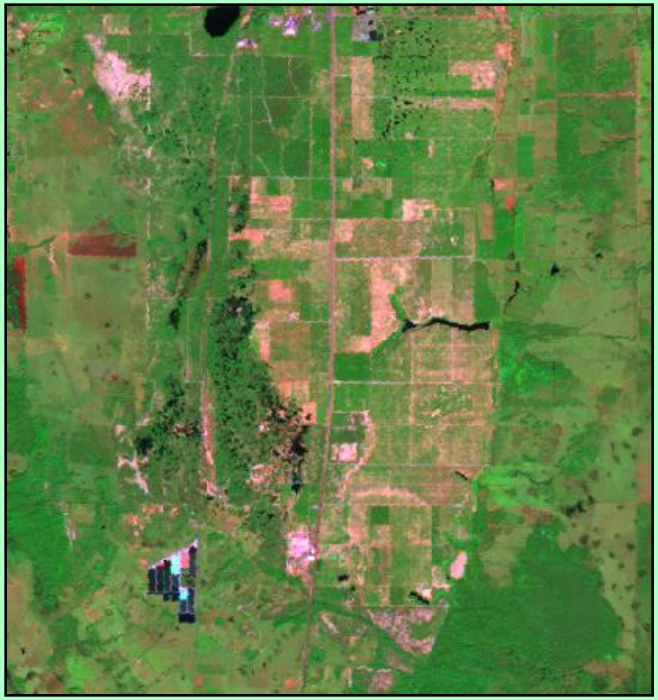
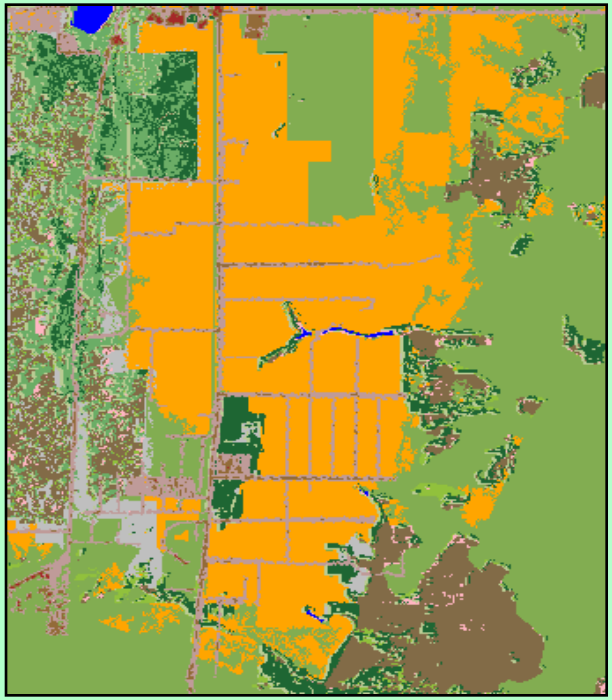
# A Florida 2004 Cropland Data Layer:
## A See5 Implementation

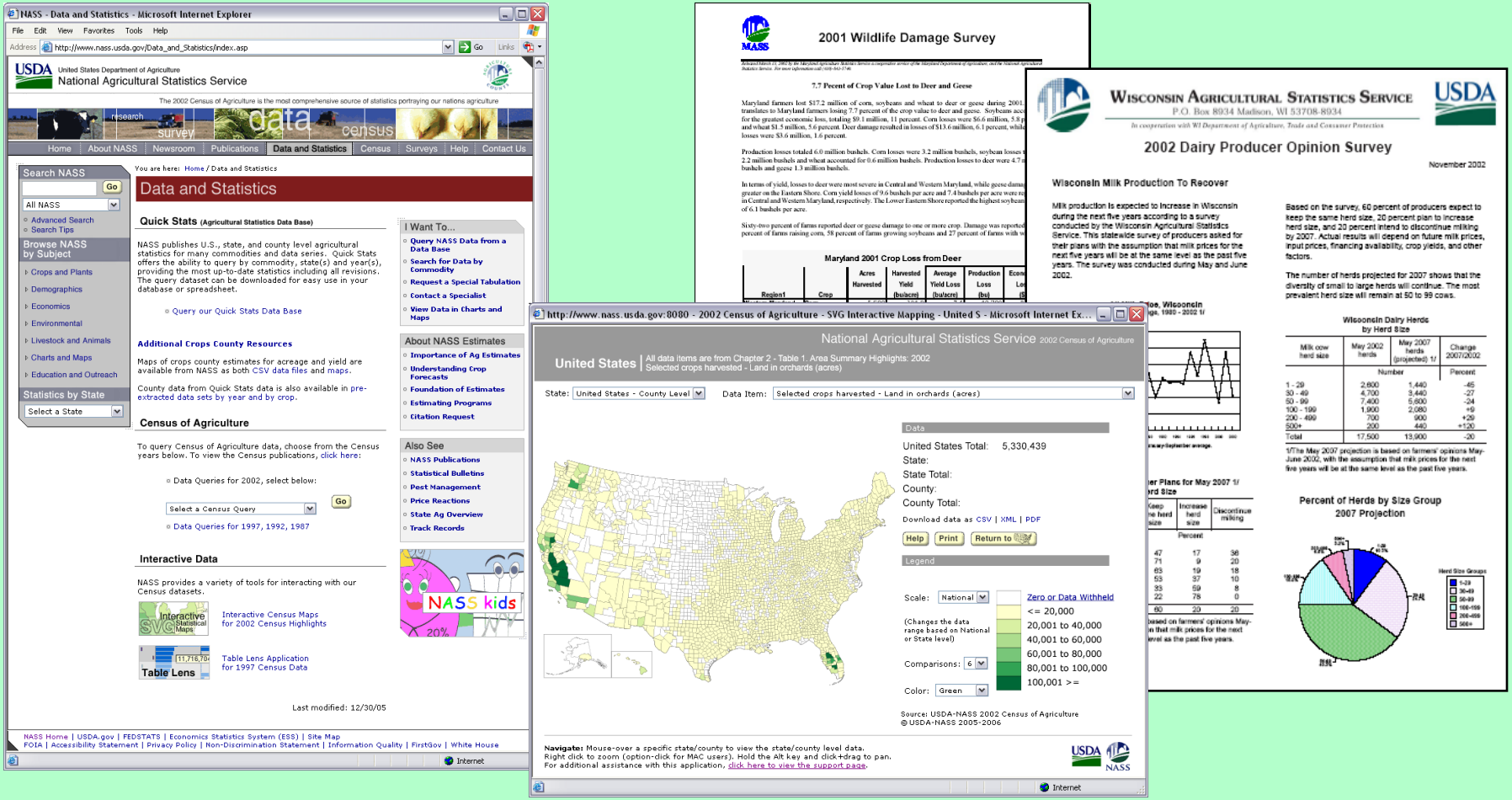




**Claire Boryan, Geographer**
United States Department of Agriculture
National Agricultural Statistics Service
Research and Development Division

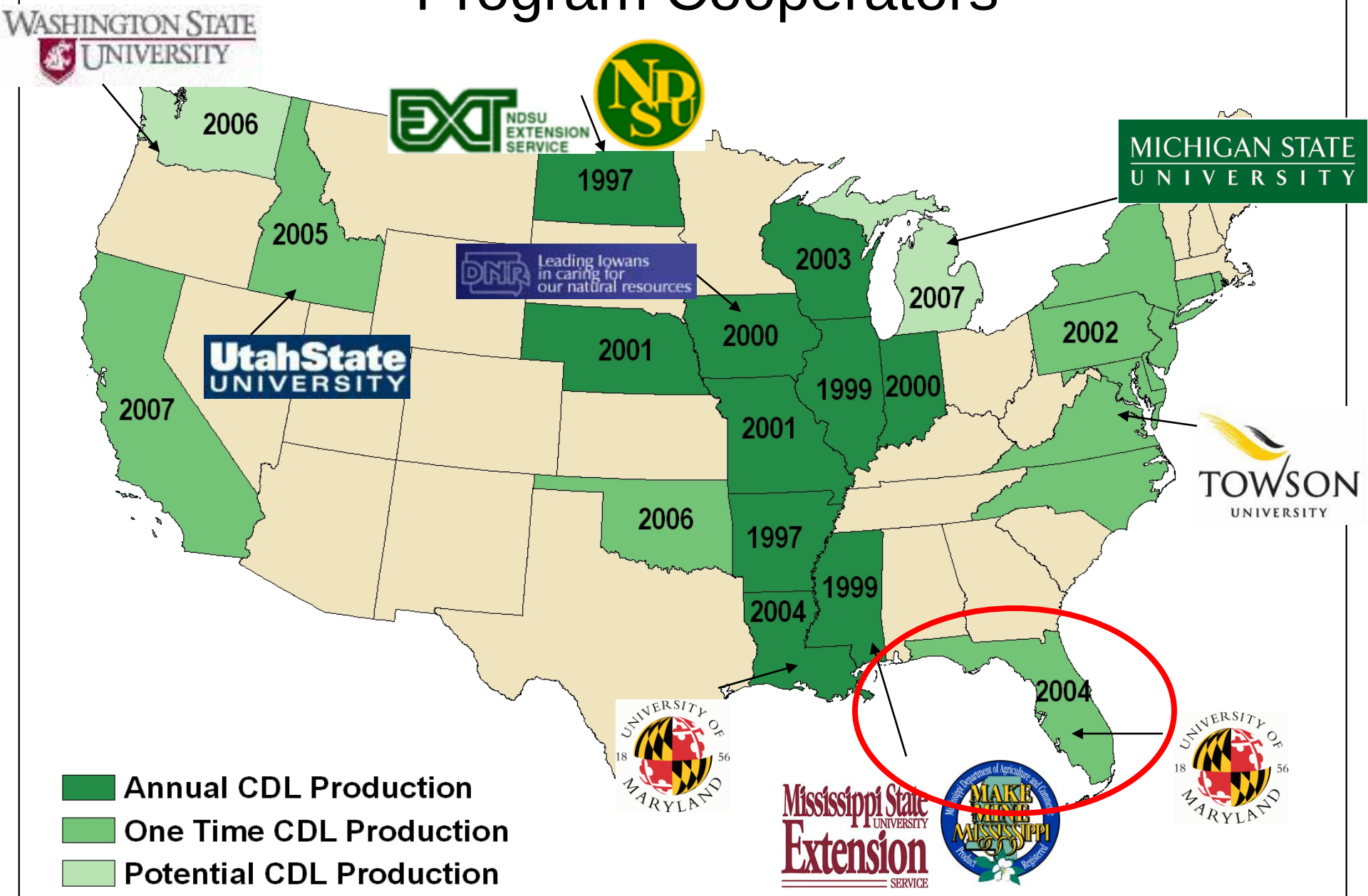
# The National Agricultural Statistics Service

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




*"The Fact Finders of Agriculture."*

# Program Cooperators



# Project Players

- **USDA/NASS Research Division**
  - SARS (Spatial Analysis Research Section)
    - Remote sensing analysts
    - Software developers
- **USDA/Foreign Agricultural Service**
  - Landsat TM/ETM+ imagery source

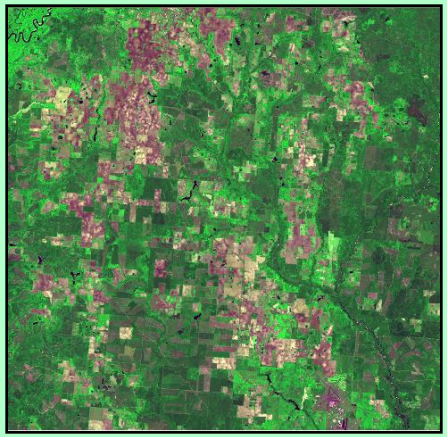
Linking U.S. Agriculture FAS to the World

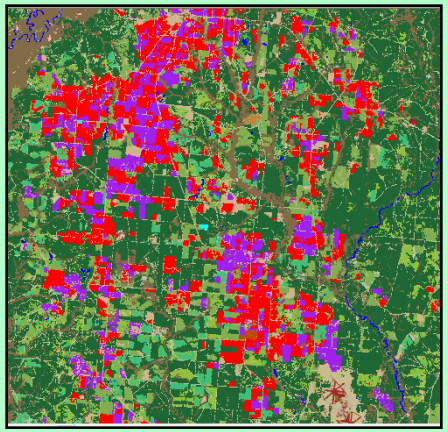
Production Estimates and Crop Assessment Division

# Florida Cropland Data Layer Benefits

- Ortho-rectified image product
- Commercial image formats
- Detailed breakdown of cropland area via large training sample
- Distribute to public via the NRCS Data Gateway

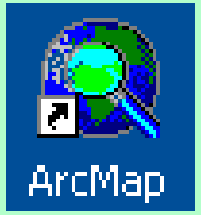
**http://datagateway.nrcs.usda.gov/**





# Program Resources

- Ground Truth Preparation
  - ESRI ArcGIS 9.1
- Imagery Preparation
  - Leica Geosystems ERDAS Imagine 9.0
- Image processing
  - Decision tree software
    - See5.0
    - www.rulequest.com



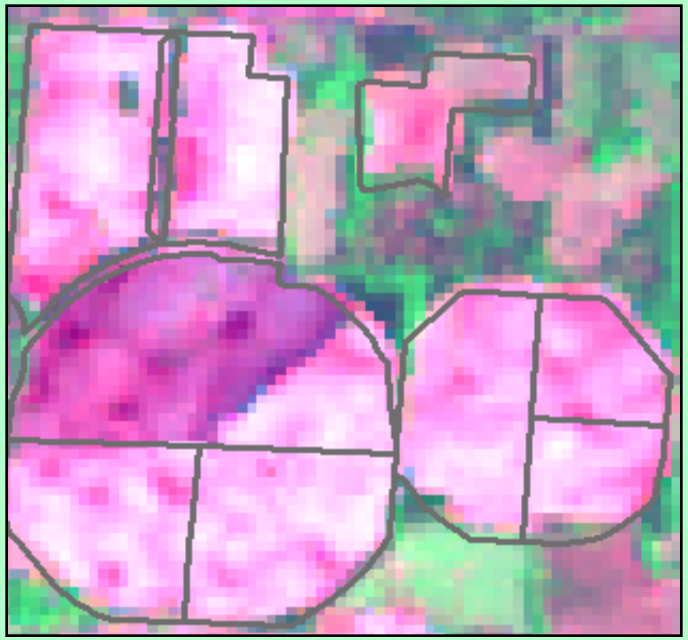


# Cropland Data Layer Inputs

Satellite Images

CLU Polygons/ FSA 578 Data / Citrus GIS

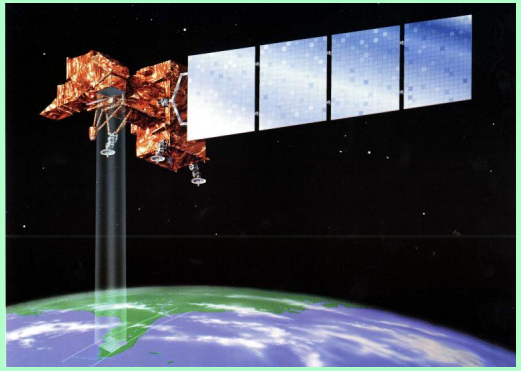
Ancillary Data



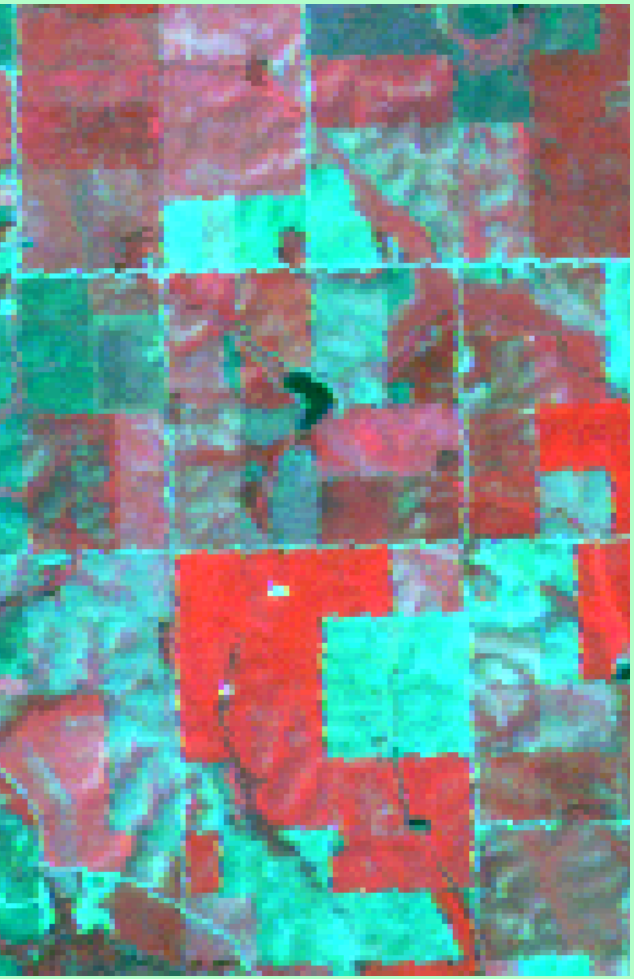
| OID | STATE | COUNTY_COD | FARM_NUMBE | TRACT_NUMB | FIELD_NUMB | CROP_ABBR | CROP_NAME | ACRES | PLANTED | CROP1 | CROP_CD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 12 | 1 | 2 | 865 | 2 | PNUTS | RUNNER PEANUTS | 20.9 | 20.9 | RUN | 75 |
| 1 | 12 | 1 | 2 | 865 | 3 | FALOW | N/A | 9.5 | 9.5 | N/A | 101 |
| 2 | 12 | 1 | 2 | 865 | 4 | GRASS | BAHIA GRASS | 16 | 16 | BHI | 102 |
| 3 | 12 | 1 | 2 | 865 | 5 | GRASS | BAHIA GRASS | 22.9 | 22.9 | BHI | 102 |
| 4 | 12 | 1 | 2 | 865 | 6 | GRASS | BAHIA GRASS | 14.8 | 14.8 | BHI | 102 |
| 5 | 12 | 1 | 2 | 865 | 1A | CORN | YELLOW | 7 | 7 | YEL | 41 |
| 6 | 12 | 1 | 2 | 865 | 1B | BEANS | VELVET BEANS | 7 | 7 | VEL | 47 |
| 7 | 12 | 1 | 2 | 865 | 1C | PNUTS | RUNNER PEANUTS | 14.1 | 14.1 | RUN | 75 |
| 8 | 12 | 1 | 2 | 865 | 1X | TRNAR | N/A | 0.4 | 0.4 | N/A | 105 |
| 9 | 12 | 1 | 2 | 865 | 2X | TRNAR | N/A | 0.7 | 0.7 | N/A | 105 |
| 10 | 12 | 1 | 13 | 2125 | 1 | GRASS | BAHIA GRASS | 13.1 | 13.1 | BHI | 102 |
| 11 | 12 | 1 | 17 | 627 | 2 | PNUTS | RUNNER PEANUTS | 22 | 22 | RUN | 75 |
| 12 | 12 | 1 | 17 | 627 | 1A | PNUTS | RUNNER PEANUTS | 54.9 | 54.9 | RUN | 75 |
| 13 | 12 | 1 | 17 | 627 | 1B | FALOW | N/A | 4.2 | 4.2 | N/A | 101 |
| 14 | 12 | 1 | 17 | 627 | 1X | TRNAR | N/A | 1.7 | 1.7 | N/A | 105 |
| 15 | 12 | 1 | 17 | 627 | 2X | TRNAR | N/A | 0.7 | 0.7 | N/A | 105 |
| 16 | 12 | 1 | 23 | 2224 | 1 | OKRA | N/A | 2.1 | 2.1 | N/A | 286 |
| 17 | 12 | 1 | 23 | 2224 | 2 | GREEN | COLLARDS | 0.9 | 0.9 | COL | 4000 |
| 18 | 12 | 1 | 23 | 2224 | 4 | CORN | YELLOW | 4.4 | 4.4 | YEL | 41 |
| 19 | 12 | 1 | 23 | 2224 | 5 | CORN | YELLOW | 8.3 | 8.3 | YEL | 41 |
| 20 | 12 | 1 | 23 | 2224 | 1X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 21 | 12 | 1 | 23 | 2224 | 2X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 22 | 12 | 1 | 23 | 2224 | 3A | WATRM | COMMON | 0.2 | 0.2 | COM | 757 |
| 23 | 12 | 1 | 23 | 2224 | 3B | PEAS | SOUTHERN ACRE | 0.5 | 0.5 | SOA | 67 |
| 24 | 12 | 1 | 23 | 2224 | 3C | CORN | YELLOW | 2 | 2 | YEL | 41 |
| 25 | 12 | 1 | 23 | 2224 | 3X | FALOW | N/A | 1.8 | 1.8 | N/A | 101 |
| 26 | 12 | 1 | 23 | 2224 | 4X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 27 | 12 | 1 | 23 | 2224 | 5X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 28 | 12 | 1 | 34 | 22116 | 1 | GRASS | BAHIA GRASS | 6.6 | 6.6 | BHI | 102 |
| 29 | 12 | 1 | 34 | 22117 | 1 | GRASS | BAHIA GRASS | 8.3 | 8.3 | BHI | 102 |
| 30 | 12 | 1 | 34 | 22117 | 2 | WATRM | COMMON | 5.5 | 0 | COM | 757 |
| 31 | 12 | 1 | 34 | 22117 | 3 | GRASS | BAHIA GRASS | 8.2 | 8.2 | BHI | 102 |
| 32 | 12 | 1 | 34 | 22117 | 2X | TRNAR | N/A | 0.2 | 0.2 | N/A | 105 |
| 33 | 12 | 1 | 34 | 22118 | 1 | WATRM | COMMON | 1 | 1 | COM | 757 |
| 34 | 12 | 1 | 34 | 22509 | 1 | WATRM | COMMON | 1 | 1 | COM | 757 |
| 35 | 12 | 1 | 40 | 22469 | 1 | FALOW | N/A | 7 | 7 | N/A | 101 |
| 36 | 12 | 1 | 40 | 22469 | 2A | PEAS | SOUTHERN ACRE | 0.5 | 0.5 | SOA | 67 |

# Landsat Platform

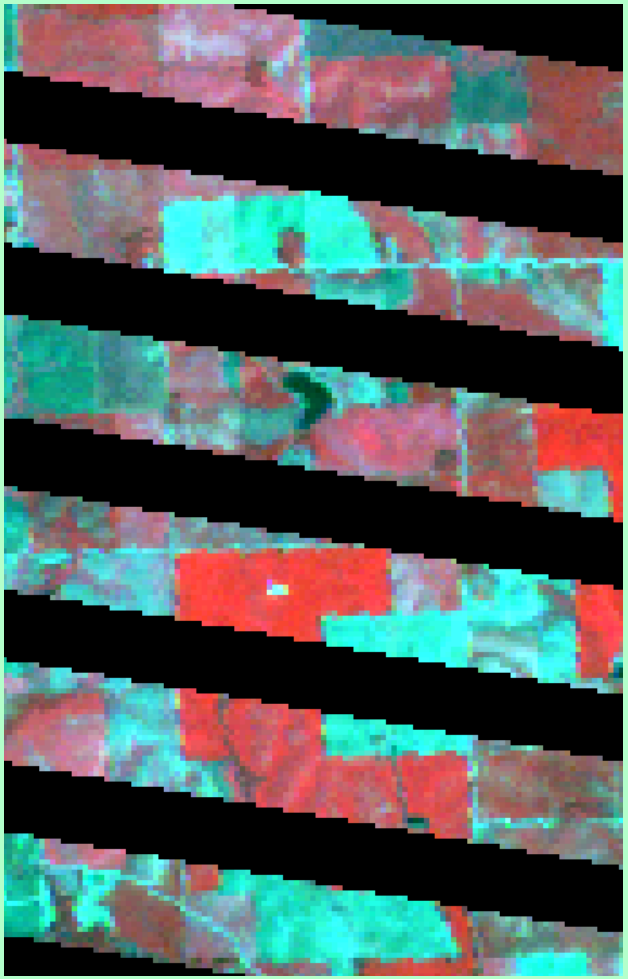
- Landsat 5 launched 1984 (3 yr design life!)
  - Thematic Mapper (TM) Sensor
- Landsat 7 launched 1999 Thematic Mapper (ETM+) Sensor



# Landsat 7
# Gap- Filled Images



**Original**



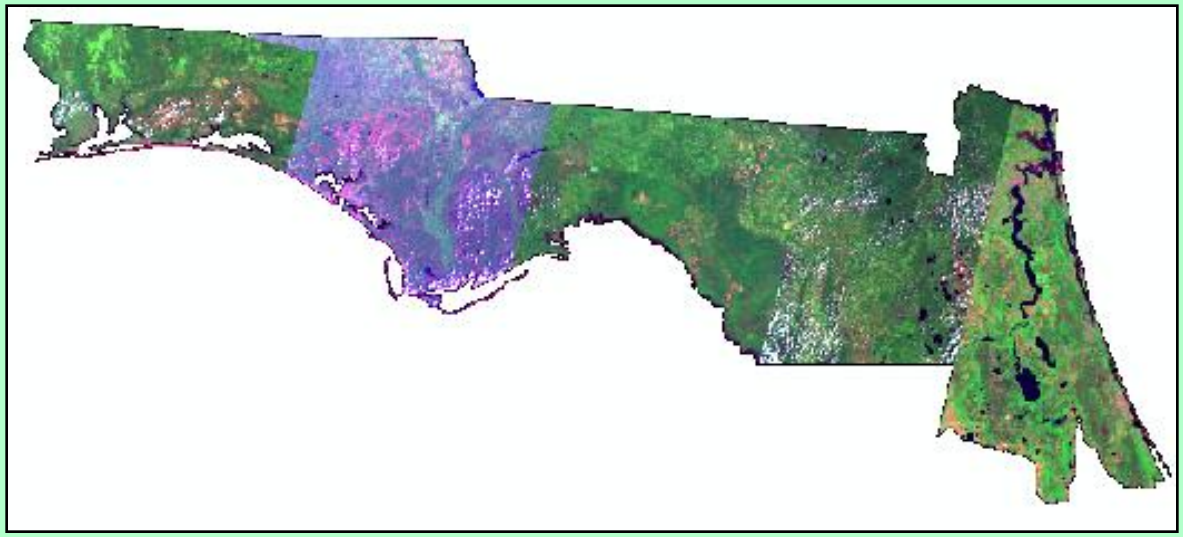
**SLC_off**

**SLC_off Filled**

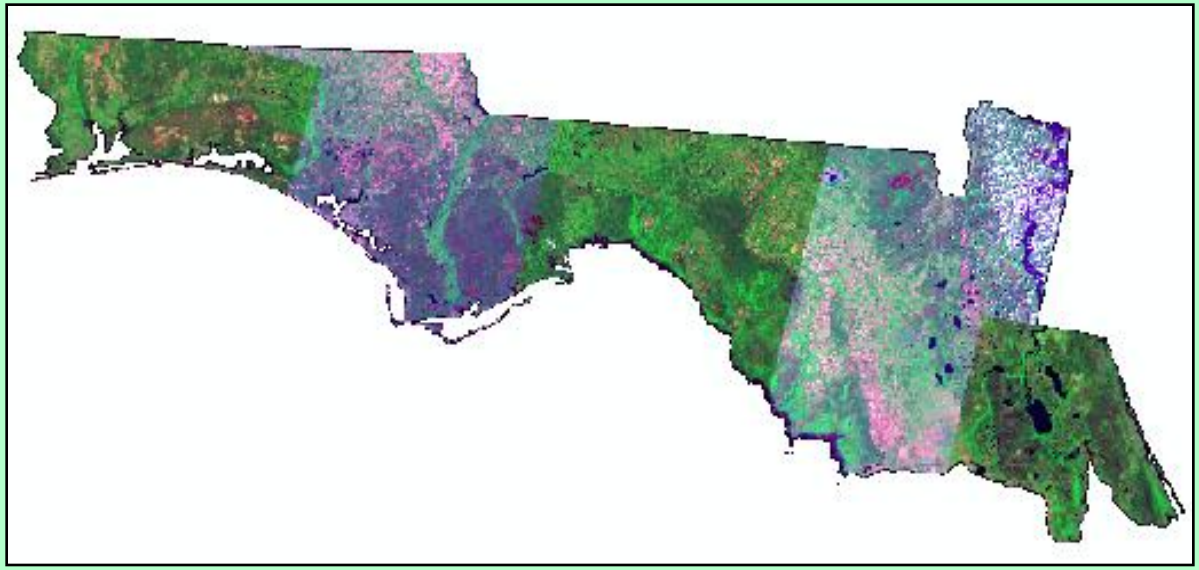
National Center for Earth Resources Observation and Science Data Center
Courtesy of Susan Maxwell, USGS

U. S. Geological Survey

# Florida Panhandle
# Imagery Mosaics created from Landsat TM and Gap Filled Landsat ETM+ scenes

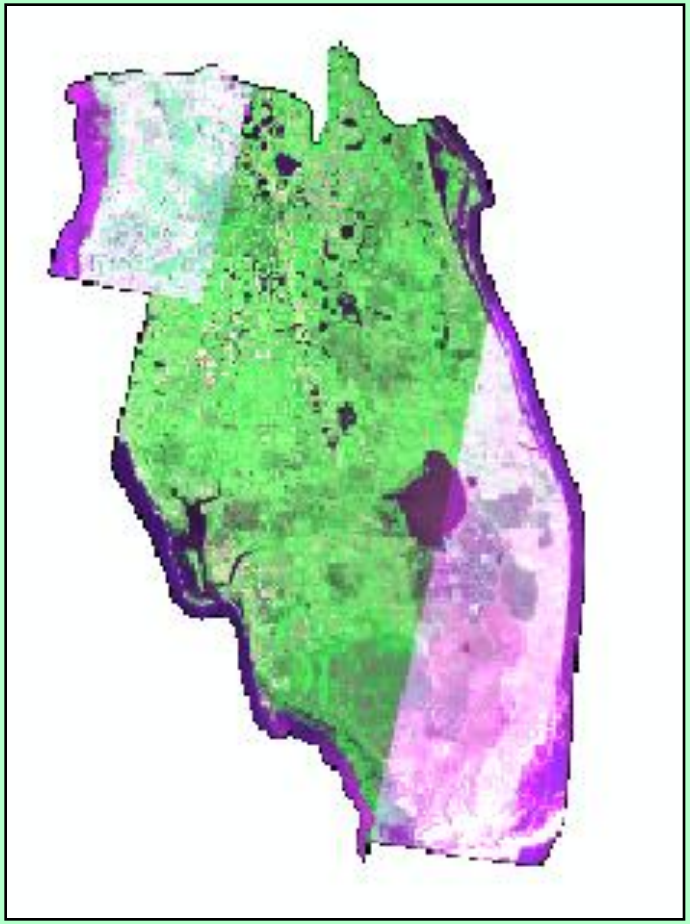


Spring Mosaic

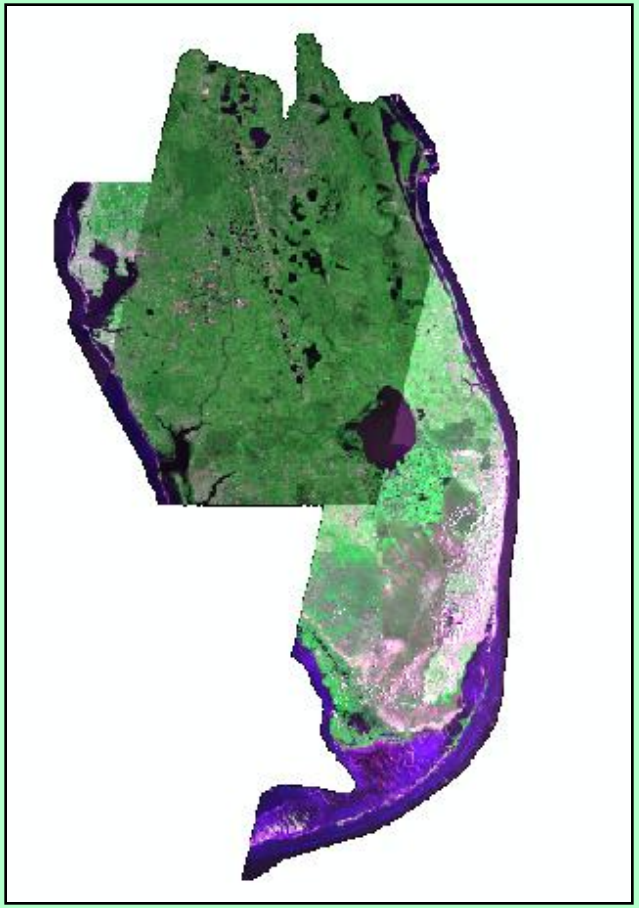


Fall Mosaic

# Florida Peninsula
# Imagery Mosaics created from Landsat TM and Gap Filled ETM+ scenes

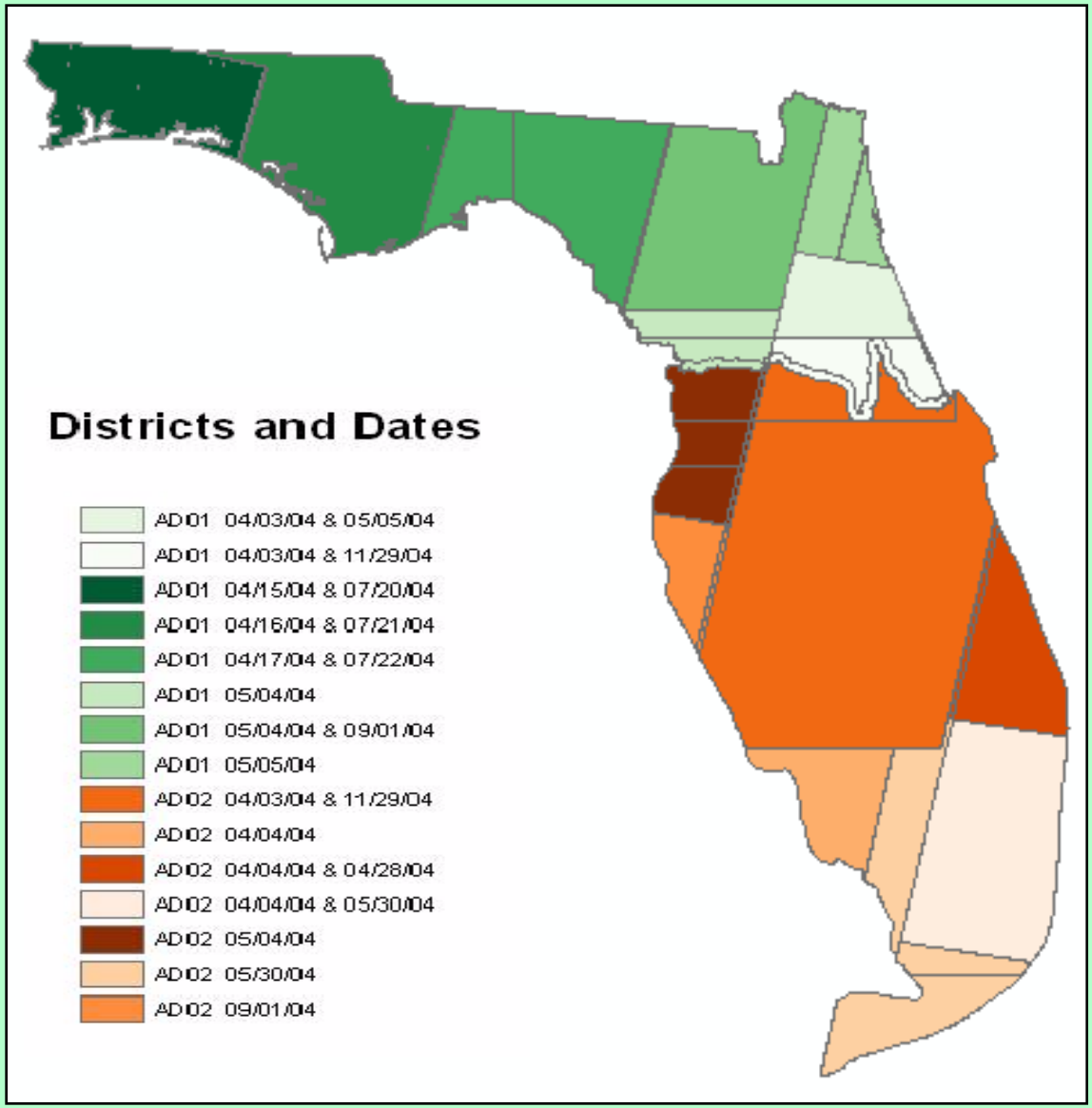


Spring Mosaic



Fall Mosaic

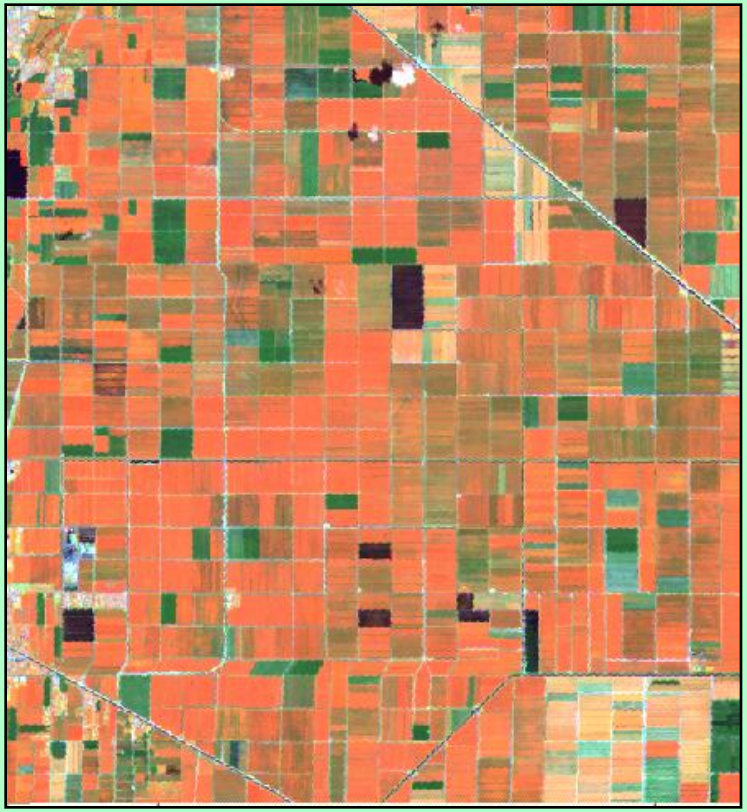
# Analysis Districts and Scene Dates



# Zoom of  Raw Scenes

Landsat 5 – 11/29/04

Landsat 5 – 05/30/04



# GIS– Ground truth

## Farm Service Agency (FSA) Common Land Unit (CLU) data


FSA CLU

| OID | STATE | COUNTY_COD | FARM_NUMBE | TRACT_NUMB | FIELD_NUMB | CROP_ABBR | CROP_NAME | ACRES | PLANTED | CROP1 | CROP_CD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 12 | 1 | 2 | 865 | 2 | PNUTS | RUNNER PEANUTS | 20.9 | 20.9 | RUN | 75 |
| 1 | 12 | 1 | 2 | 865 | 3 | FALOW | N/A | 9.5 | 9.5 | N/A | 101 |
| 2 | 12 | 1 | 2 | 865 | 4 | GRASS | BAHIA GRASS | 16 | 16 | BHI | 102 |
| 3 | 12 | 1 | 2 | 865 | 5 | GRASS | BAHIA GRASS | 22.9 | 22.9 | BHI | 102 |
| 4 | 12 | 1 | 2 | 865 | 6 | GRASS | BAHIA GRASS | 14.8 | 14.8 | BHI | 102 |
| 5 | 12 | 1 | 2 | 865 | 1A | CORN | YELLOW | 7 | 7 | YEL | 41 |
| 6 | 12 | 1 | 2 | 865 | 1B | BEANS | VELVET BEANS | 7 | 7 | VEL | 47 |
| 7 | 12 | 1 | 2 | 865 | 1C | PNUTS | RUNNER PEANUTS | 14.1 | 14.1 | RUN | 75 |
| 8 | 12 | 1 | 2 | 865 | 1X | TRNAR | N/A | 0.4 | 0.4 | N/A | 105 |
| 9 | 12 | 1 | 2 | 865 | 2X | TRNAR | N/A | 0.7 | 0.7 | N/A | 105 |
| 10 | 12 | 1 | 13 | 2125 | 1 | GRASS | BAHIA GRASS | 13.1 | 13.1 | BHI | 102 |
| 11 | 12 | 1 | 17 | 627 | 2 | PNUTS | RUNNER PEANUTS | 22 | 22 | RUN | 75 |
| 12 | 12 | 1 | 17 | 627 | 1A | PNUTS | RUNNER PEANUTS | 54.9 | 54.9 | RUN | 75 |
| 13 | 12 | 1 | 17 | 627 | 1B | FALOW | N/A | 4.2 | 4.2 | N/A | 101 |
| 14 | 12 | 1 | 17 | 627 | 1X | TRNAR | N/A | 1.7 | 1.7 | N/A | 105 |
| 15 | 12 | 1 | 17 | 627 | 2X | TRNAR | N/A | 0.7 | 0.7 | N/A | 105 |
| 16 | 12 | 1 | 23 | 2224 | 1 | OKRA | N/A | 2.1 | 2.1 | N/A | 286 |
| 17 | 12 | 1 | 23 | 2224 | 2 | GREEN | COLLARDS | 0.9 | 0.9 | COL | 4000 |
| 18 | 12 | 1 | 23 | 2224 | 4 | CORN | YELLOW | 4.4 | 4.4 | YEL | 41 |
| 19 | 12 | 1 | 23 | 2224 | 5 | CORN | YELLOW | 8.3 | 8.3 | YEL | 41 |
| 20 | 12 | 1 | 23 | 2224 | 1X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 21 | 12 | 1 | 23 | 2224 | 2X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 22 | 12 | 1 | 23 | 2224 | 3A | WATRM | COMMON | 0.2 | 0.2 | COM | 757 |
| 23 | 12 | 1 | 23 | 2224 | 3B | PEAS | SOUTHERN ACRE | 0.5 | 0.5 | SOA | 67 |
| 24 | 12 | 1 | 23 | 2224 | 3C | CORN | YELLOW | 2 | 2 | YEL | 41 |
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| 26 | 12 | 1 | 23 | 2224 | 4X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
| 27 | 12 | 1 | 23 | 2224 | 5X | TRNAR | N/A | 0.1 | 0.1 | N/A | 105 |
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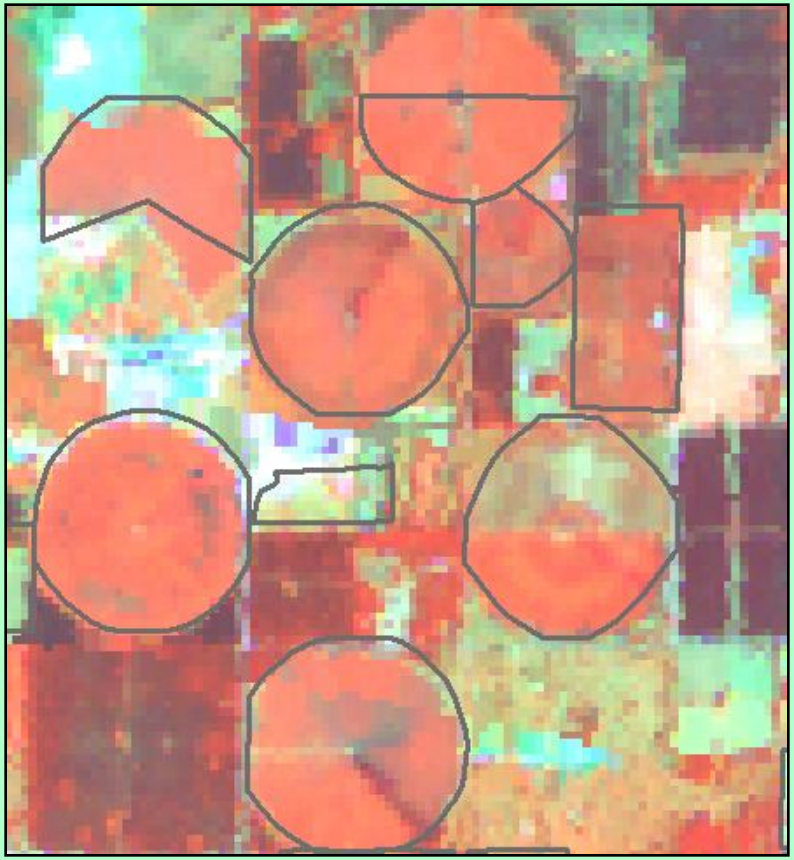
| 30 | 12 | 1 | 34 | 22117 | 2 | WATRM | COMMON | 5.5 | 0 | COM | 757 |
| 31 | 12 | 1 | 34 | 22117 | 3 | GRASS | BAHIA GRASS | 8.2 | 8.2 | BHI | 102 |
| 32 | 12 | 1 | 34 | 22117 | 2X | TRNAR | N/A | 0.2 | 0.2 | N/A | 105 |
| 33 | 12 | 1 | 34 | 22118 | 1 | WATRM | COMMON | 1 | 1 | COM | 757 |
| 34 | 12 | 1 | 34 | 22509 | 1 | WATRM | COMMON | 1 | 1 | COM | 757 |
| 35 | 12 | 1 | 40 | 22469 | 1 | FALOW | N/A | 7 | 7 | N/A | 101 |
| 36 | 12 | 1 | 40 | 22469 | 2A | PEAS | SOUTHERN ACRE | 0.5 | 0.5 | SOA | 67 |

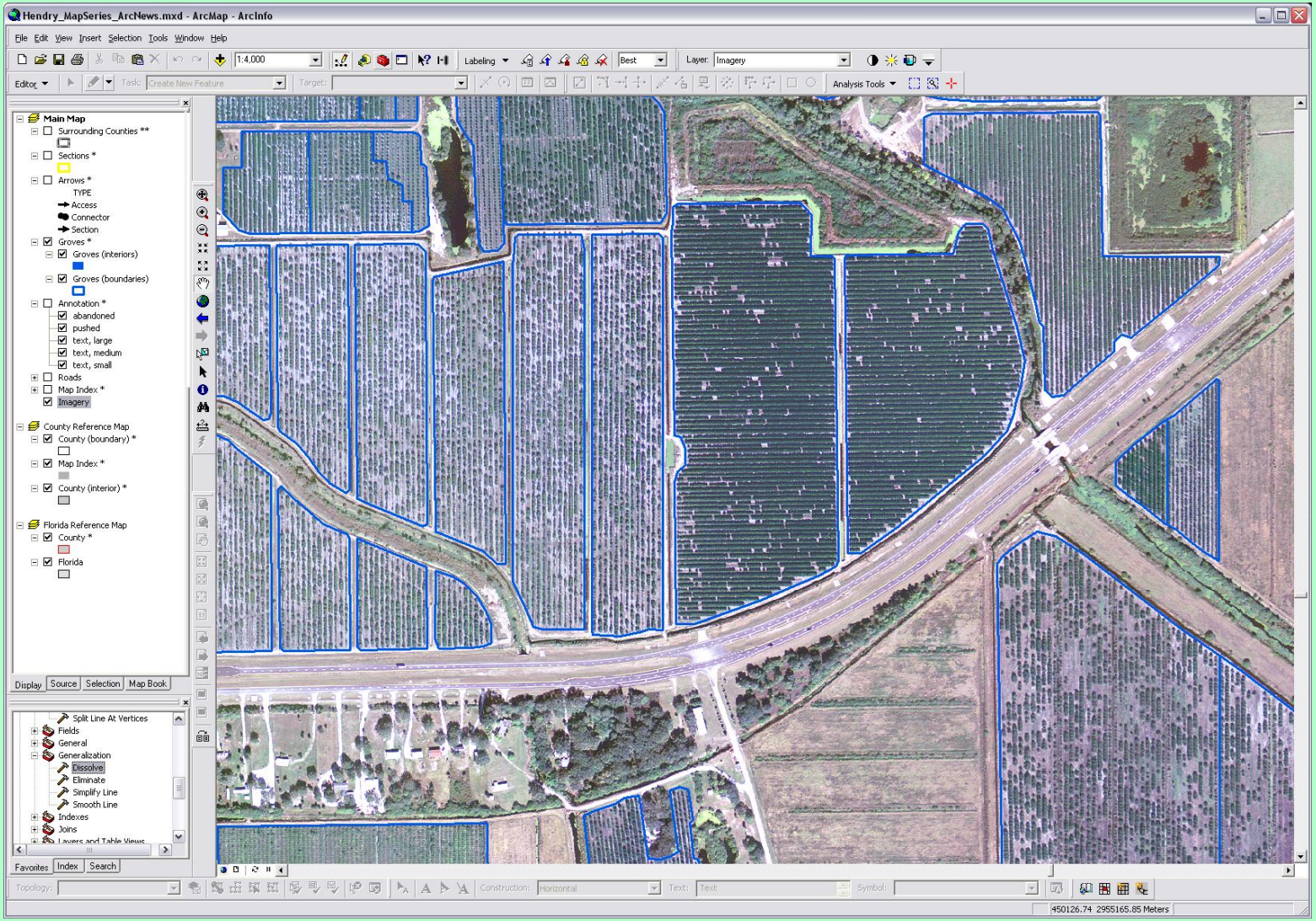
578 Admin Data

# Farm Service Agency (FSA) Data



FSA (CLU) Data Used for Ground Truth Information

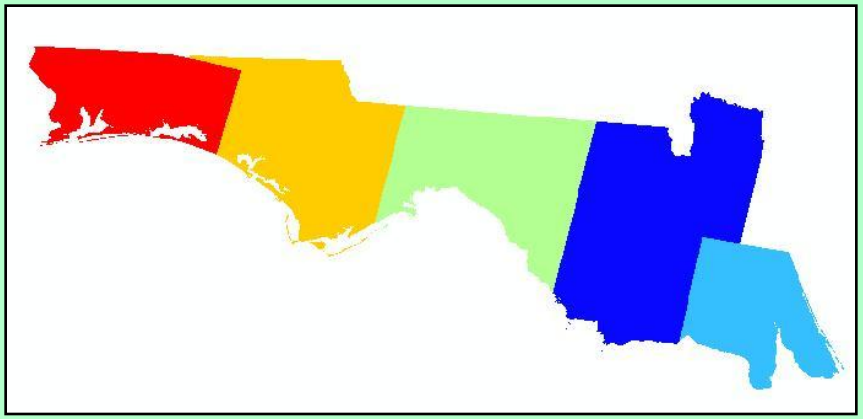
# Florida Commercial Citrus Inventory GIS Groundtruth for Citrus Crop



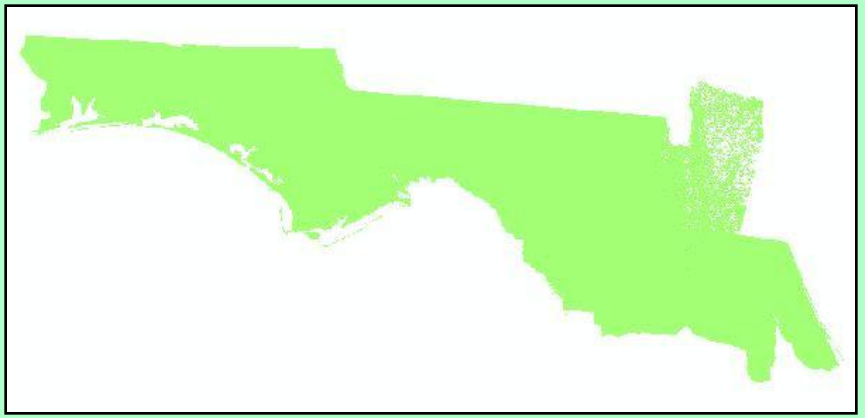

**Screen capture of ArcMap in action**

# Ancillary Data Sets

- Cloud Masks
- Date Masks



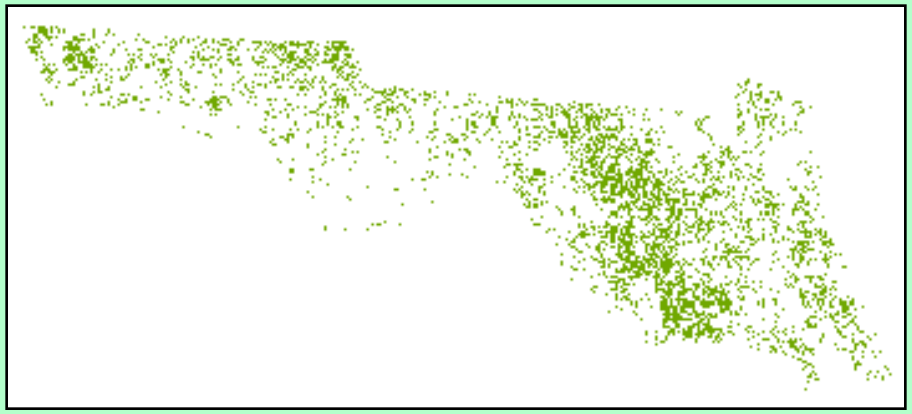
- Date Mask



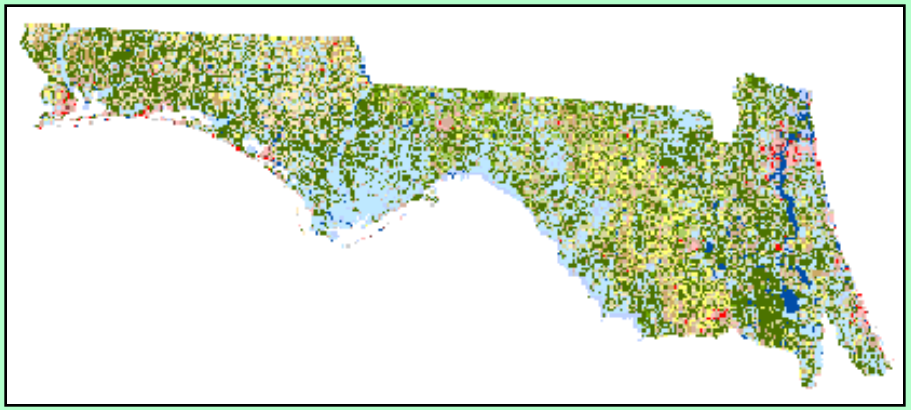
- Cloud Mask

# More Ancillary Data sets

- Agricultural Masks
- National Land Cover Data Set (NLCD) 2001



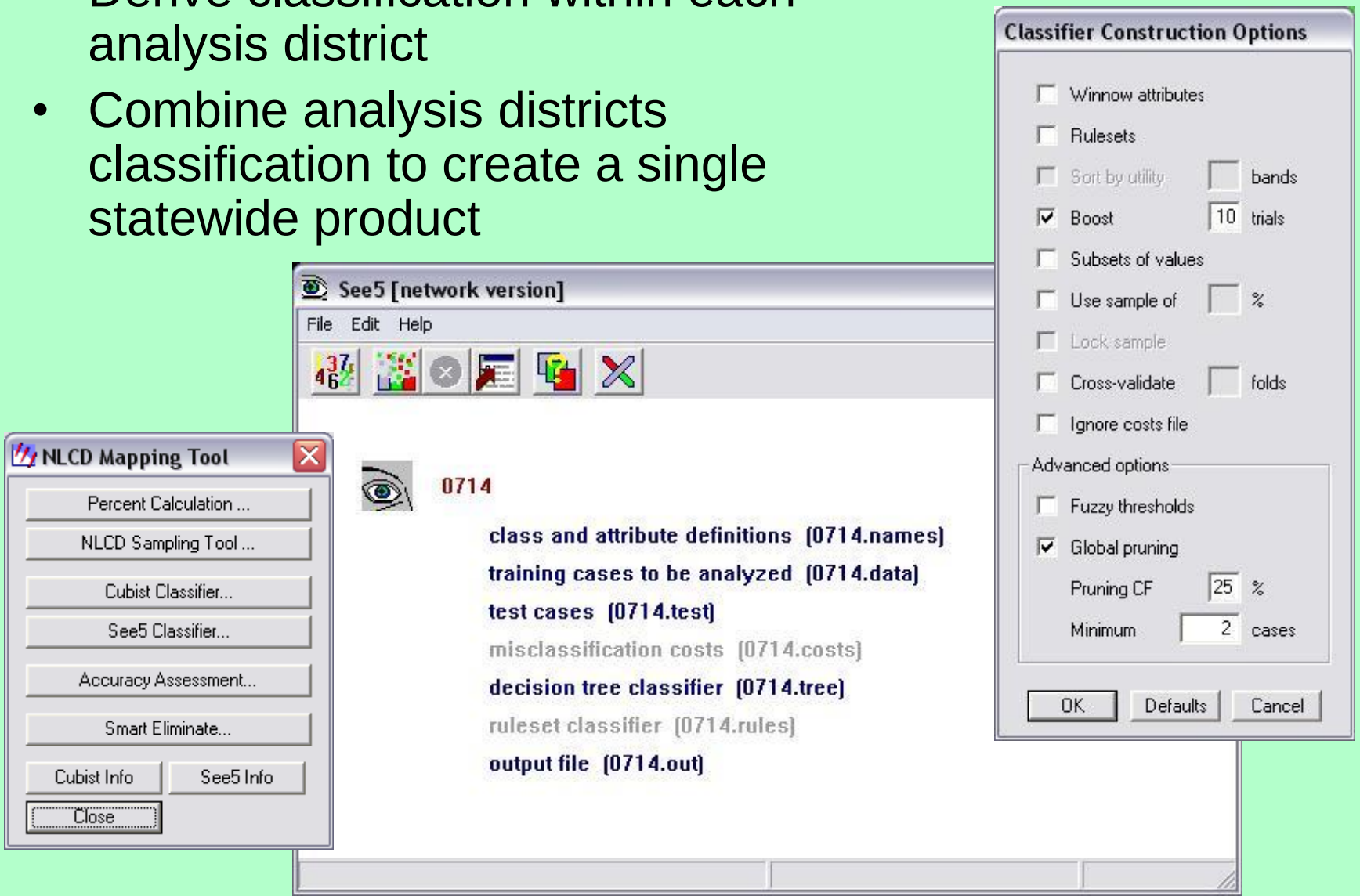
- Agricultural Mask



- (NLCD) 2001

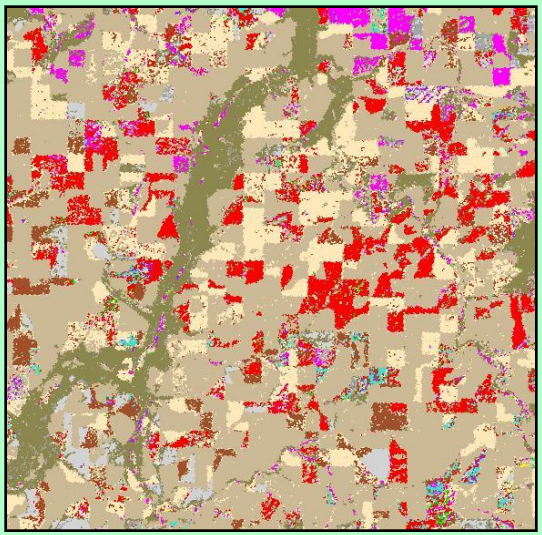
# Classification Overview (See5)

- Derive classification within each analysis district
- Combine analysis districts classification to create a single statewide product

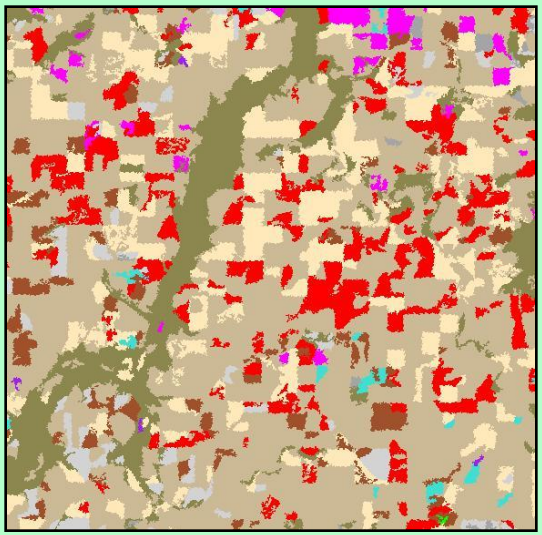


# Post Classification Enhancements

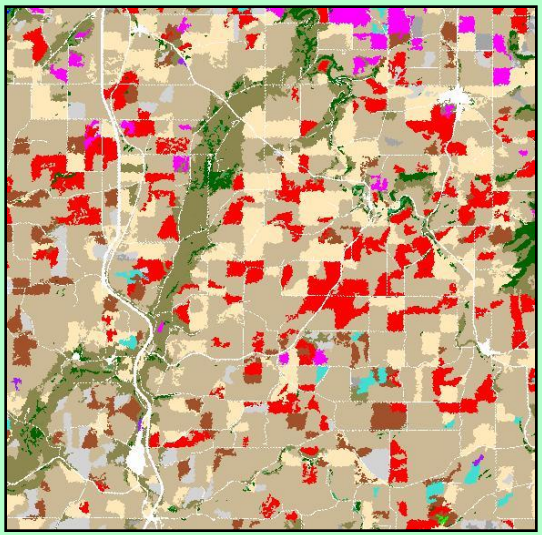
- Polish
  - 20 acre minimum mapping unit works best
- Overlay non agricultural classes with those from ancillary data
  - For example: National Land Cover Dataset



Original



Polished



Ancillary added

# Florida Cropland Data Layer
# Error Matrix

| B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference | | | | | | | | | | | | | |
| | Corn | Cotton | Sorghum | Soybeans | Peanuts | WW/Rye/ | Other Cı | Sugarcan | Waterm | Grass/Pa | Citrus | Totals | User Accuracies | |
| Corn | 41386 | 21 | 0 | 1 | 14 | 71 | 6 | 0 | 98 | 7727 | 275 | 49599 | 83.441 | |
| Cotton(Upla | 73 | 96224 | 0 | 97 | 453 | 598 | 47 | 0 | 13 | 4733 | 0 | 102238 | 94.118 | |
| Sorghum | 12 | 0 | 2592 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 2625 | 98.743 | |
| Soybeans | 33 | 35 | 0 | 17624 | 39 | 50 | 6 | 0 | 0 | 155 | 0 | 17942 | 98.228 | |
| Peanuts | 155 | 966 | 1 | 27 | 148665 | 201 | 135 | 0 | 357 | 3541 | 123 | 154171 | 96.429 | |
| WW/Rye/Oa | 69 | 150 | 9 | 9 | 135 | 69652 | 3277 | 0 | 0 | 1052 | 0 | 74342 | 93.691 | |
| Other Crop_ | 1473 | 0 | 2618 | 0 | 0 | 0 | 4313 | 1 | 0 | 1306 | 26575 | 36286 | 11.886 | |
| Sugarcane | 134 | 0 | 0 | 0 | 0 | 0 | 1474 | 56013 | 0 | 0 | 4108 | 61729 | 90.74 | |
| Watermelor | 0 | 3 | 0 | 0 | 46 | 50 | 382 | 0 | 6812 | 43 | 0 | 7336 | 92.857 | |
| Grass/Pastu | 696 | 810 | 116 | 296 | 2356 | 5528 | 9713 | 428 | 1771 | 729996 | 454562 | 1E+06 | 60.517 | |
| Citrus | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 3 | 525 | 2055068 | 2E+06 | 99.974 | |
| Sum Classif | 44031 | 98209 | 5336 | 18054 | 151708 | 76150 | 19365 | 56442 | 9054 | 749099 | 2540711 | 4E+06 | | |
| Accuracies | 93.993 | 97.979 | 48.5757 | 97.618256 | 97.9942 | 91.46684 | 22.2721 | 99.23993 | 0.75237 | 97.4499 | 80.8855 | | 0.8567 | |
| | Producer Accuracies | | | | | | | | | | | Agriculture Accuracy | | |
| | | | | | | | | | | | | (NLCD) not included | | |

# User's Accuracies

Table 1: User's Accuracies

| | |
|---|---|
| Corn | 83.42% |
| Cotton (Upland) | 94.12% |
| Sorghum | 98.74% |
| Soybeans | 98.29% |
| Peanuts: | 96.43% |
| Winter Wheat/Rye/Oats/Millet | 93.69% |
| Other Crop | 11.89% |
| Watermelon/Other Fruit | 92.86% |
| Grass/Pasture | 60.50% |
| Sugarcane: | 90.74% |
| Citrus | 99.97% |

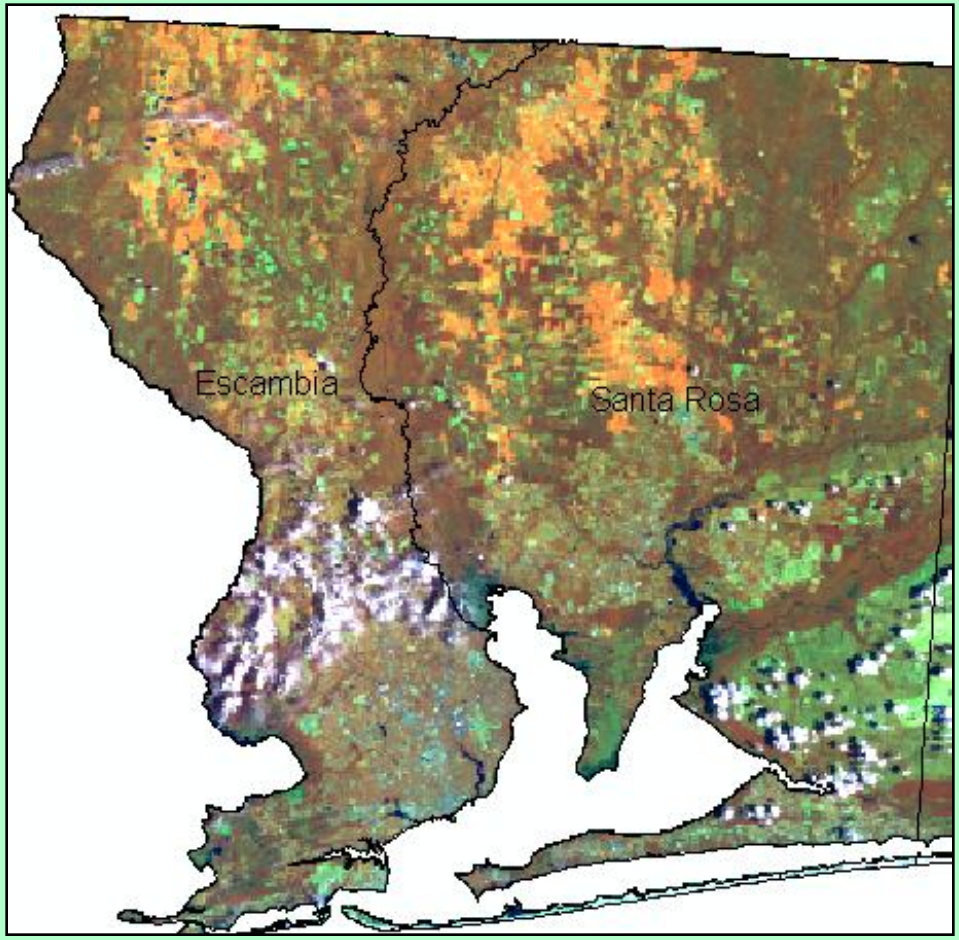
User Accuracies indicate the probability that a pixel from the CDL classification actually matches the ground truth data and measures errors of commission.

# Producer's Accuracies

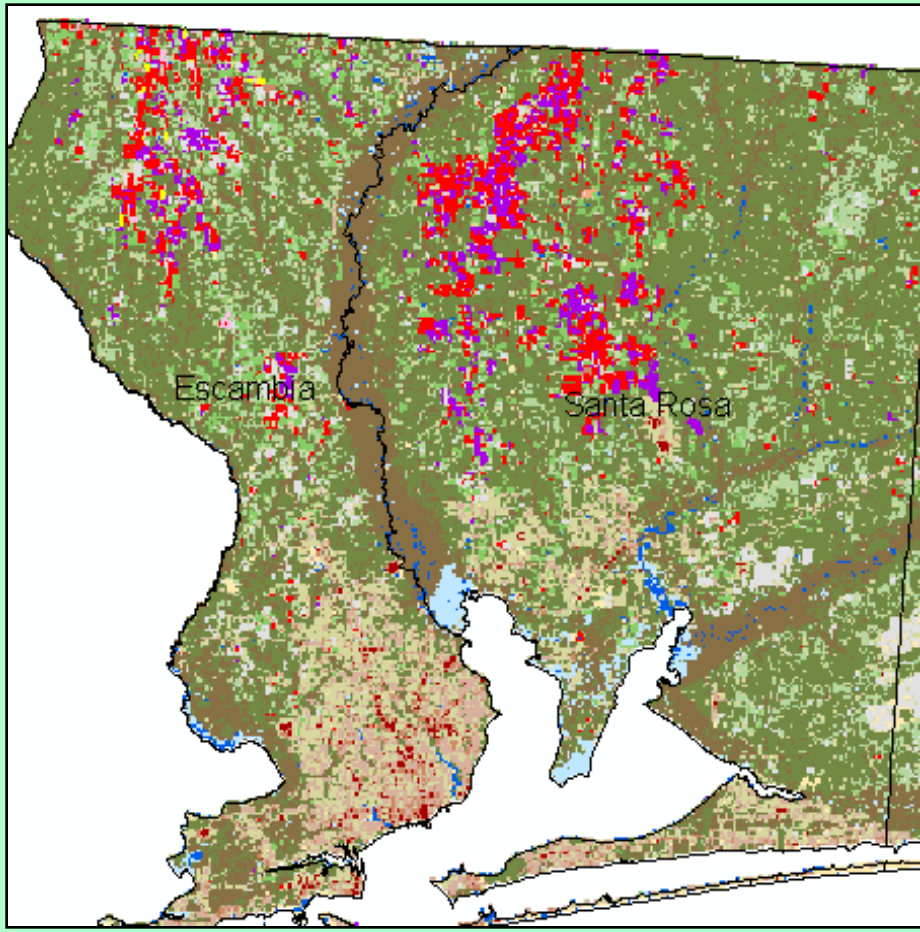
| Table 2: Producer's Accuracies | |
|---|---|
| Corn | 93.99% |
| Cotton (Upland) | 97.98% |
| Sorghum | 45.58% |
| Soybeans | 97.62% |
| Peanuts: | 97.99% |
| Winter Wheat/Rye/Oats/Millet | 91.47% |
| Other Crop | 22.27% |
| Watermelon/Other Fruit | 75.24% |
| Grass/Pasture | 97.45% |
| Sugarcane: | 99.24% |
| Citrus | 80.89% |

Producer's accuracies relate to the probability that a ground truth pixel will be correctly mapped and measures errors of omission.

# Santa Rosa and Escambia Counties

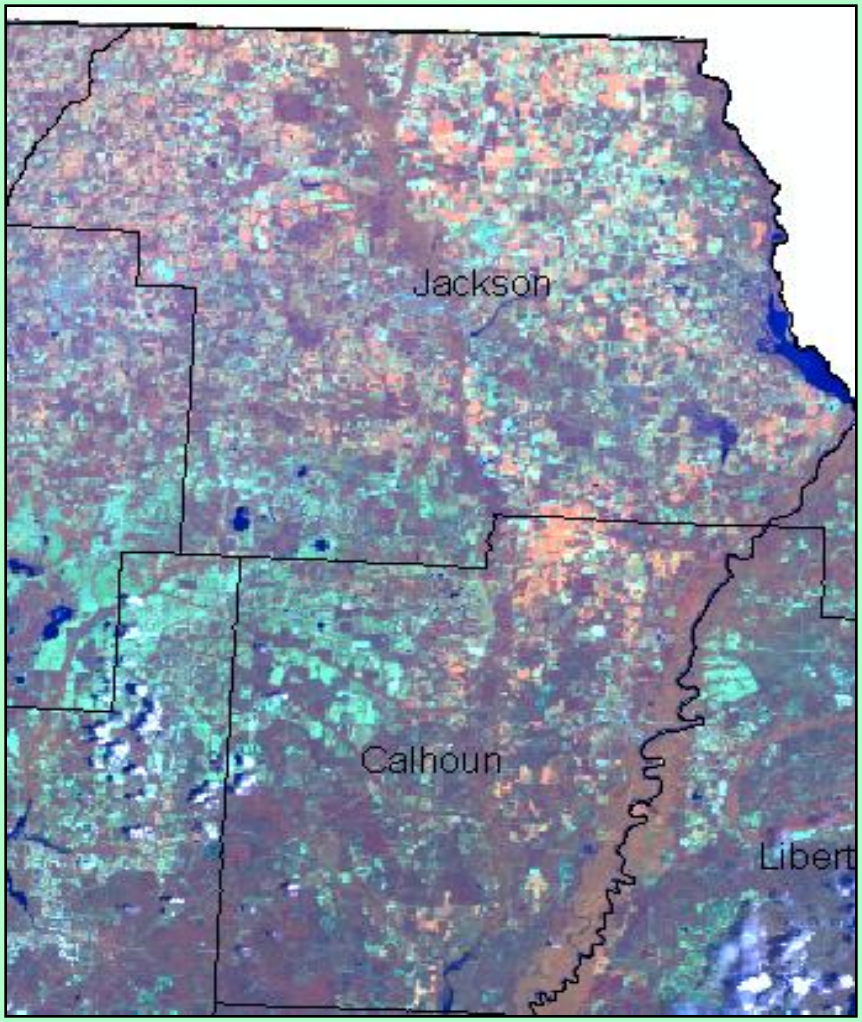



**Raw Landsat TM Imagery Bands 4,5,3**

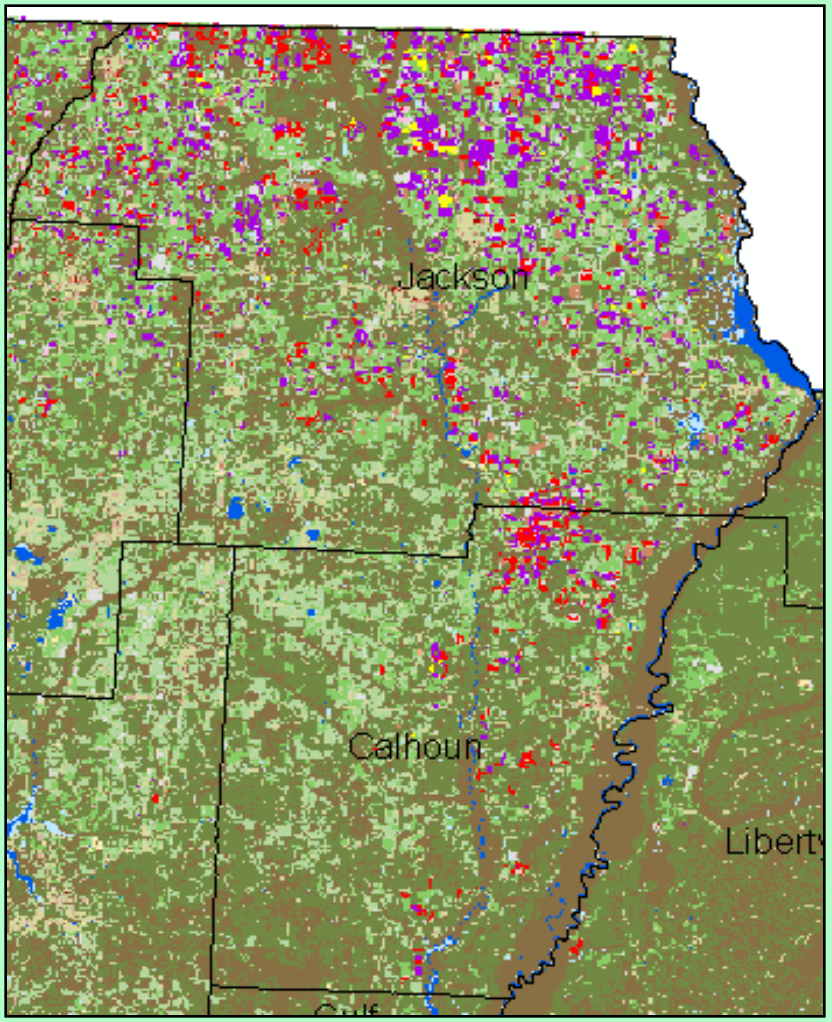



**Florida CDL Zoom**
**of Santa Rosa and Escambia Counties**

# Jackson and Calhoun Counties

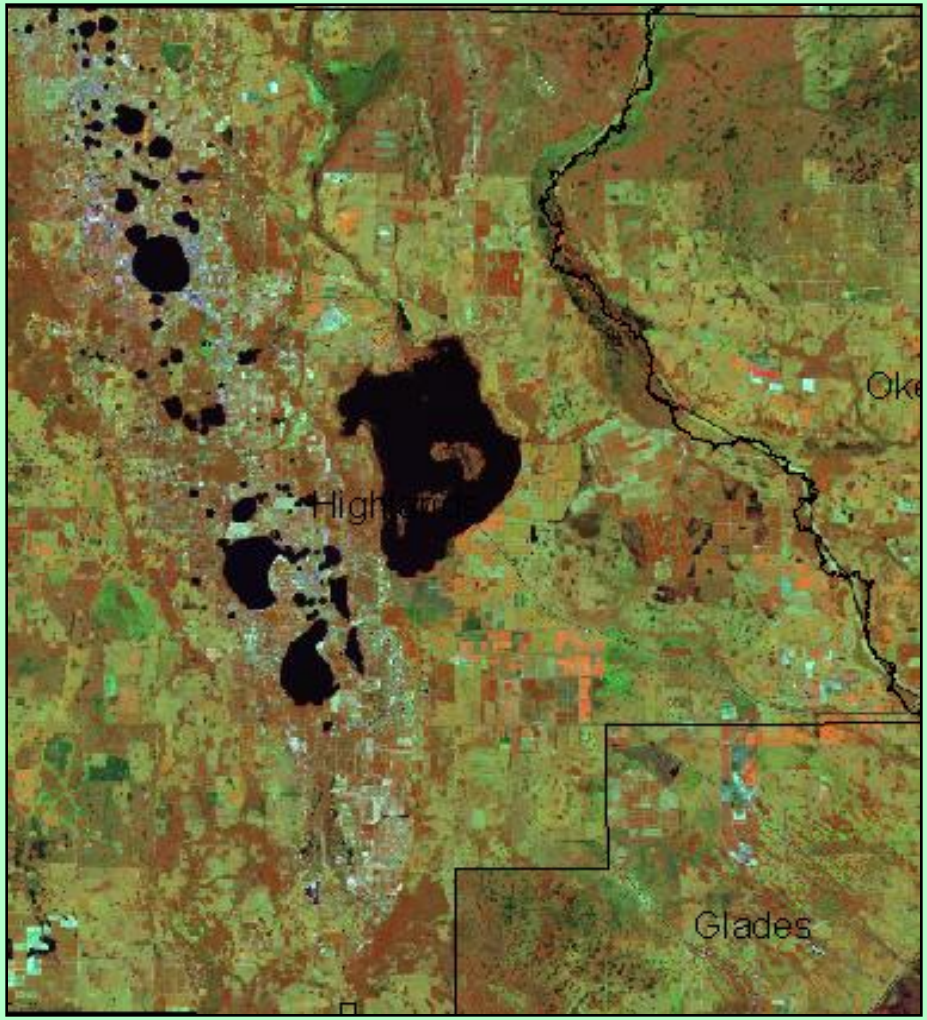



**Raw Landsat TM Imagery Bands 4,5,3**

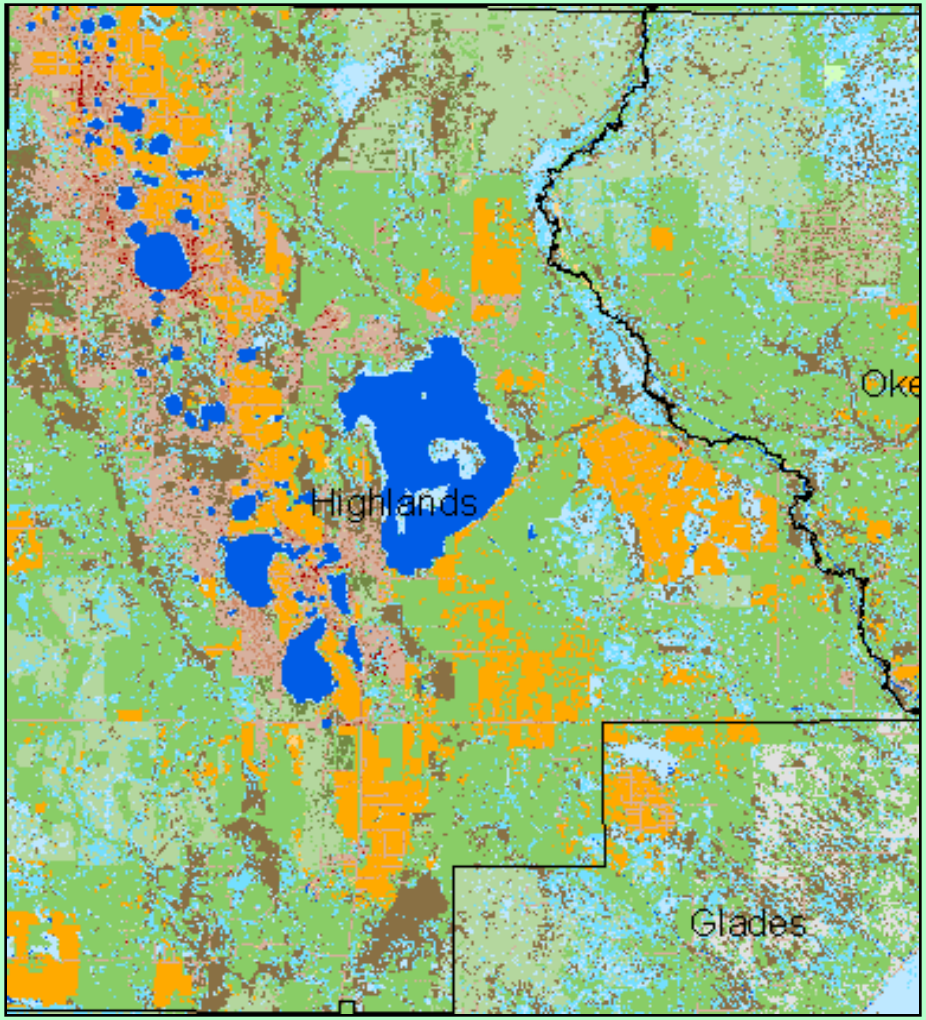



**Florida CDL Zoom**
**of Jackson and Calhoun Counties**

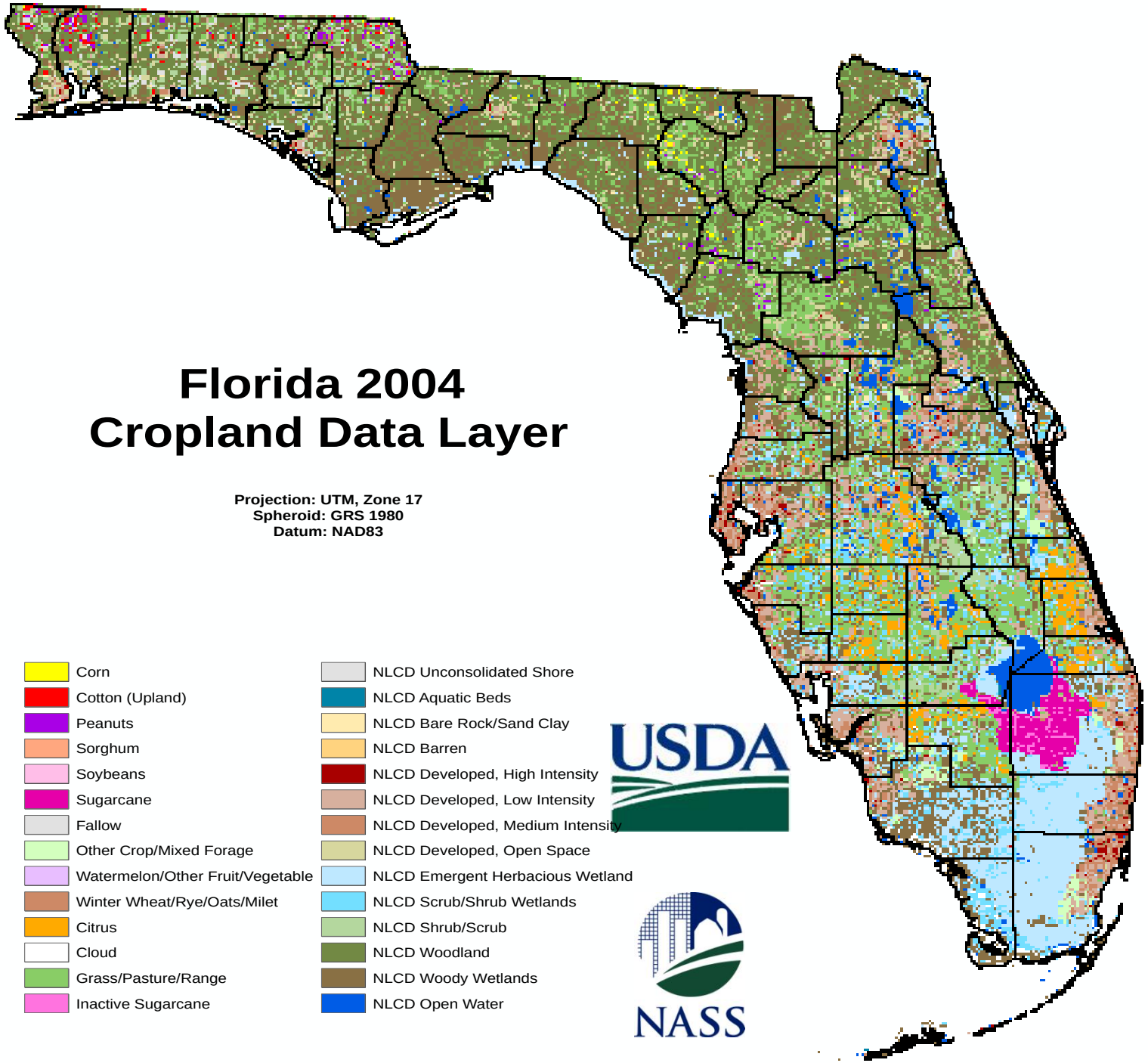
# Highlands County



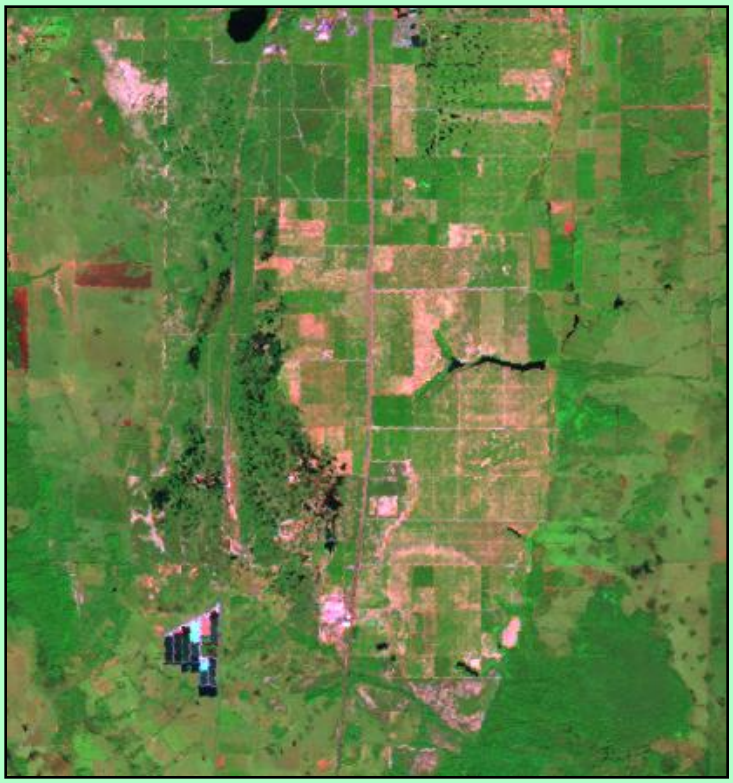

Raw Landsat TM Imagery Bands 4,5,3

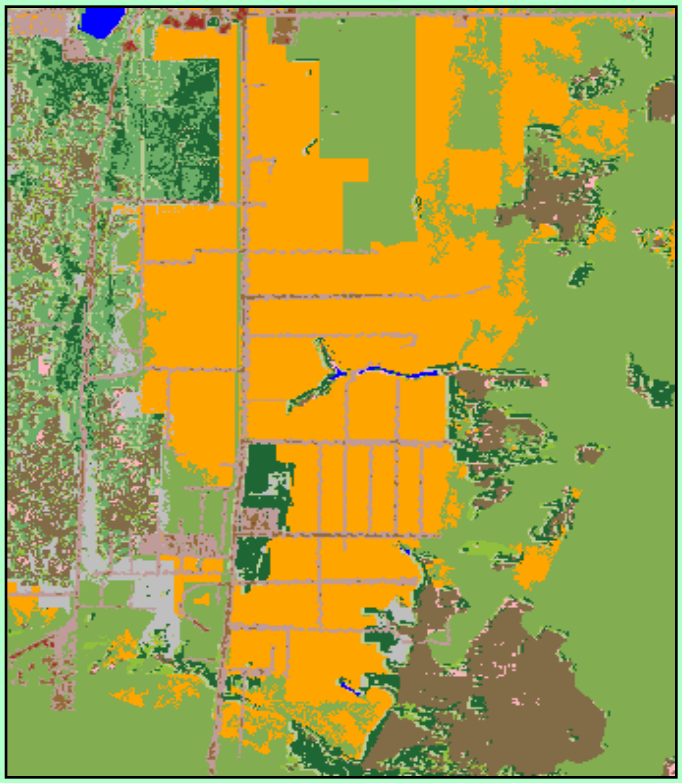



Florida CDL Zoom of Highlands County


Florida 2004
Cropland Data Layer
Projection: UTM, Zone 17
Spheroid: GRS 1980
Datum: NAD83
Corn
Cotton (Upland)
Peanuts
Sorghum
Soybeans
Sugarcane
Fallow
Other Crop/Mixed Forage
Watermelon/Other Fruit/Vegetable
Winter Wheat/Rye/Oats/Milet
Citrus
Cloud
Grass/Pasture/Range
Inactive Sugarcane
NLCD Unconsolidated Shore
NLCD Aquatic Beds
NLCD Bare Rock/Sand Clay
NLCD Barren
NLCD Developed, High Intensity
NLCD Developed, Low Intensity
NLCD Developed, Medium Intensity
NLCD Developed, Open Space
NLCD Emergent Herbacious Wetland
NLCD Scrub/Shrub Wetlands
NLCD Shrub/Scrub
NLCD Woodland
NLCD Woody Wetlands
NLCD Open Water
USDA
NASS

# Thank You





**Claire Boryan, Geographer**

USDA/NASS/RDD/SARS

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