalfa)
 2. Pasture
 3. Non-agriculture, grassland, waste, idle, ...
 - These have been poorly defined and/or inconsistent through the years
- FSA provides information about 5 grass usage types
 1. “Forage”
 2. “Grazing”
 3. “Left Standing”
 4. “Seed”
 5. “Sod”
- Trying to force into cover type versus usage one could say
 1. Cut grass
 2. Chewed grass
 3. Undisturbed grass
 4. Seed grass
 5. Sod grass
- Also there is FSA information about CRP and cover type/usage
 - Not all CRP is grassy!

Hay/forage accuracies for all states 2010

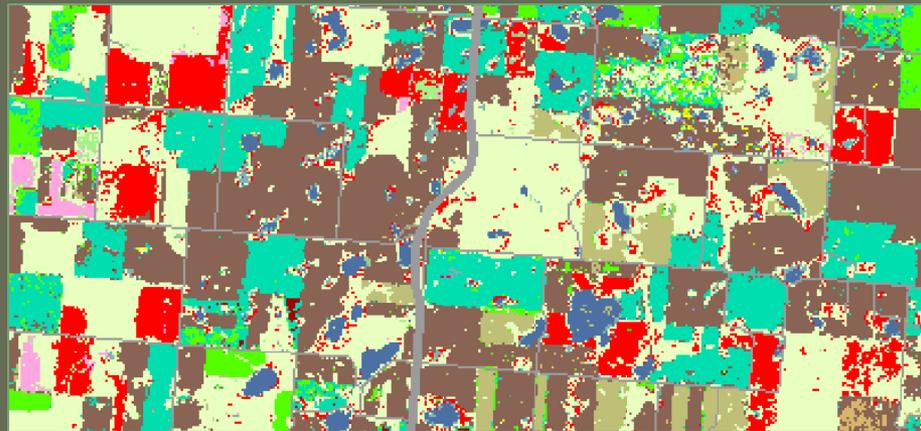
STATE	PRODUCER'S ACCURACY	USER'S ACCURACY
AL	43.0%	29.5%
AZ	47.0%	80.5%
CA	42.9%	57.8%
CO	39.9%	80.8%
FL	43.6%	42.7%
GA	33.7%	51.3%
IA	11.2%	42.9%
ID	38.3%	67.5%
IL	7.0%	43.9%
IN	10.4%	43.7%
KY	43.2%	51.5%
MD,DE,NJ	66.1%	60.6%
ME,MA,CT,RI,VT,NH	87.6%	80.1%
MI	59.7%	69.8%
MN	7.8%	47.7%
MS	60.0%	20.5%
MT	17.7%	37.6%
NC	39.0%	50.5%
ND	41.3%	71.6%
NM	23.7%	88.7%
NV	83.3%	90.7%
NY	75.5%	65.8%
OH	14.7%	55.2%
OR	47.0%	59.8%
PA	71.6%	67.3%
SC	36.8%	55.7%
SD	56.1%	46.9%
TN	56.7%	41.1%
UT	94.4%	97.4%
VA,WV	48.5%	58.7%
WA	47.5%	85.6%
WI	31.2%	54.7%
WY	88.5%	95.4%
unweighted average	45.9%	60.4%

Pasture/Grazing accuracies all states 2010

STATE	PRODUCER'S ACCURACY	USER'S ACCURACY
AL	46.0%	80.5%
CA	54.6%	92.2%
FL	45.9%	77.6%
GA	71.8%	70.9%
IA	42.8%	78.3%
ID	62.4%	93.8%
IL	39.1%	85.2%
IN	23.0%	72.5%
KY	46.3%	73.7%
MD,DE,NJ	60.7%	61.8%
ME,MA,CT,RI,VT,NH	42.9%	64.6%
MN	65.3%	86.2%
NC	63.0%	65.9%
NY	29.7%	50.3%
OH	31.8%	76.4%
OR	30.2%	95.2%
PA	60.8%	62.9%
SC	62.5%	73.6%
TN	59.9%	77.7%
VA,WV	76.1%	75.8%
WA	53.0%	94.7%
WI	60.8%	77.1%
unweighted average	51.3%	76.7%

Cropland Reserve Program accuracies

- Experimented adding CRP category for within season CDL products (56m, overall crop accuracy = 78.1%)
 - only used when know to be a grassland type cover
 - CRP results
 - 61.08% producer's accuracy
 - 74.37% user's accuracy
 - Not horrible

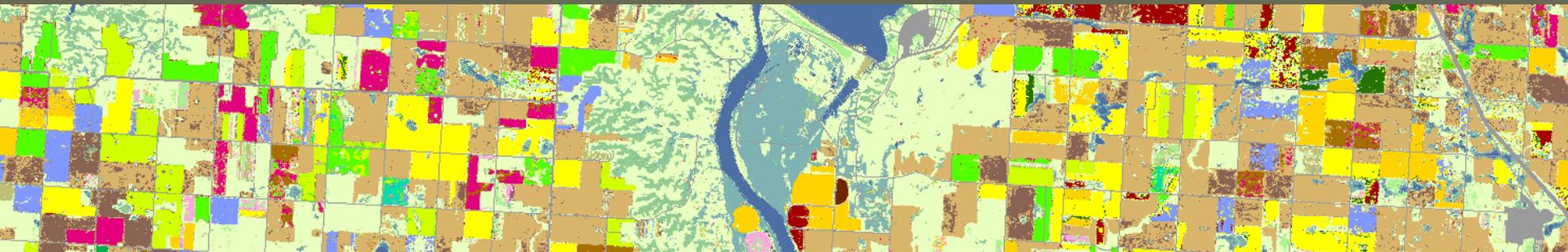


Red = CRP

CLASS	Correct	Producer	User	Bias
Corn	1 141131	90.98%	94.43%	-3.7%
Soybeans	5 314465	95.33%	95.38%	-0.1%
Sunflowers	6 63206	87.43%	89.18%	-2.0%
Barley	21 15370	37.01%	73.94%	-49.9%
Durum wheat	22 147770	68.88%	75.14%	-8.3%
Spring wheat	23 571979	89.59%	84.78%	5.7%
Winter wheat	24 25832	72.86%	87.25%	-16.5%
Canola	31 96998	94.26%	96.57%	-2.4%
Flaxseed	32 13210	51.82%	81.49%	-36.4%
Mustard	35 1330	51.25%	86.76%	-40.9%
Alfalfa	36 21761	38.88%	62.68%	-38.0%
Other hays	37 44939	33.81%	57.88%	-41.6%
Beets	41 5358	89.61%	92.14%	-2.7%
Dry beans	42 29806	77.91%	84.18%	-7.4%
Lentils	52 27772	86.93%	88.03%	-1.2%
Peas	53 33376	80.34%	87.42%	-8.1%
Idle / Fallow	61 11739	38.79%	81.14%	-52.2%
CRP	102 183859	61.08%	74.37%	-17.9%

Grassland mapping thoughts and conclusions

- Herbaceous differentiation
 - Difficult because typically land use (versus cover) designations
 - Little spectral difference between grass types
 - The data from FSA is not usually statistically representative of what is on the ground
 - CRP may be reasonable but we are trying to move away from any land use type categories and only focus on land cover
 - Will continue to haunt us
 - If someone can figure it out they will be a hero
- Recommendation to CDL use is to
 - Treat any grassy cover type cautiously and
 - Lump into a general grassland cover type



2011 CDL campaign

- National cover once again at 30m
- Considering clumping together all grass usage categories into one
 - Avoids perception that we can actually separate them
- Release to public early 2012
- Landsat TM is the primary data source
 - God willing
- DEIMOS and UK2 will also likely be incorporated
 - Native 22m, 3 band
 - But would be resampled to 30m

North Dakota crop timing

