



Operational Use of Remote Sensing within USDA

March 11, 2006

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(202) 720-1280

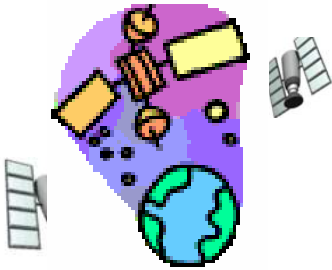




USDA Imagery

- ◄ Multi-Platforms
- ◄ Acquisitions 2005
 - ◄ Satellite
 - ◄ Aerial
- ◄ Plans for 2006

Satellites



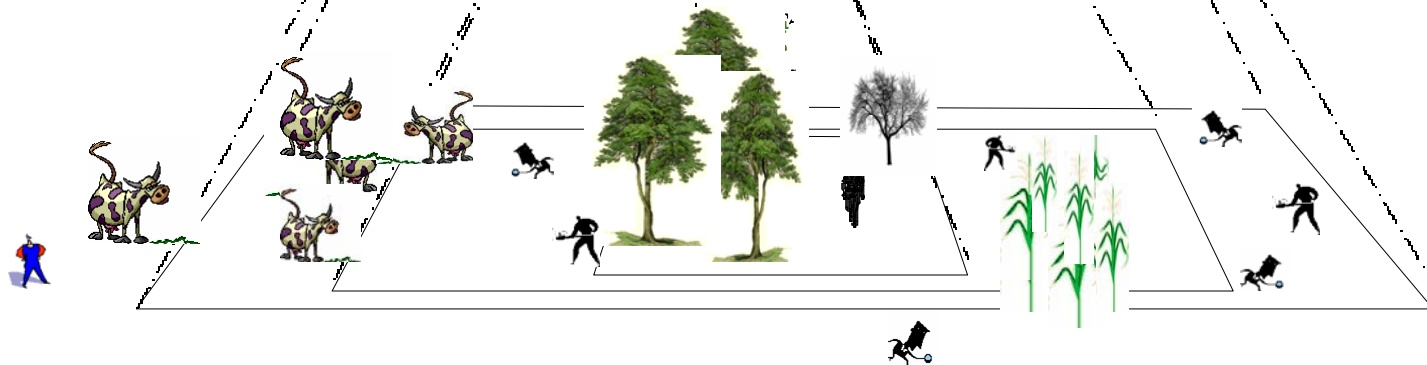
High Altitude Airborne



Low Altitude Airborne



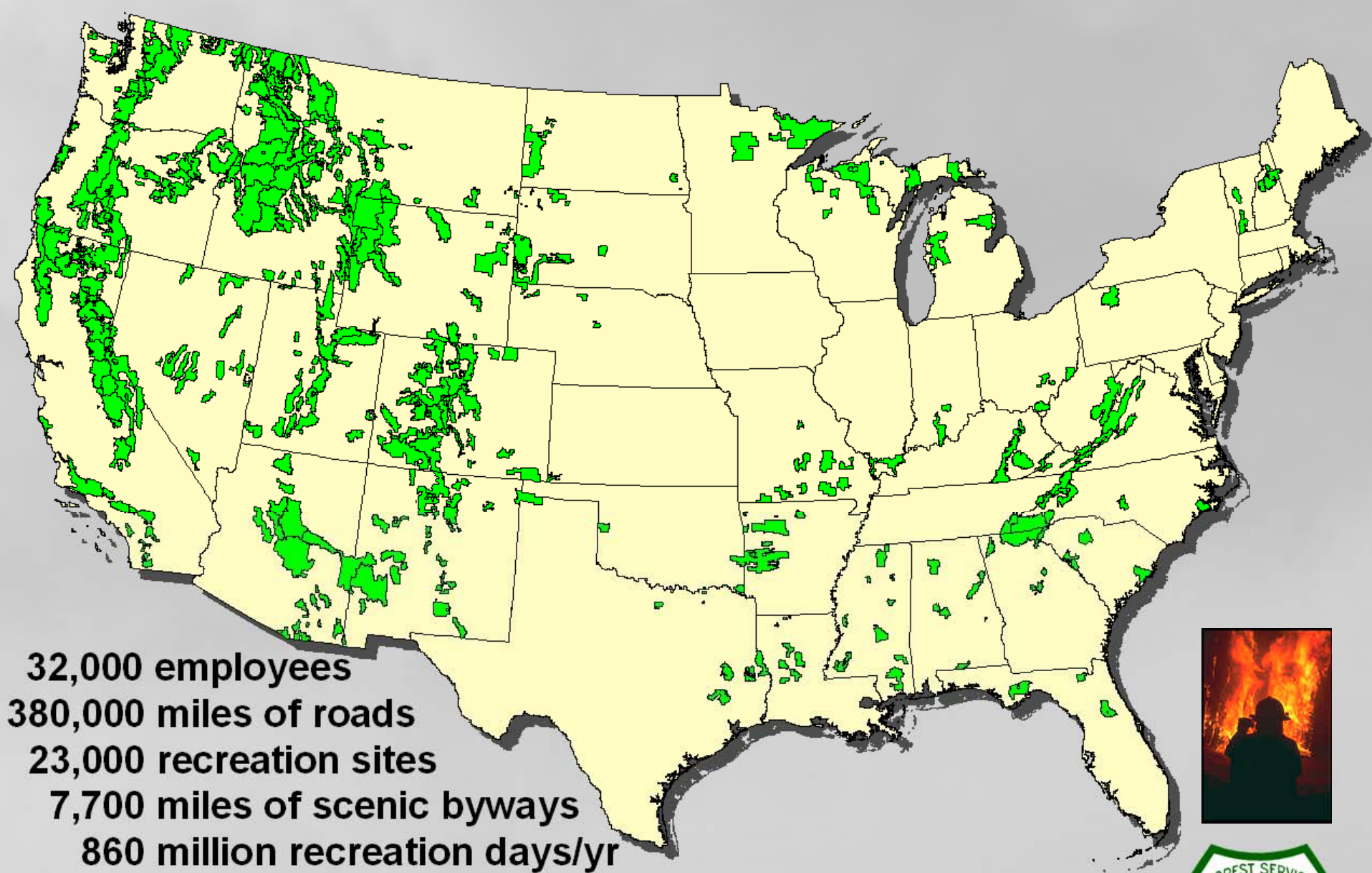
Boots on the Ground





Foreign Agricultural Service: Foreign Posts

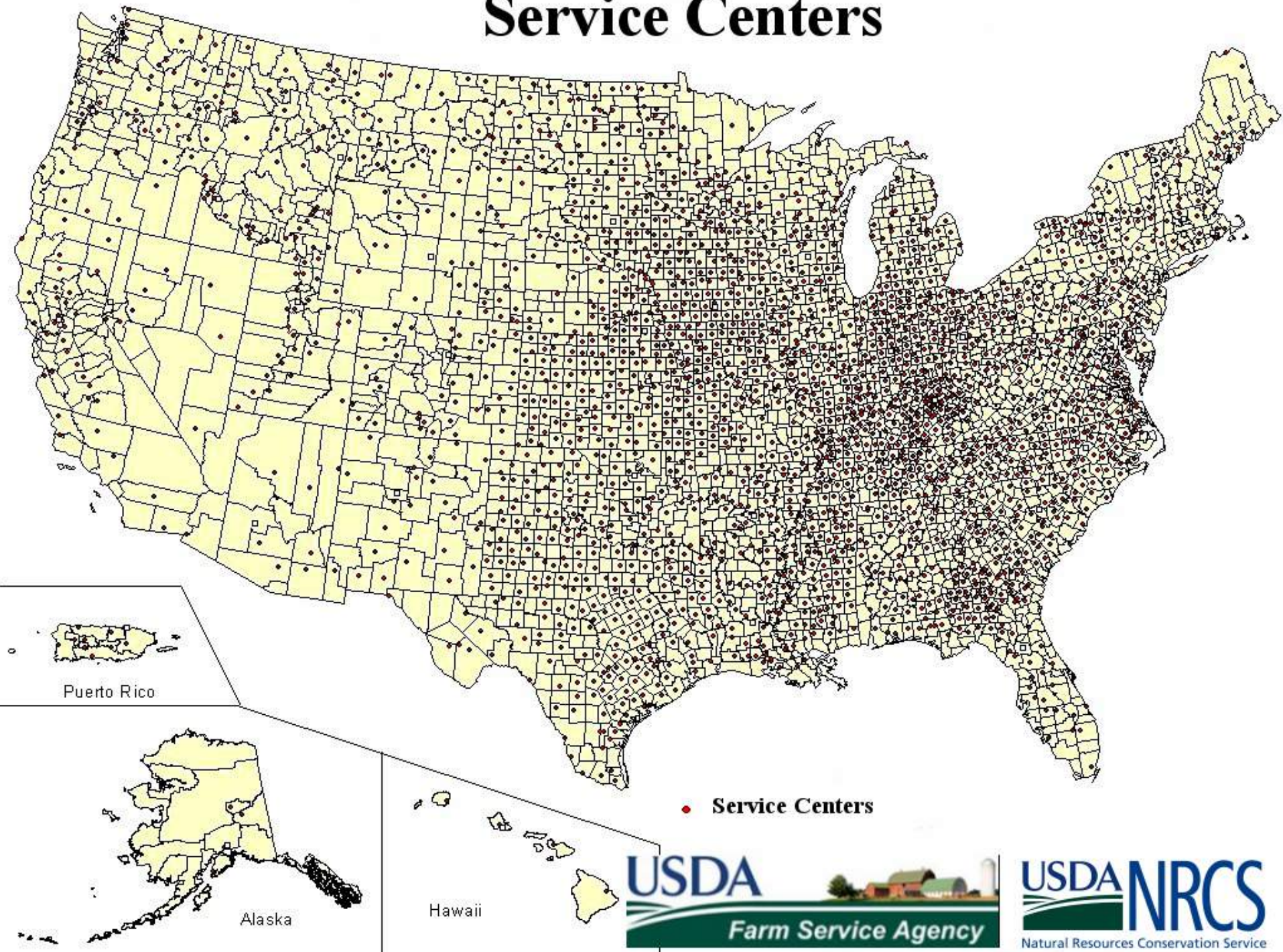




32,000 employees
380,000 miles of roads
23,000 recreation sites
7,700 miles of scenic byways
860 million recreation days/yr
3.4 billion board feet timber sales
4,400 miles of wild and scenic rivers
\$21 billion worth of hunting & fishing to U.S. economy



Service Centers



Puerto Rico

Alaska

Hawaii

• Service Centers



USDA Employees Create Information: Empowered With Imagery, GIS, GPS, and Digital Cameras



USDA Applications



- ✦ **Agricultural Competitiveness**
- ✦ **Agro-Terrorism**
- ✦ **Base Maps**
- ✦ **Carbon Syntheses**
- ✦ **Compliance**
- ✦ **Crop Area Monitoring**
- ✦ **Crop Condition Assessment**
- ✦ **Cropland Data Layer**
- ✦ **Disaster Monitoring**
- ✦ **Drought Monitoring**
- ✦ **Early Warning**
- ✦ **Environmental Monitoring**
- ✦ **Fire Suppression**
- ✦ **Homeland Security**
- ✦ **Inventory**
- ✦ **Invasive Species**
- ✦ **Land Use Conversion**
- ✦ **Yield Monitoring**



Remote Sensing Sources

Aerial photography

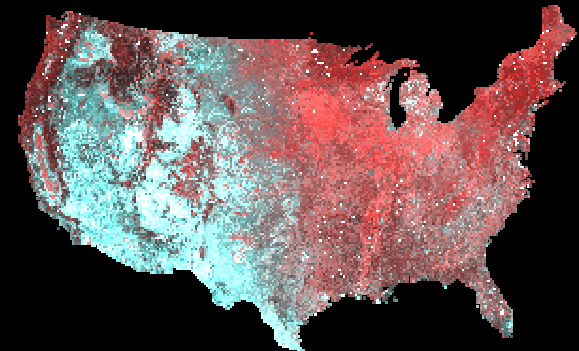
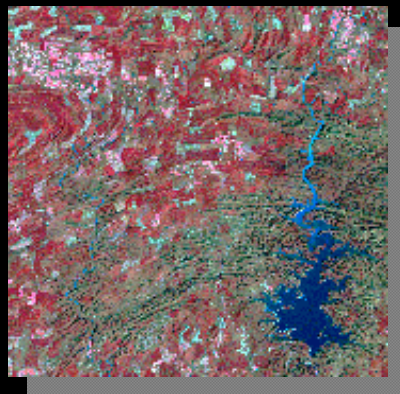
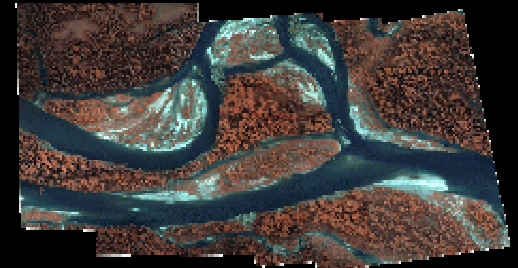
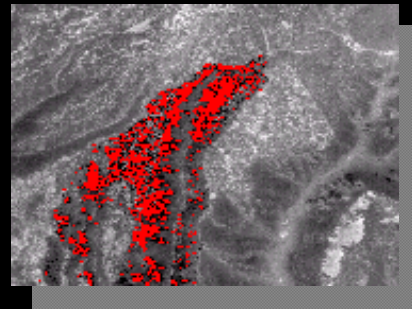
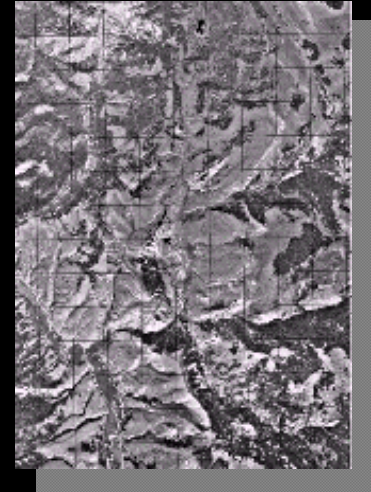
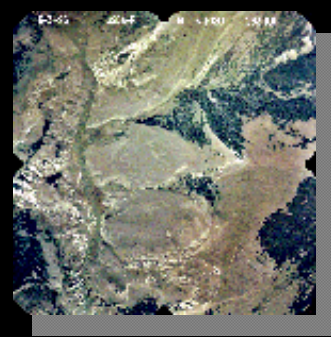
- Natural color, color infrared, B&W
- Scales from 1:2,000 to 1:60,000

Airborne digital





- Thermal infrared scanner
- Multispectral scanner
- Digital frame cameras
- Airborne video

Satellite

- IRS, AWIFS, LIS
- Landsat
- SPOT, SPOT Veg
- AVHRR, SeaWiFS
- MODIS
- IKONOS, QuickBird



Primary Imagery Users

- Foreign Agricultural Service (FAS) 
- Farm Service Agency (FSA) 
- Forest Service (FS) 
- Natural Resources Conservation Service (NRCS) 
- National Agricultural Statistics Service (NASS)
- Risk Management Agency (RMA)
- Agricultural Research Service (ARS)
- Animal and Plant Health Inspection Service (APHIS)

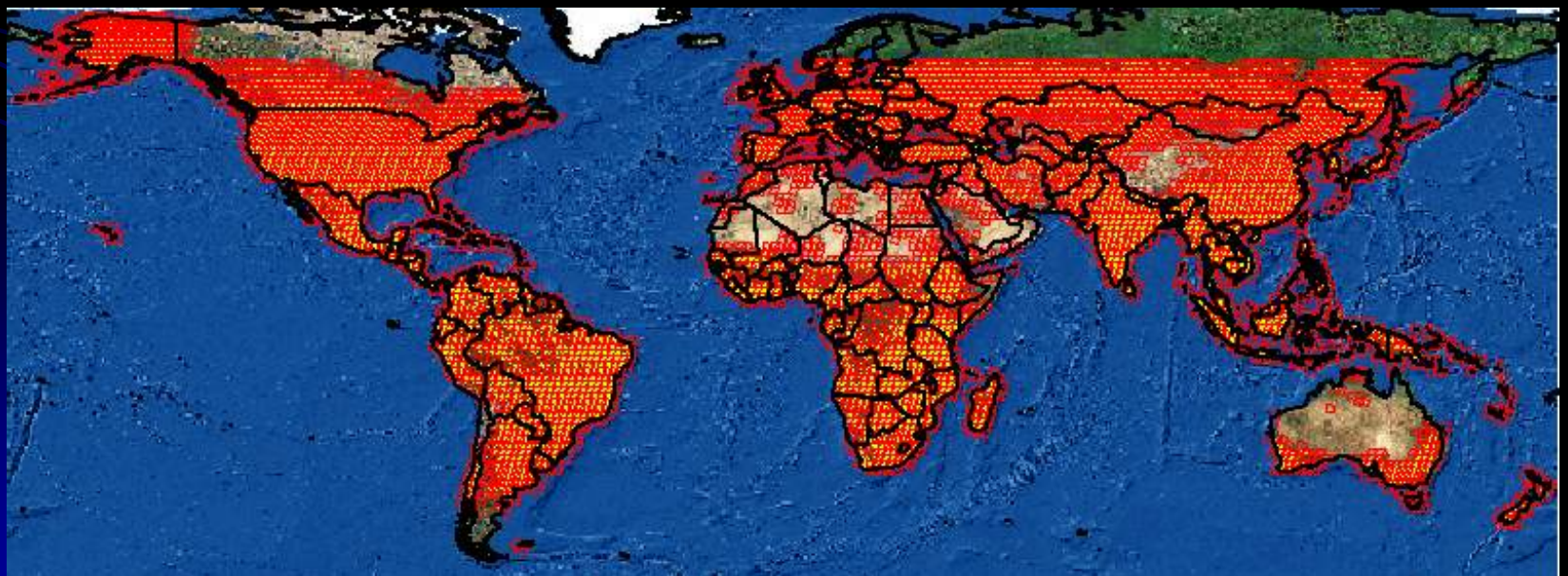
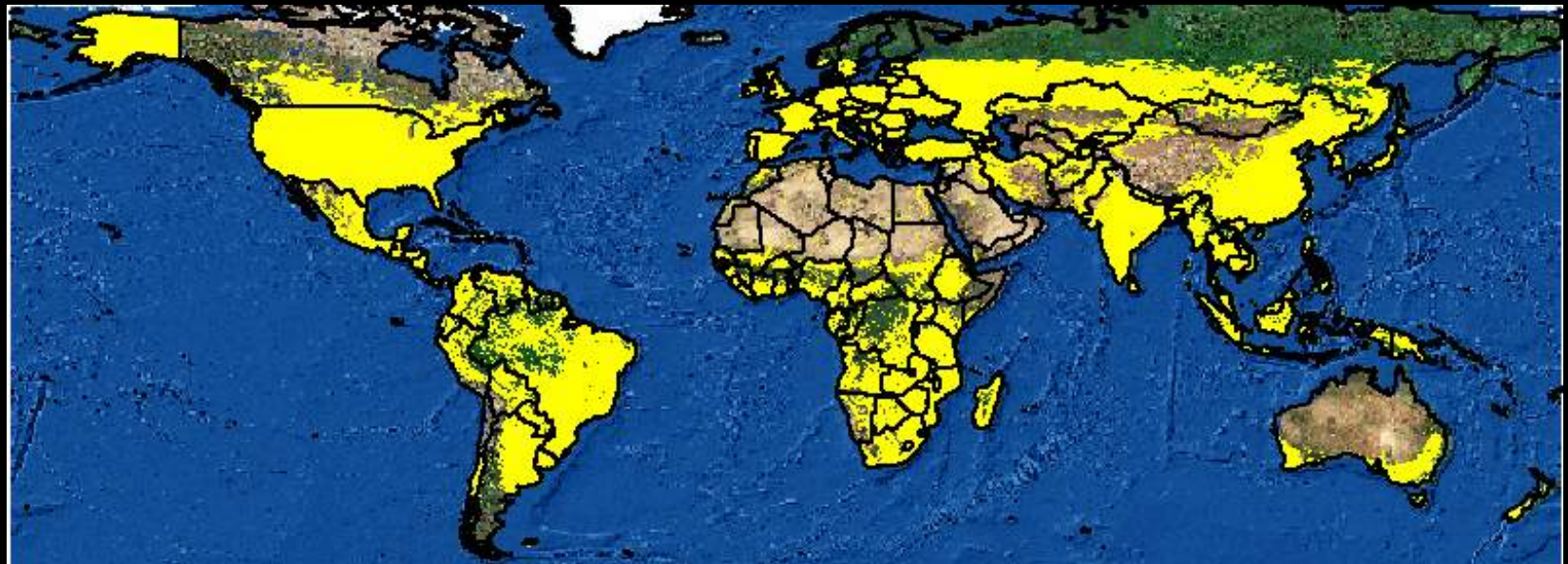


Acquires global imagery

Acquires US imagery (2 meters and less)



USDA Global Requirement



Satellites used by Foreign Agricultural Service

✦ **Geo-stationary satellites** monitor weather (rainfall & temperature) which is collected/processed by US Air Force Weather Agency (AFWA)

- ✦ **GOES** (North & South America)
- ✦ **METEOSAT** (Europe & Africa)
- ✦ **GMS** (Asia and Australia)

✦ **Polar-orbiting satellites** monitor *NDVI* & generate *false-color composites* for year-to-year comparisons

✦ Daily repeat cycle

- ✦ **NOAA-AVHRR** (1-km and 8-km resolution)
- ✦ **SPOT-VEG** (1-km resolution)
- ✦ **Terra/Aqua** Satellites (MODIS sensor with 250 meter resolution)
- ✦ **SSM/I** (Special Sensor Microwave Imager (SSM/I, 25-km) to monitor soil moisture)

✦ 16-day and 5-24-day repeat cycle

- ✦ **Landsat** (30-m)
- ✦ **AWiFS** (70-m) on IRS

✦ **Radar altimeter satellites** monitor lake water-level variations (10-day overpass)

- ✦ **TOPEX/Poseidon** (1992-2002) & Jason-1 (2002-present)



Updated every 10 days, Crop Explorer provides Time Series Maps, Graphs and Charts:

Weather, Soil Moisture, and Vegetation Condition over Major Crop Regions

File Edit View Favorites Tools Help Back Search

Address <http://www.pecad.fas.usda.gov/cropexplorer/>

USDA United States Department of Agriculture
Foreign Agricultural Service

Production Estimates and Crop Assessment Division

Crop Explorer

Home Help Contact Us

Explore by Region

Site Index

North America
United States
Canada

Central America
Mexico
Central America and Caribbean

South America
Brazil
Northern South America
Southern South America

Europe
Europe

Middle East
Iran, Iraq, Syria and Turkey

Oceania
Australia

Former Soviet Union
Kazakhstan
Russia, Azerbaijan, Armenia and Georgia
Ukraine, Moldova, and Belarus

Africa
North Africa
Southern Africa
East Africa
West Africa

Asia
Eastern China
South Asia
Southeast Asia
Central Asia
Korea

News & Events

- The FAS Crop Explorer: A Web Success Story
- New Orleans image from GLOVIS

Related Sites

- Agricultural Production
- PECAD
- Foreign Agricultural Service
- MODIS Image Gallery
- Global Reservoirs/Lakes
- Landsat GloVis

Metadata

- Live Data and Maps
- Geospatial One-Stop
- NASA Global Change
- GeographyNetwork

News and Updates

Global Durum Output Lower in 2005/06.
(Oct 27, 2005)
World durum output in 2005/06 is estimated at approximately 27 million tons, up 1.0 million tons from July's estimate, but down sharply from last year's record of 33 million tons. Major exporters, Canada, European Union (EU), and the United States combined, account for approximately 60 percent of total durum production. Their total output has decreased by nearly 20 percent this year, mostly due to smaller crops in the European Union. On September 30, the National Agricultural Statistics Service revised the United States durum production estimate upward to 2.7 million tons from their July estimate based on increased area. Yields are down in all States except North Dakota.

Europe: Autumn Update.
(Oct 26, 2005)
Weather during October has been largely beneficial for agriculture in Europe. It

Partnerships

NASA USGS FEWS NET

Satellite Information for Agricultural Monitoring

Maps and time-series charts for:

• Weather Data

- ➔ Dekadal (10-day) precipitation & temperatures compared to climate normals

• Soil Moisture & Crop Models

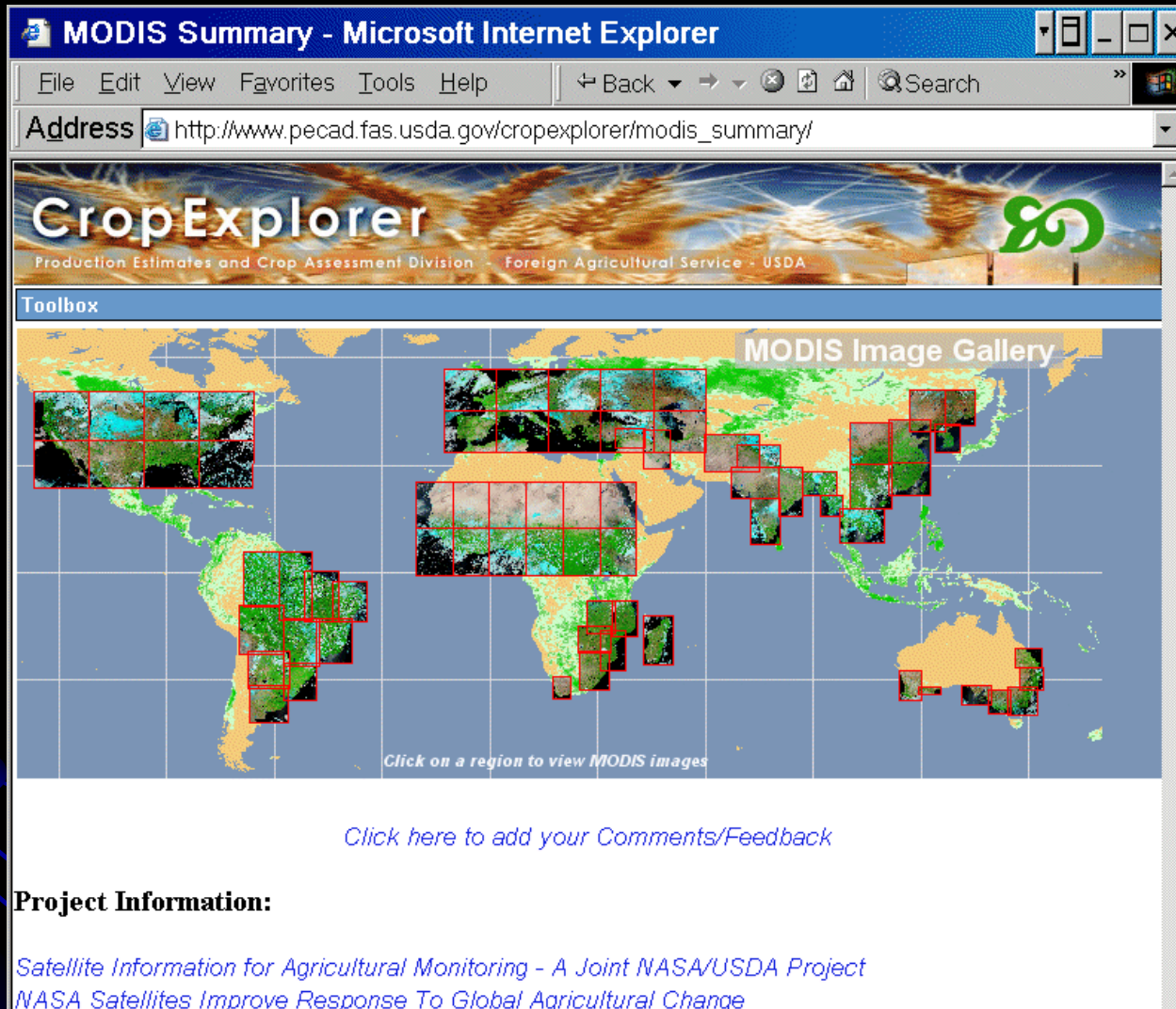
- ➔ Two-layer soil moisture
- ➔ **Behind firewall:** Crop calendars & alarm models for wheat, corn, & sorghum

• Vegetation Indices

- ➔ GAC (8-km) (behind firewall)
- ➔ SPOT-VEG (1-km)
- ➔ MODIS (250-m) for many regions.

<http://www.pecad.fas.usda.gov/cropexplorer>

Daily MODIS images (250-m) are Loaded as Twice per Day



The screenshot shows a Microsoft Internet Explorer browser window displaying the 'MODIS Summary' page. The address bar shows the URL: http://www.pecad.fas.usda.gov/cropexplorer/modis_summary/. The page header features the 'Crop Explorer' logo and the text 'Production Estimates and Crop Assessment Division - Foreign Agricultural Service - USDA'. Below the header is a 'Toolbox' section. The main content area is titled 'MODIS Image Gallery' and displays a world map with numerous red-bordered rectangular thumbnails representing MODIS satellite images of various regions. A text prompt at the bottom of the map reads 'Click on a region to view MODIS images'. Below the map is a link: 'Click here to add your Comments/Feedback'. At the bottom of the page, there is a 'Project Information' section with the text: 'Satellite Information for Agricultural Monitoring - A Joint NASA/USDA Project' and 'NASA Satellites Improve Response To Global Agricultural Change'. On the right side of the page, there are logos for the 'FOREIGN AGRICULTURAL SERVICE' and 'USDA', and the 'NASA' logo.

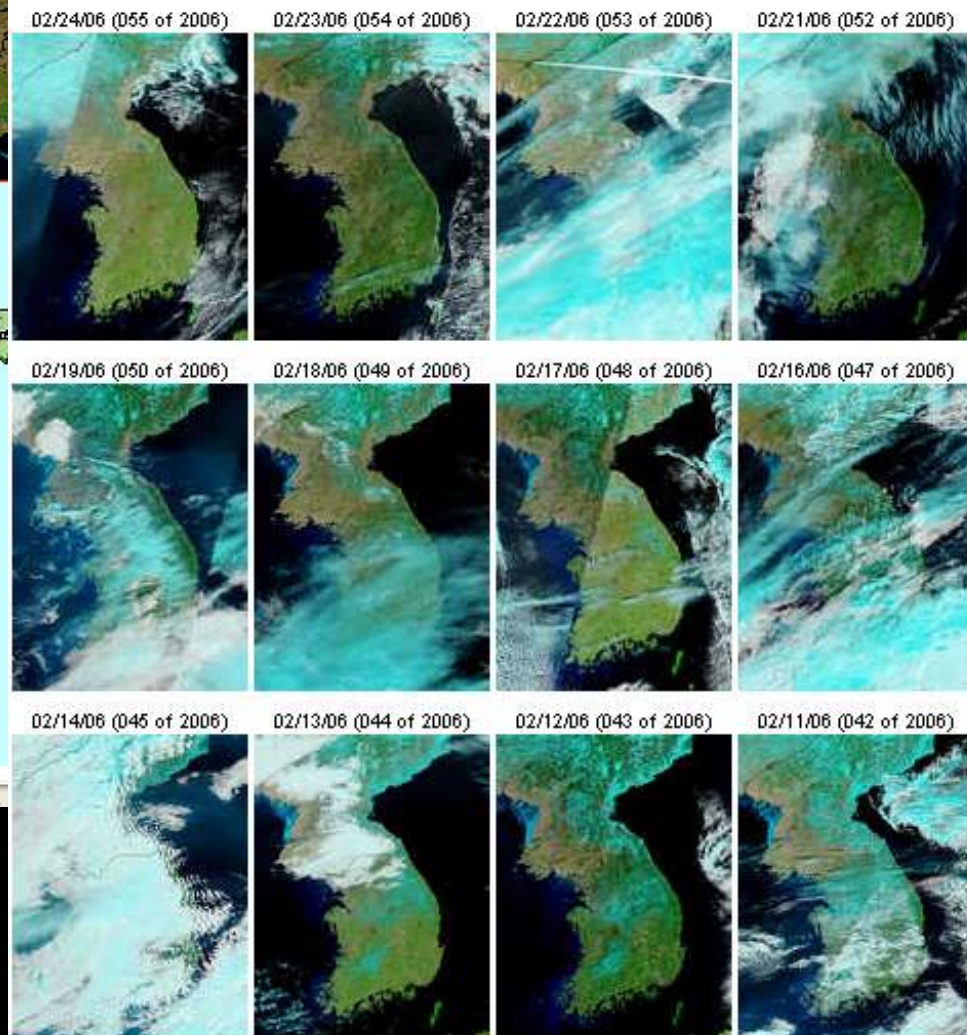
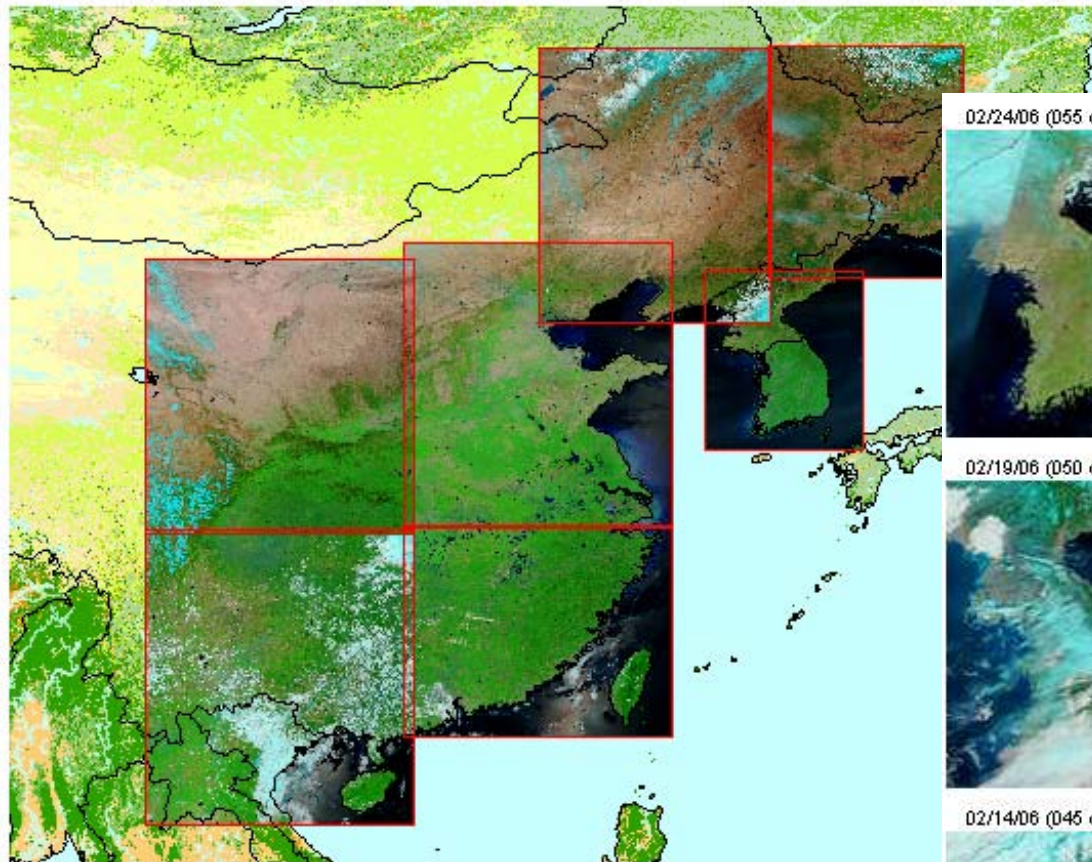
- ⬅ All images available in JPG 2000 and GeoTiff format for easy import into GIS
- ⬅ http://www.pecad.fas.usda.gov/cropexplorer/modis_summary/



Pick A Region, Browse and Download

Eastern China - MODIS Image Gallery

Click on a region to see MODIS images





[Terra \(AM\)](#)

Pixel size:
[250m](#) [500m](#) [1km](#)



[Aqua \(PM\)](#)

Pixel size:
[250m](#) [500m](#) [1km](#)

True Color



Terra (AM)

Pixel size:
[250m](#) | [500m](#) | [1km](#)



Aqua (PM)

Pixel size:
[250m](#) | [500m](#) | [1km](#)

NDVI Images



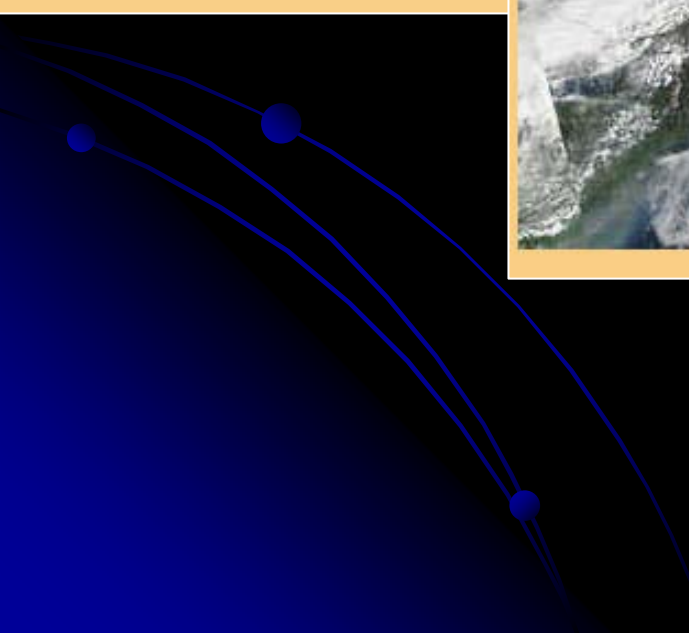
Terra NDVI

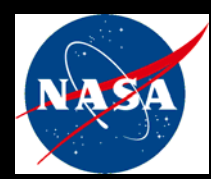
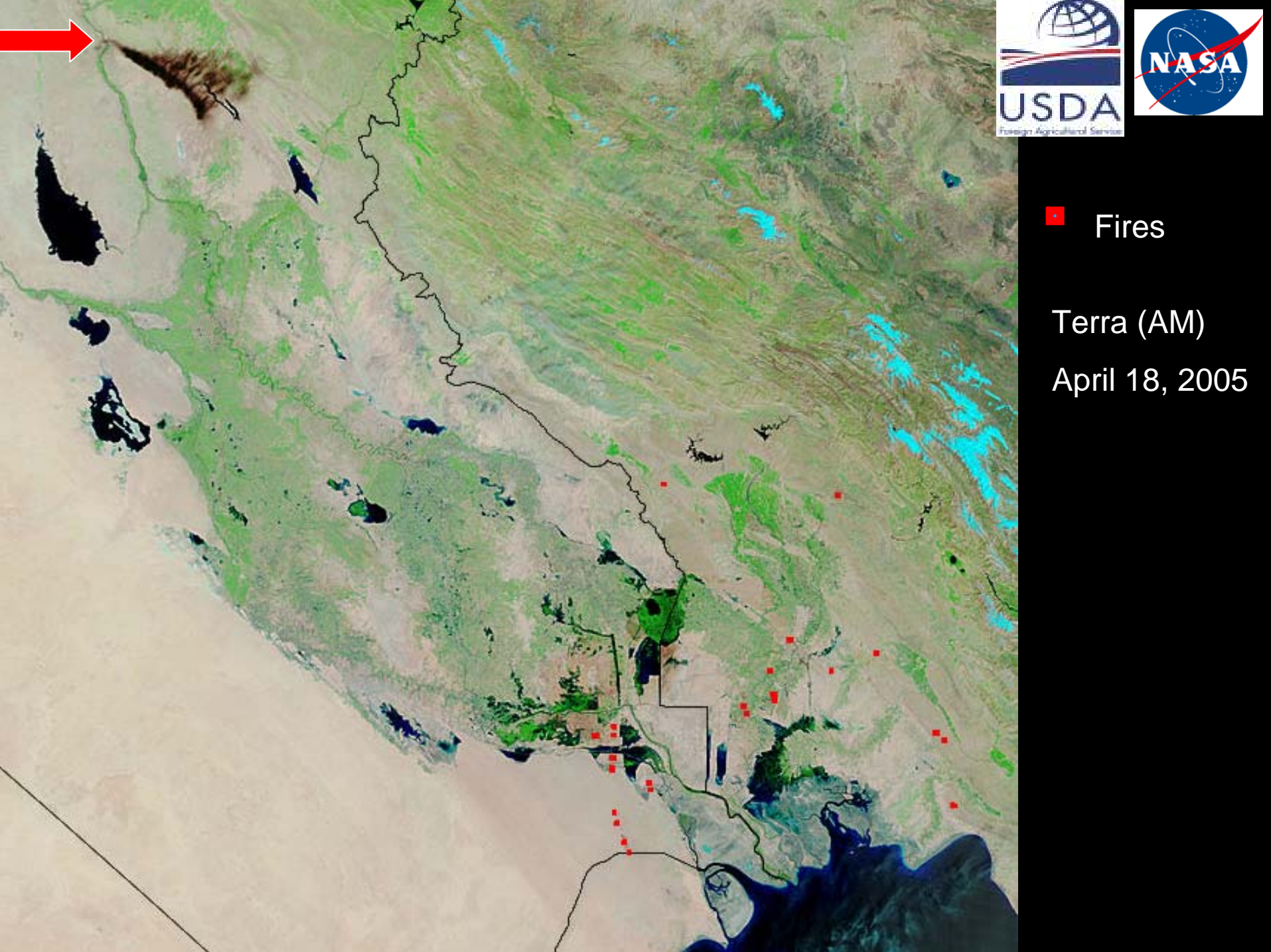
Pixel size:
[250m](#) | [500m](#) | [1km](#)



Aqua NDVI

Pixel size:
[250m](#) | [500m](#) | [1km](#)

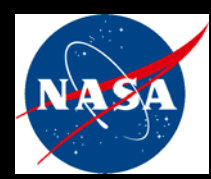
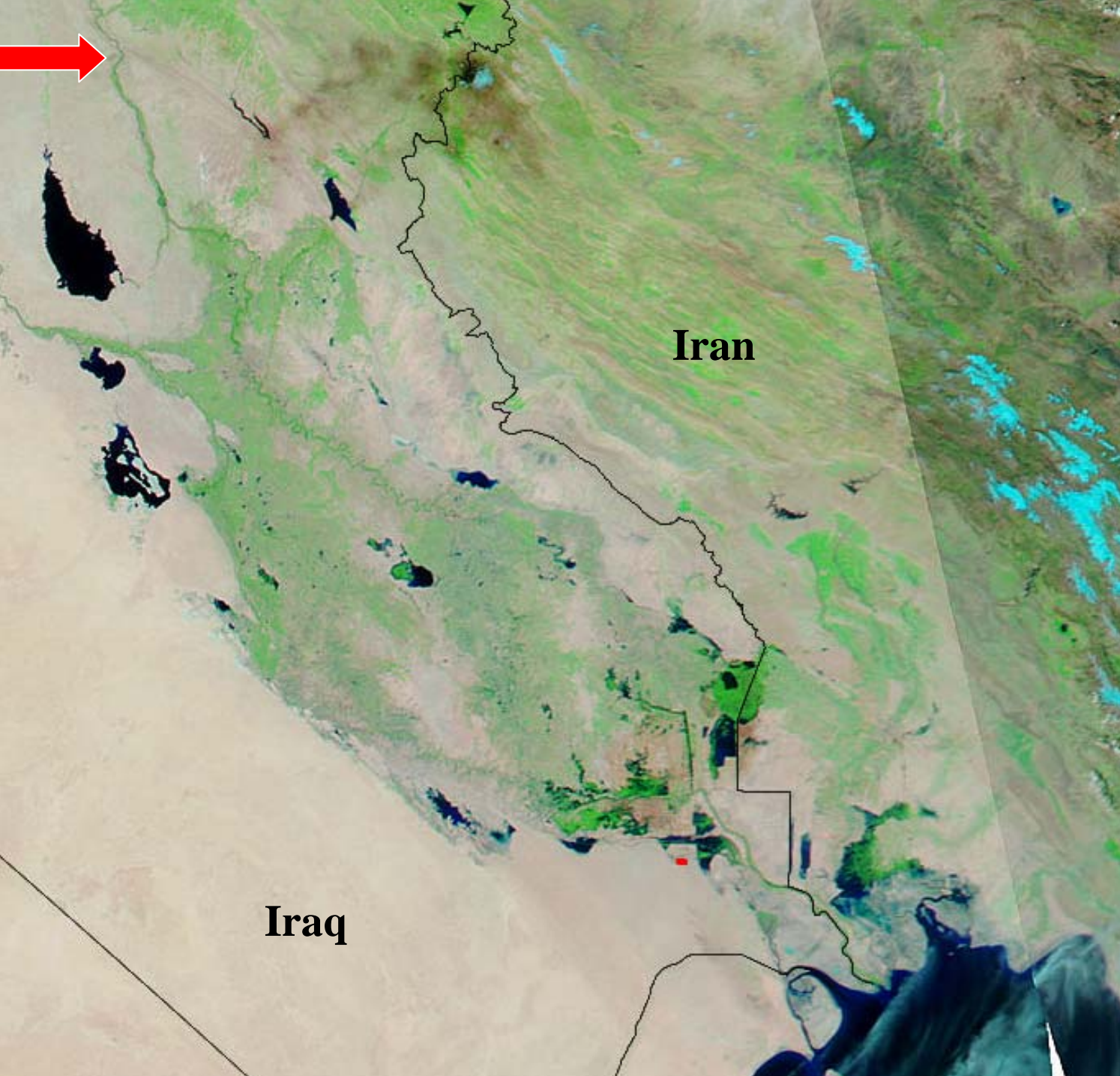




■ Fires

Terra (AM)

April 18, 2005



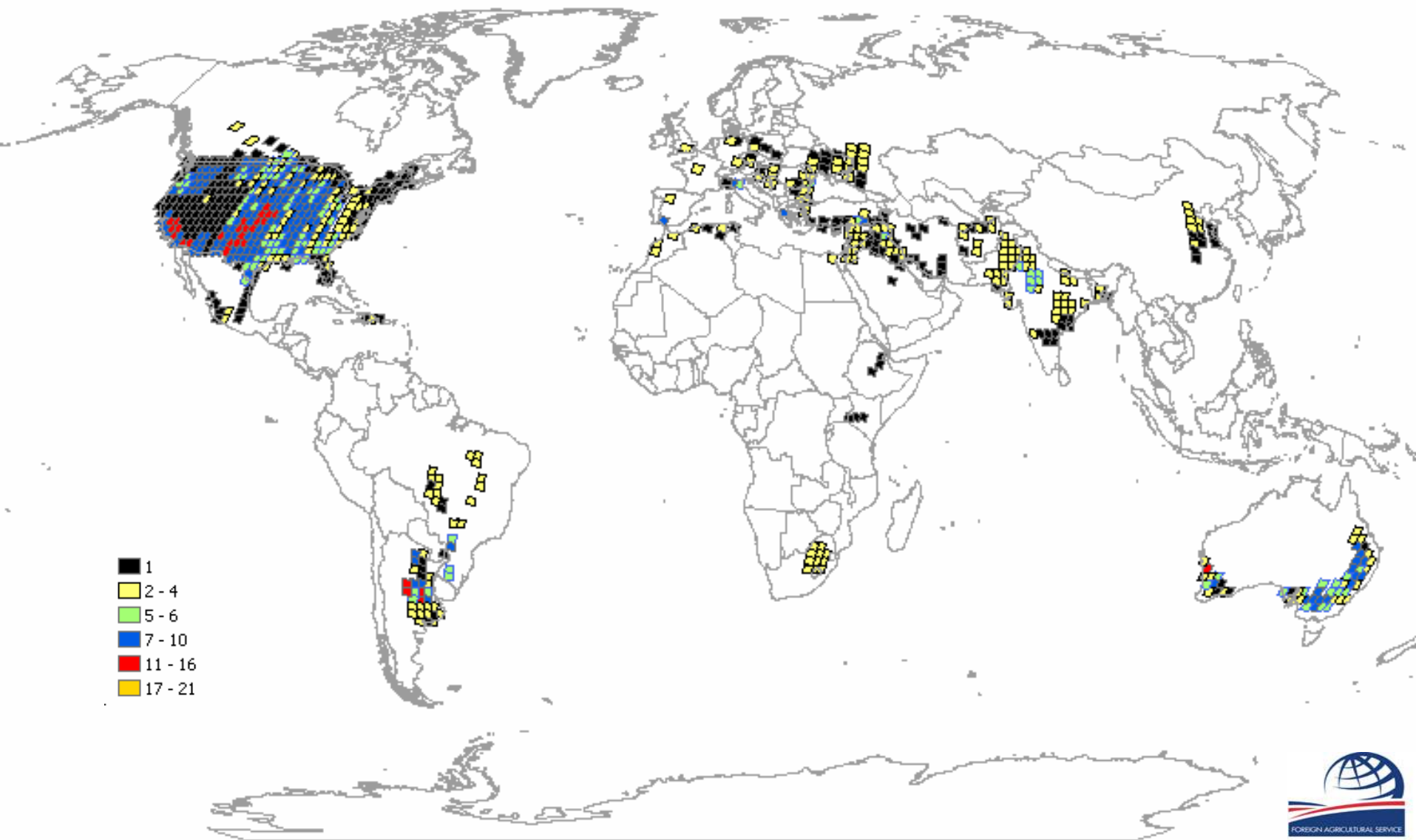
■ Fires

Aqua (PM)

April 18, 2005

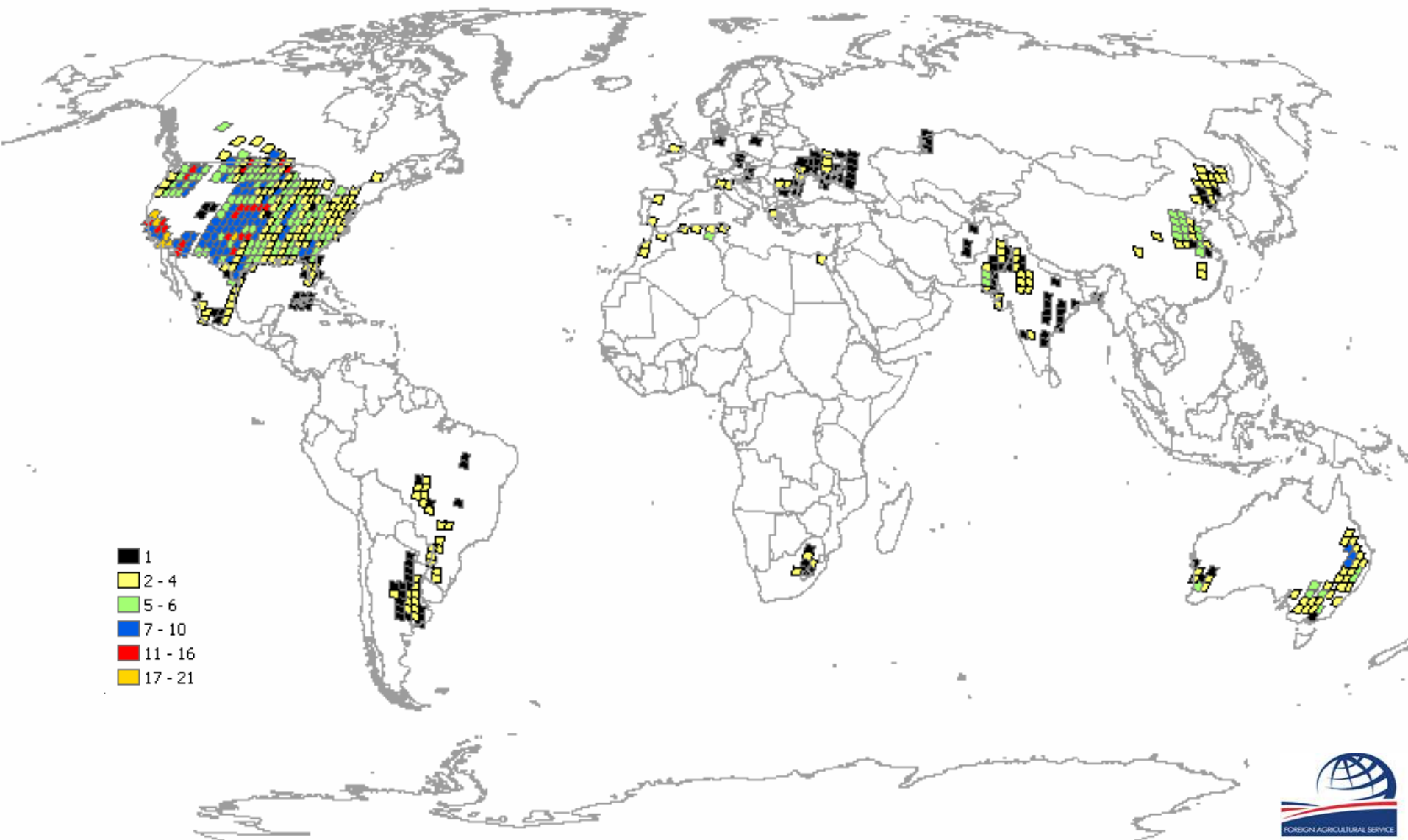


2003 Landsat Acquisitions



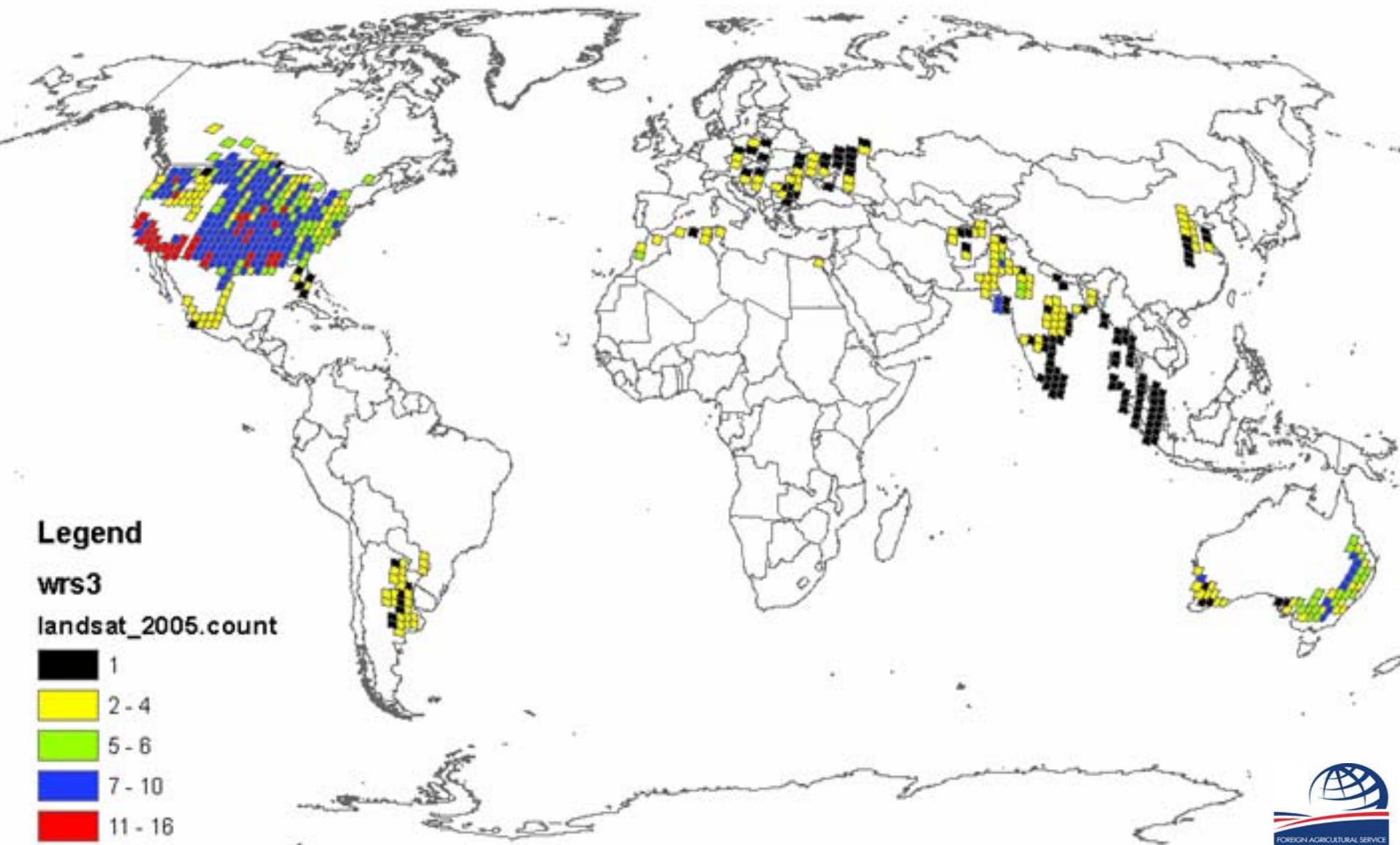


2004 Landsat Acquisitions





2005 Landsat Acquisitions





2006 Landsat? AWiFS? LIS? DMC?



2006 Acquisitions will include Commercial Satellite Imagery for Pacific Basin and Alaska



Maug



Pajaros



Medinilla



Satellite Acquisitions

**Foreign Agricultural Service (FAS) Provides
Contract Support Global Satellite Imagery and Services
Image Library**

- **Digital Globe**
- **Earthsat**
- **Eurimage**
- **MDA Geospatial Services-Radarsat International**
- **OrbImage**
- **Space Imaging**
- **SPOT**
- **USGS**



Aerial Acquisitions:

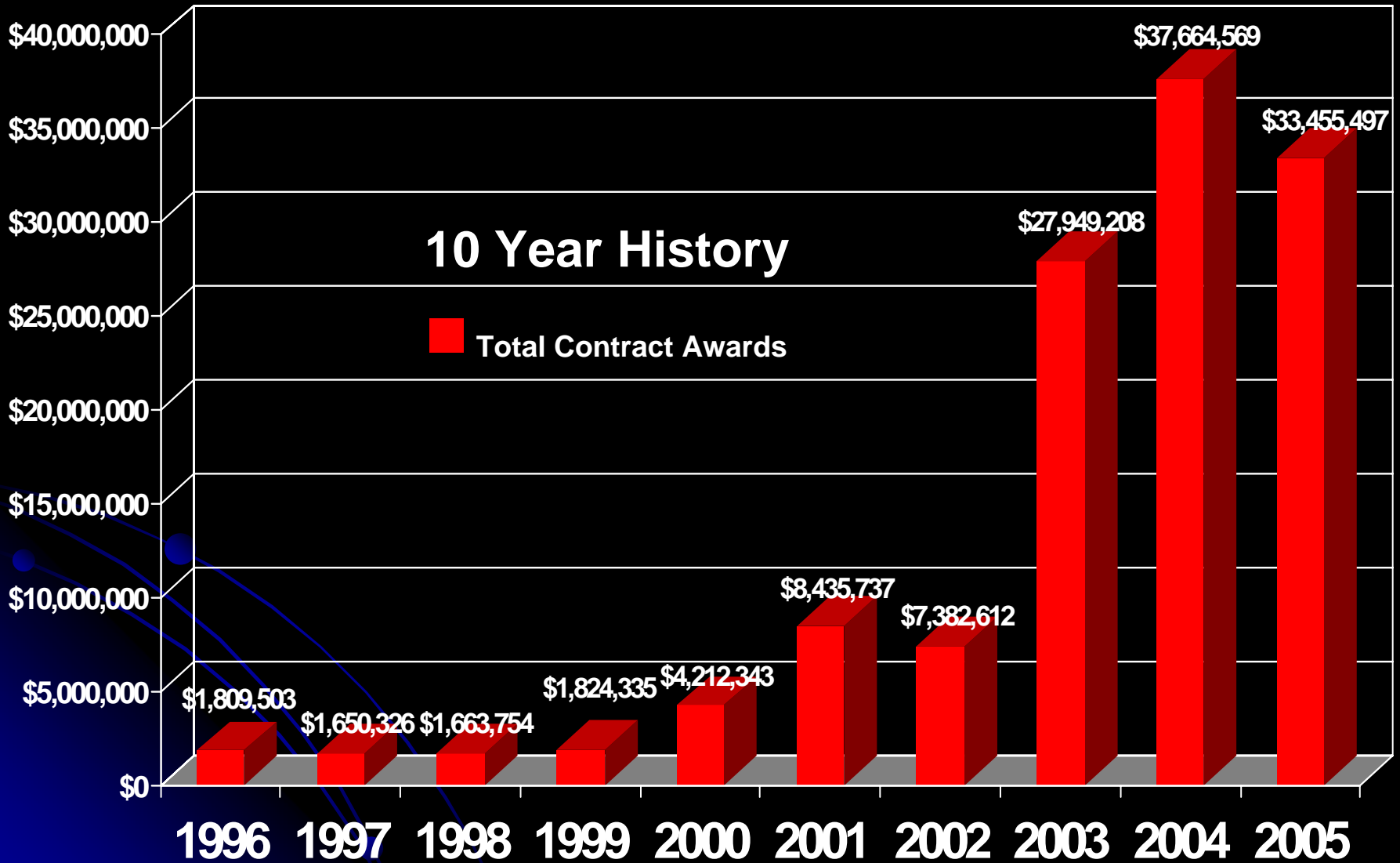
Farm Service Agency Provides Contract Support



- USDA Aerial Photography Field Office
 - Contracting of major USDA aerial needs
 - Centralized Photography/Image Library
 - Over 10 million exposures

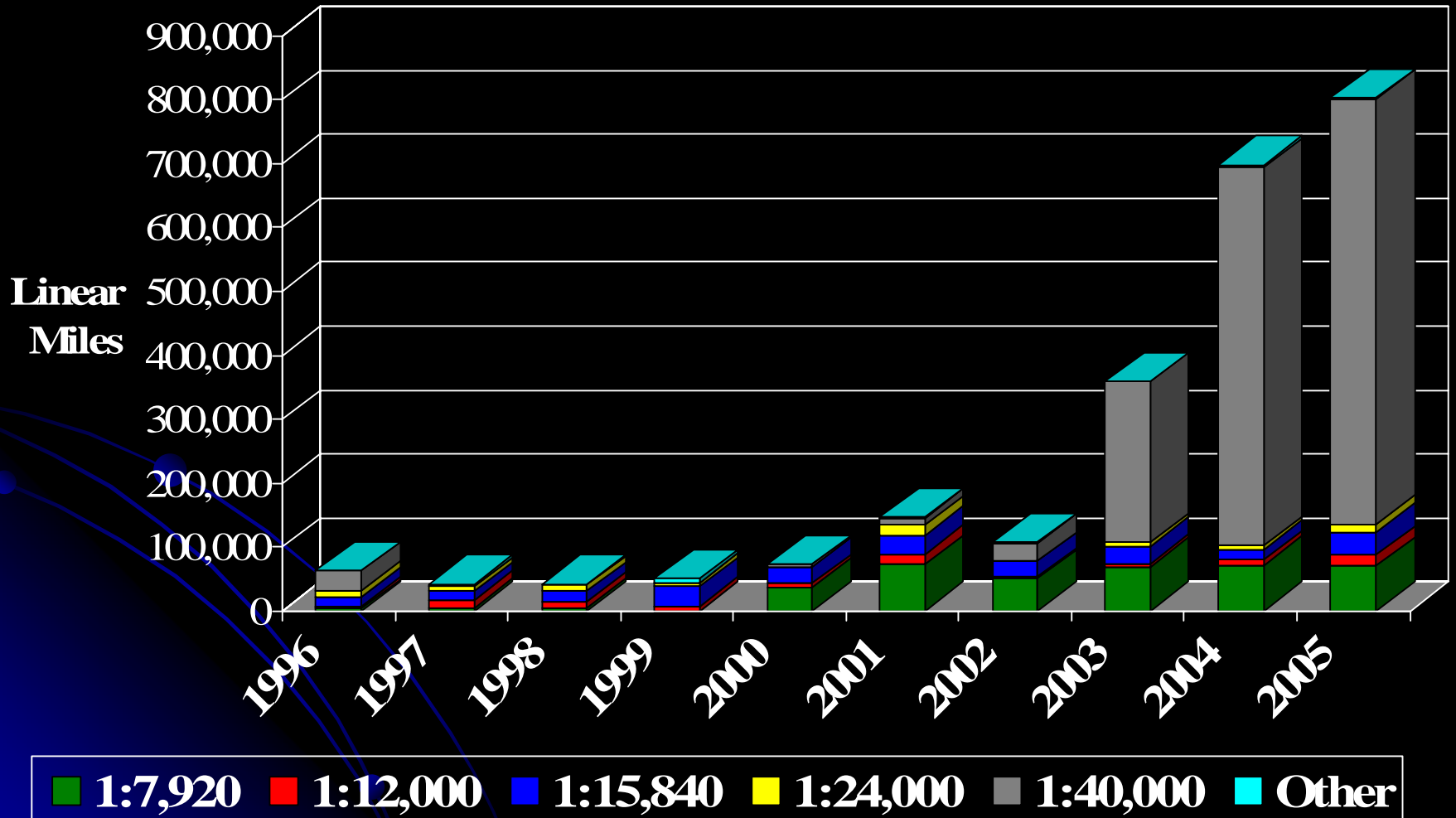


USDA Aerial Contract Awards



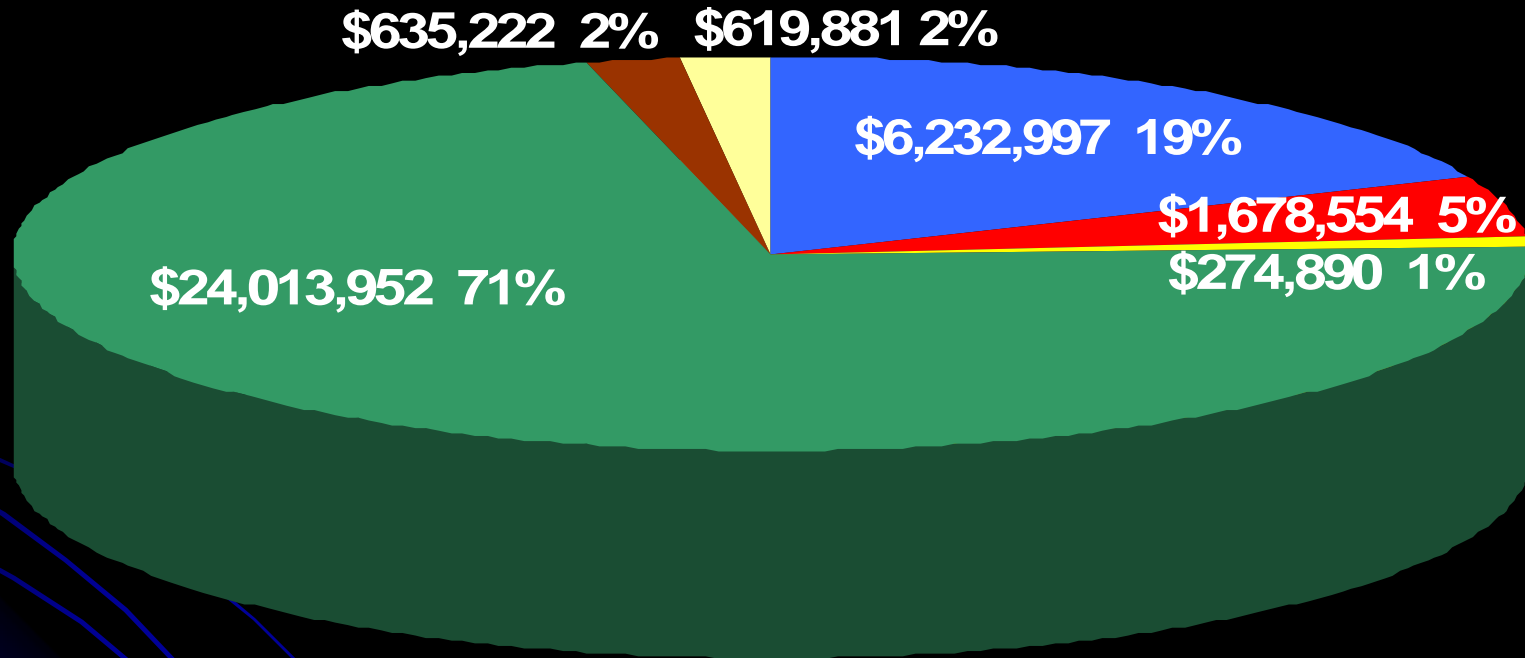
Linear Miles Contracted

According to Photographic Scale



USDA Contract Awards

FY 2005 CONTRACT AWARDS: \$33,455,497



■ Small Area Contract (NRI)

■ NRCSS Soil Survey

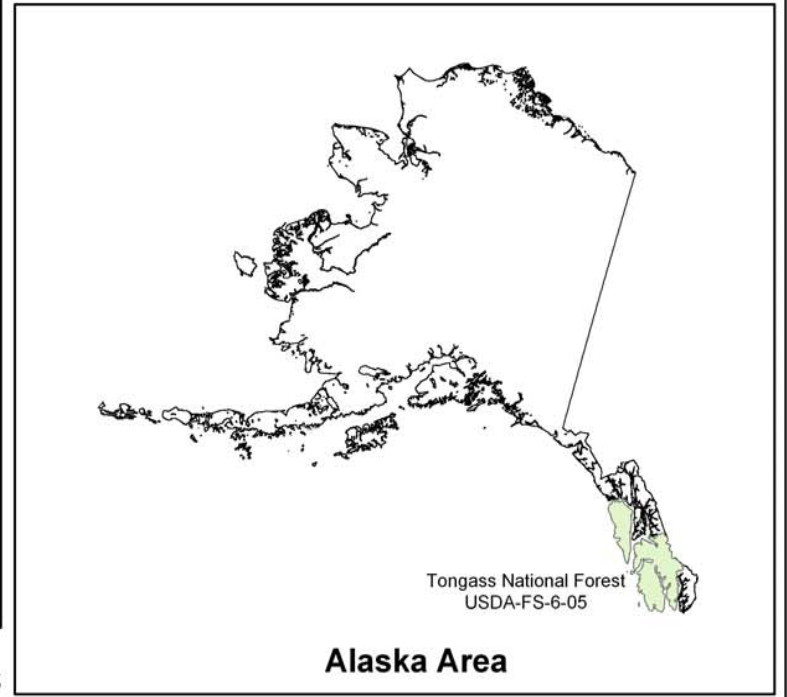
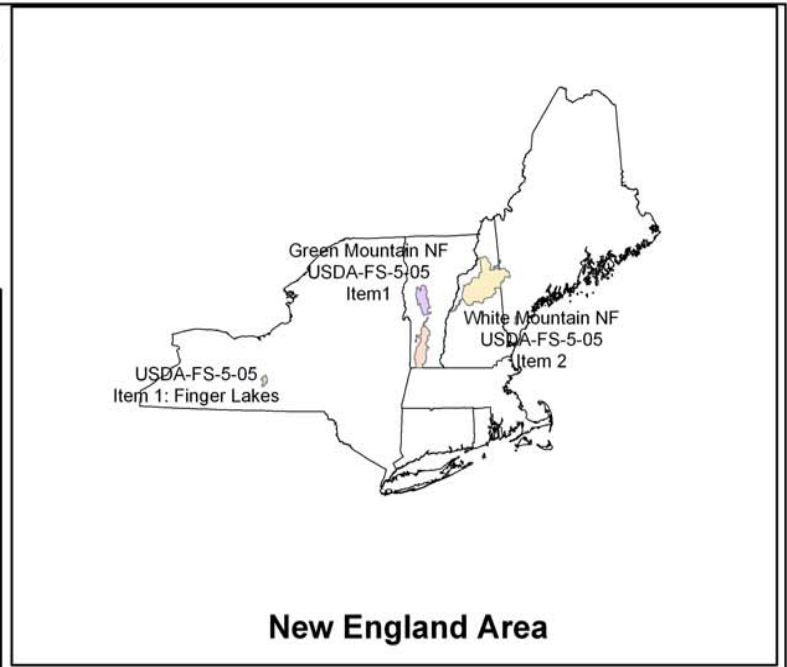
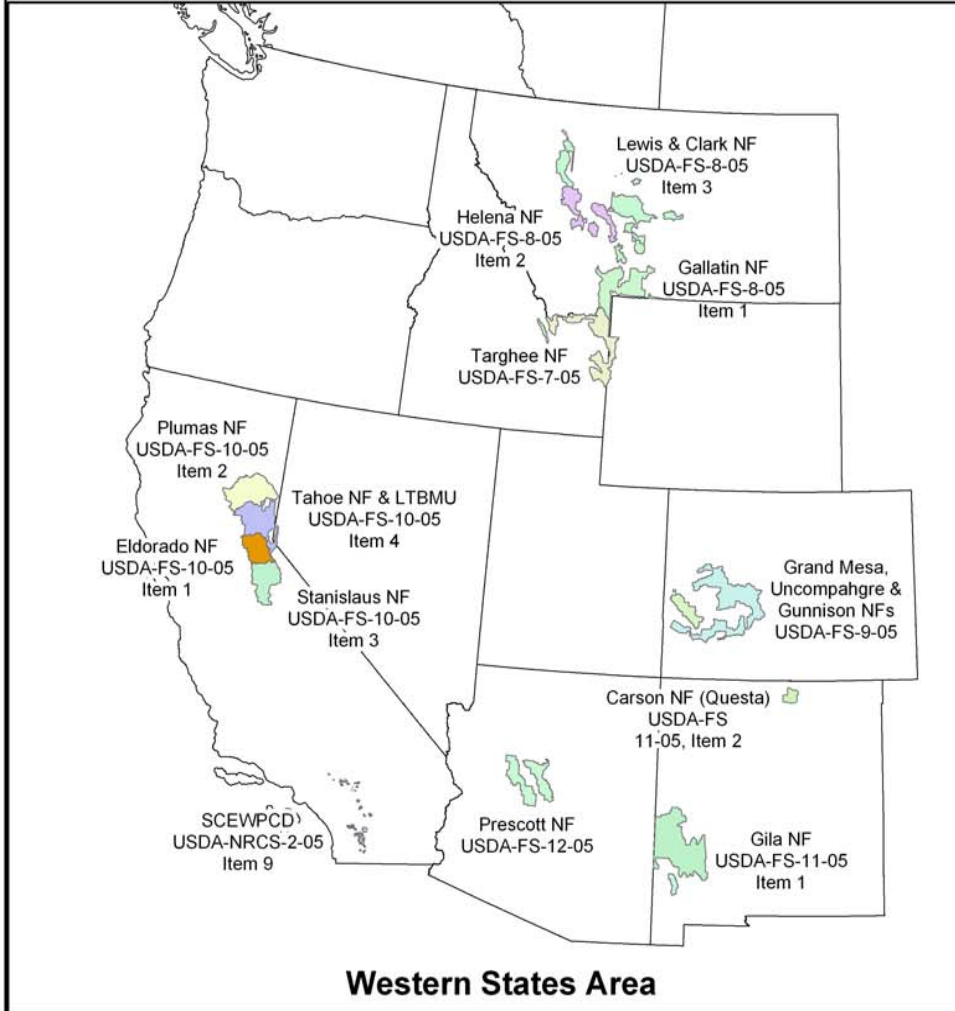
■ Non-Imagery Purchases

■ USFS & Other Resource

■ USDA NAIP IMAGERY ★

■ NRCSS NRI ALASKA

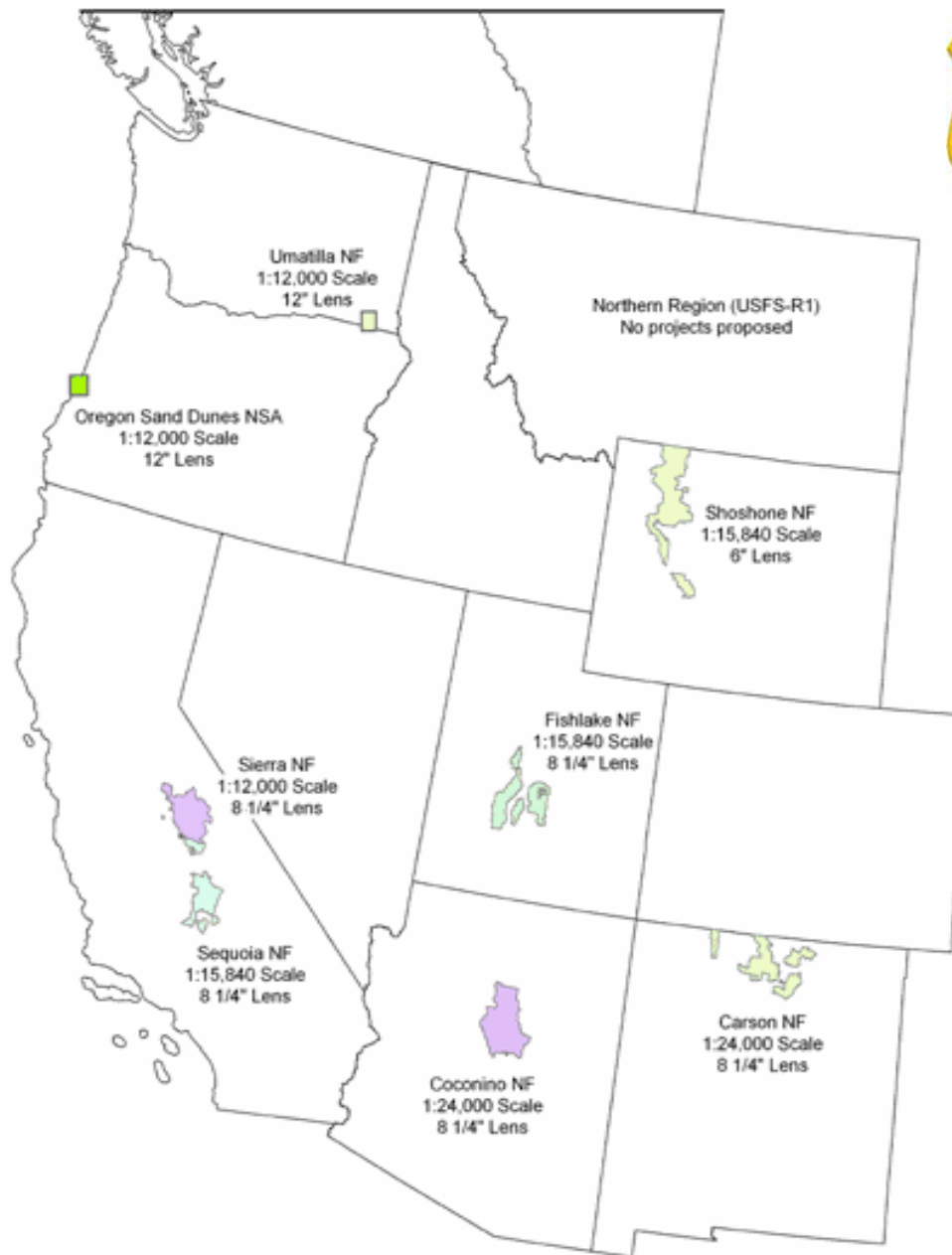
2005 RESOURCE AERIAL PHOTOGRAPHY PROJECTS





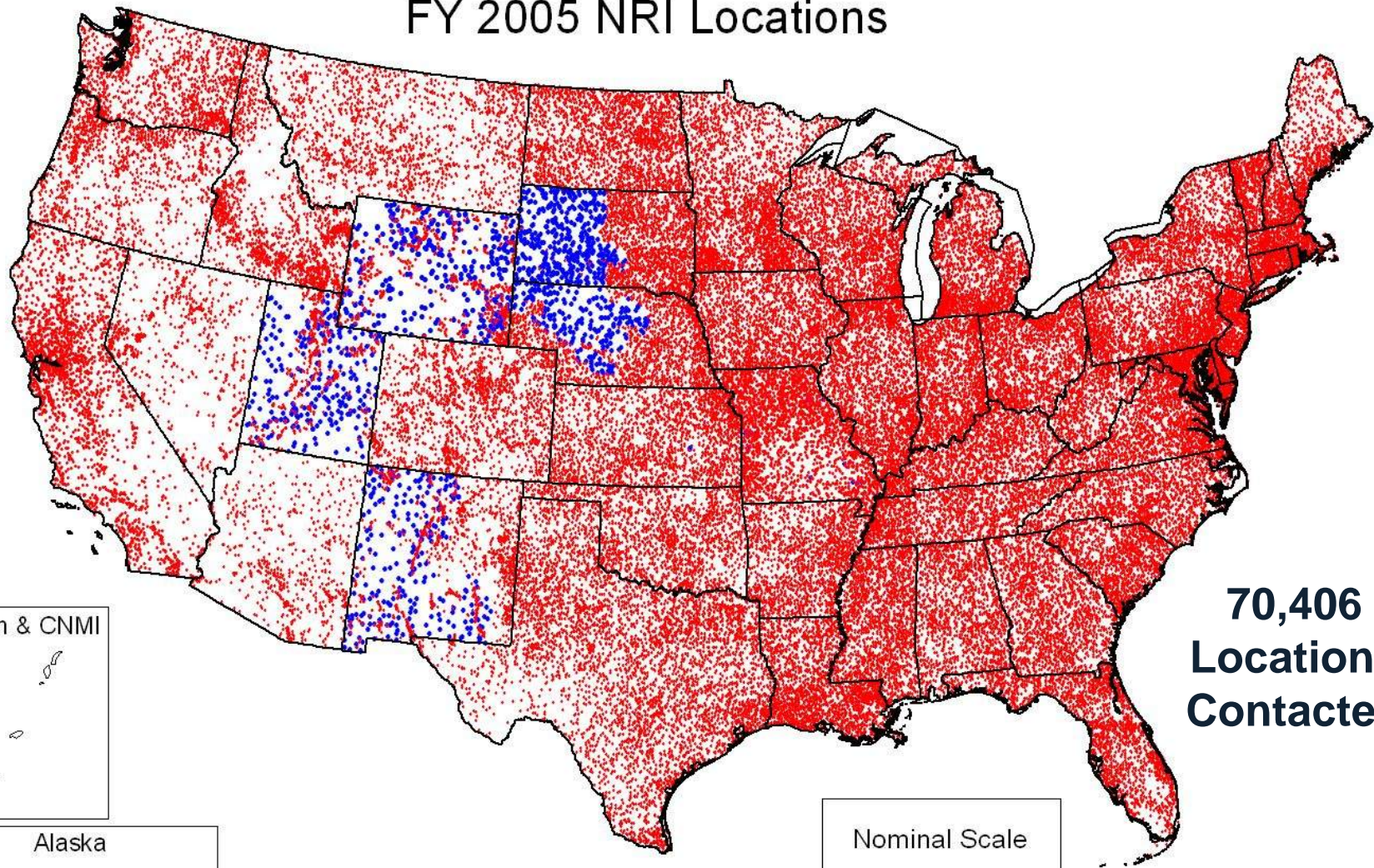
Scale	Projects
1:12,000	3
1:15,840	4
1:24,000	2
1:40:000	1

PROPOSED 2006 RESOURCE AERIAL PHOTOGRAPHY PROJECTS

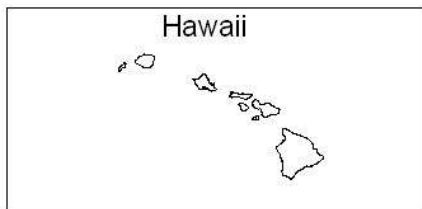
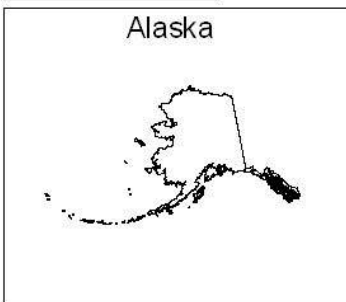
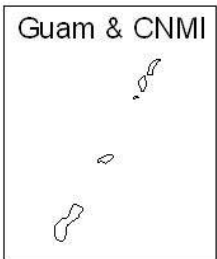


Western States Area

FY 2005 NRI Locations



**70,406
Locations
Contacted**



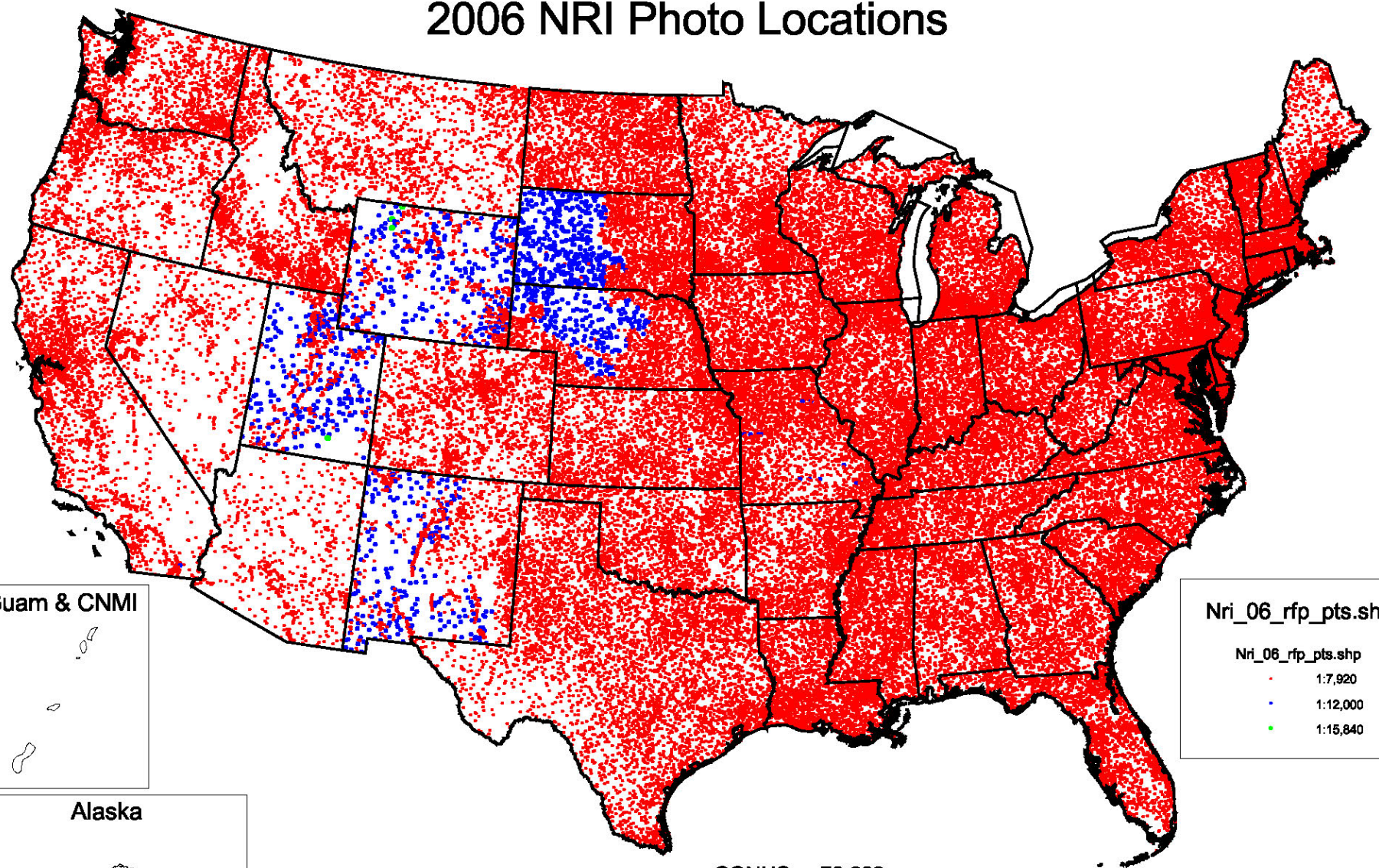
Nominal Scale

Wy_rfp_2005.shp

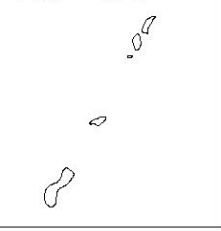
- 1:7,920
- 1:12,000
- 1:15,840



2006 NRI Photo Locations



Guam & CNMI



Alaska



Hawaii



Nri_06_rfp_pts.shp


•	1:7,920
•	1:12,000
•	1:15,840

CONUS = 70,689
Hawaii = 375
Puerto Rico = 450
Total = 71,514

PR & USVI

Base Photo Periods

St_nsew.shp

	Mar 15 - May 31
	Apr 15 - Jun 15
	May 1 - Jul 31
	May 15 - Jul 15
	May 15 - Jul 31
	May 15 - Aug 15
	May 15 - Sep 30
	Jun 1 - Jun 30
	Jun 1 - Jul 15
	Jun 1 - Jul 31
	Jun 1 - Aug 15
	Jun 1 - Sep 30
	Jun 15 - Jul 15
	Jun 15 - Jul 31
	Jun 15 - Aug 15
	Jun 15 - Sep 30
	Jul 1 - Jul 31
	Jul 1 - Aug 15
	Jul 1 - Aug 31
	Jul 1 - Sep 30
	Jul 15 - Aug 15
	Jul 15 - Sep 15
	Aug 1 - Aug 31
	Aug 1 - Sep 30
	Aug 15 - Sep 15

9" x 9" NRI Aerial Photograph



Washington Coast

FILM

$$7,920 / (125 \text{ lp/mm} \times 1000 \text{ mm/m}) = \text{GRD}$$

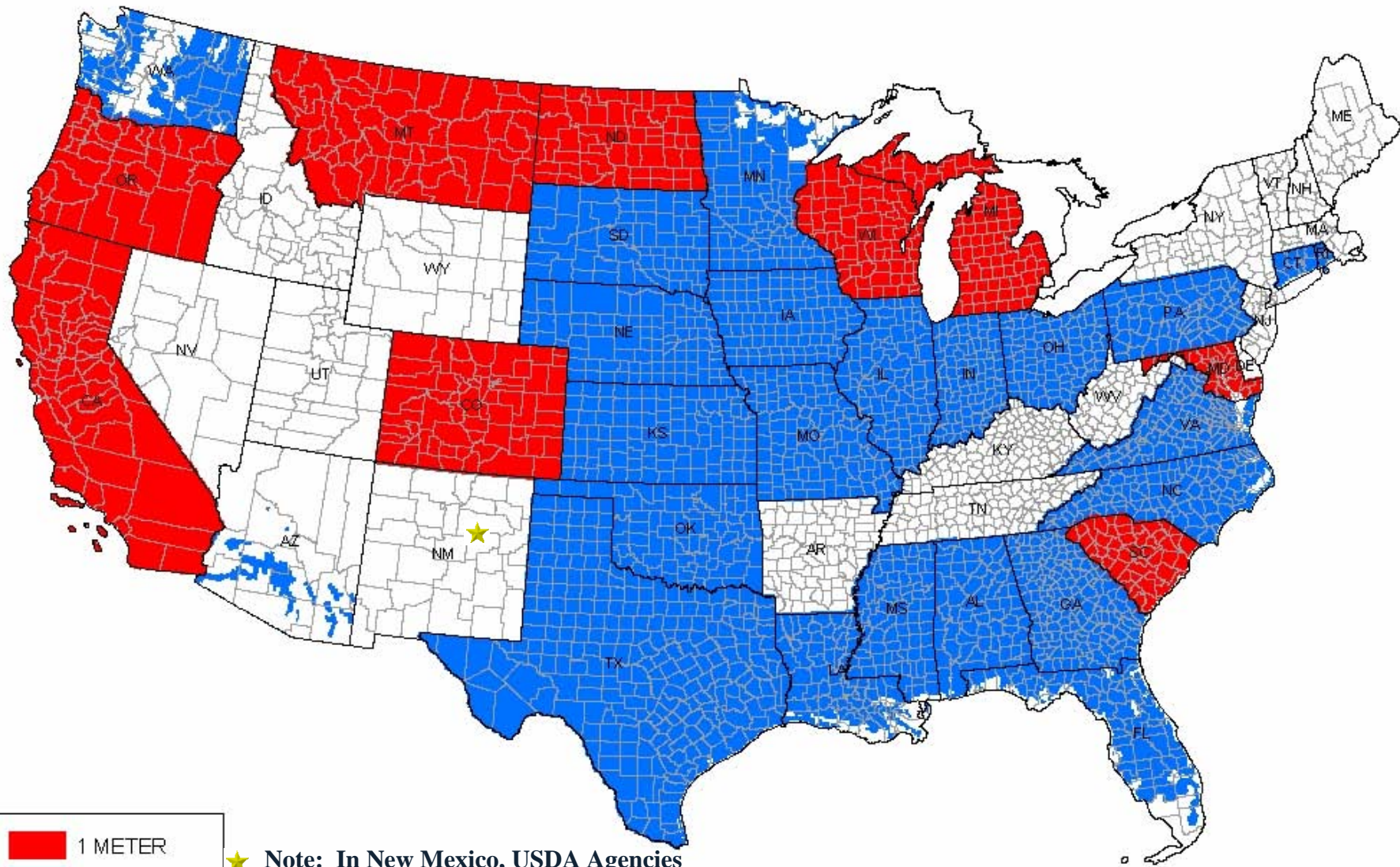
$$0.063 \text{ m or } 0.206 \text{ ft or } 2.5 \text{ in} = \text{GRD}$$




SCAN

$$7,920 / (600 \text{ dpi} / 12'') = \text{GSD}$$

$$1.1 \text{ ft} = \text{GSD}$$

2005 NAIP



	1 METER
	2 METER
	NOT FLOWN

★ **Note: In New Mexico, USDA Agencies cost-shared with State run Acquisition for NAIP-like products.**



2005 NAIP Funding Sources



• Natural Resources Conservation Service	\$2,800,000
• U.S. Forest Service	\$840,738
• U.S. Geological Survey	\$666,000
• U.S. Air Force Space Command	\$202,400
• U.S. Department of Interior Agencies	\$160,600
• State/County Government Agencies	<u>\$1,702,268</u>
Total 2005 Cost Shares:	\$6,372,006

• Farm Service Agency	<u>\$17,423,348</u>
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2005 NAIP Funding Total: \$23,795,354



State/County Government Partnerships for 2005 NAIP



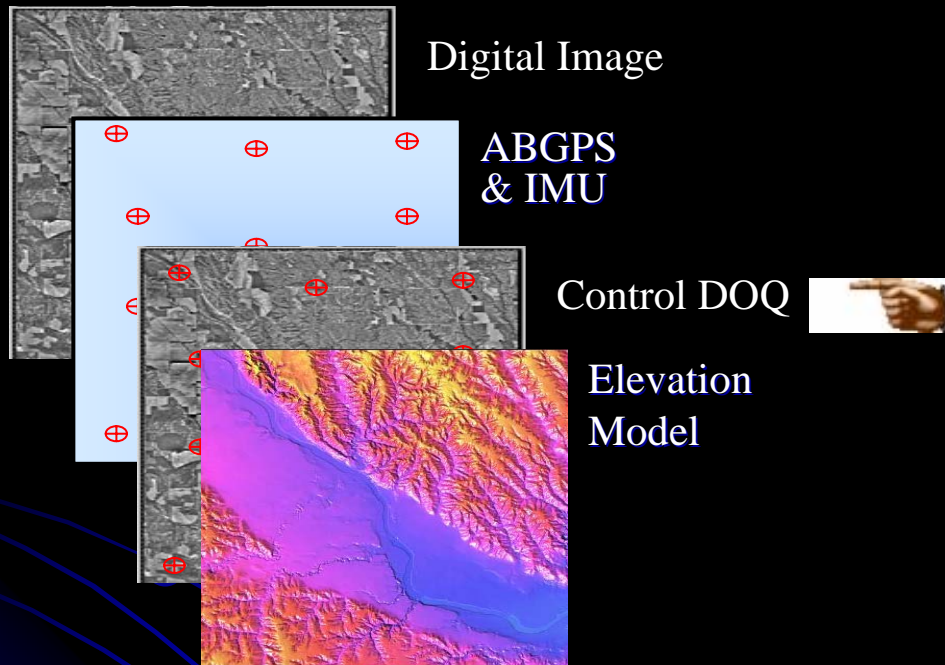
MICHIGAN STATE
UNIVERSITY



11 Wisconsin Counties

Average Costs 2004 and 2005

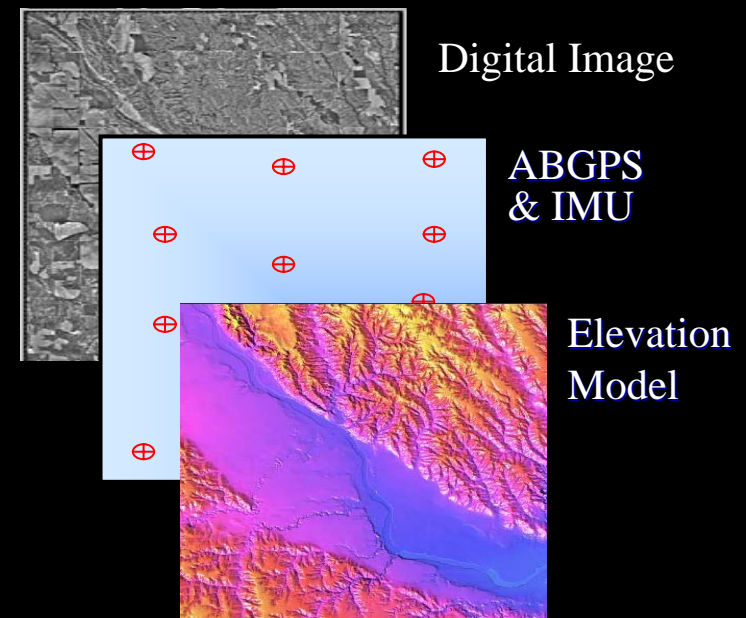
1m Ortho Rectified



'05 Actual Avg. Price Awarded
\$171.85 per DOQQ

'04 Actual Avg. Price Awarded
\$12.58 per Sq. Mi.
\$177.17 per DOQQ

2m Ortho Rectified



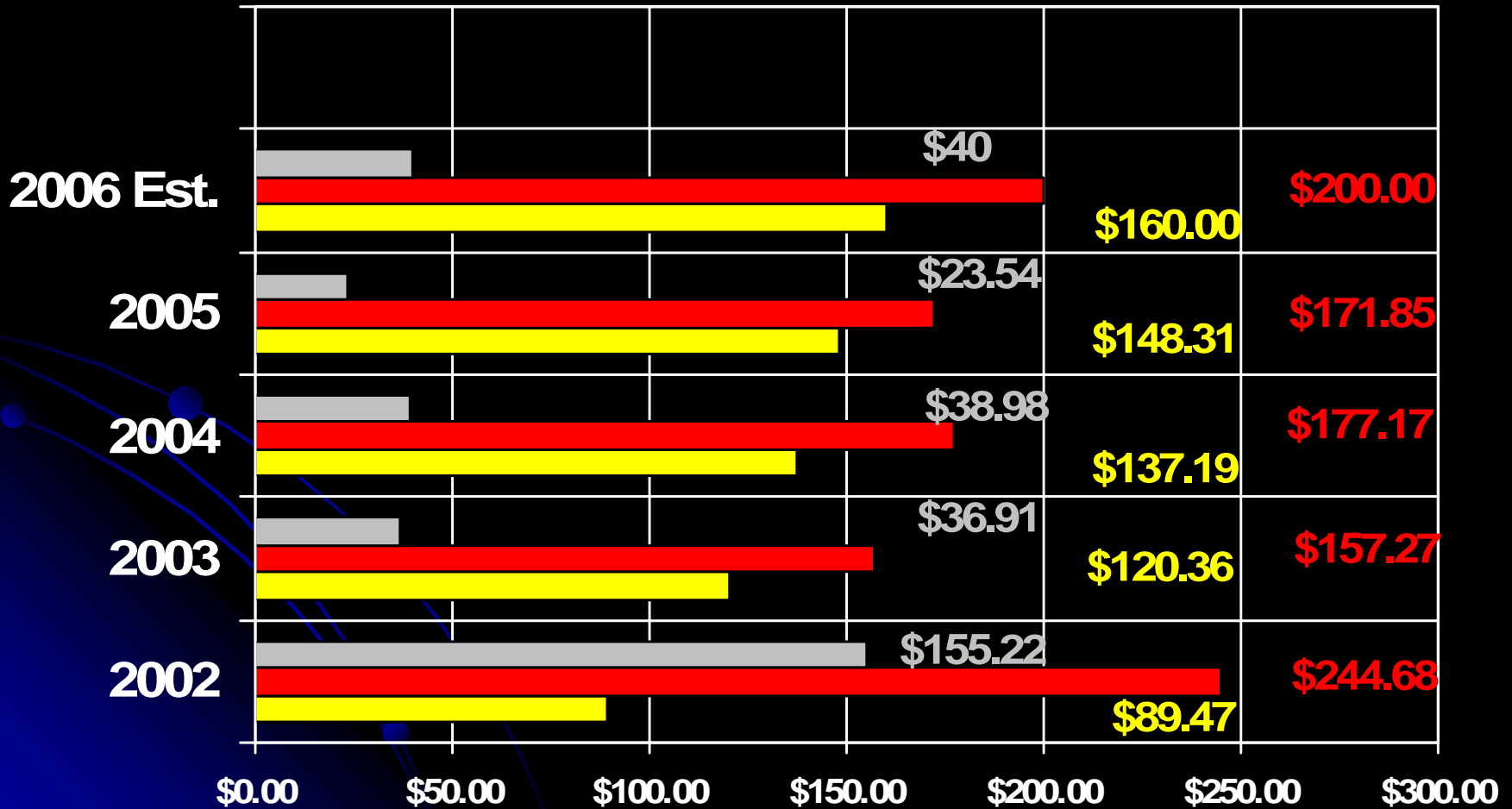
'05 Actual Avg. Price Awarded
\$158.02 per DOQQ

'04 Actual Avg. Price Awarded
\$10.09 per Sq. Mi.
\$137.19 per DOQQ

NAIP DOQQ Pricing History

2002 - 2005 USDA NAIP Contracts

■ Two Meter ■ One Meter ■ Marginal Cost



NAIP 2005 Contractors



Prime Contractors

- ✦ Aerial Services, Inc
- ✦ Aero-Metric, Inc
- ✦ Horizons, Inc
- ✦ LandAir Mapping
- ✦ NW Geomatics Ltd
- ✦ Photo Science Inc
- ✦ Sanborn Mapping Co
- ✦ Surdex Corporation
- ✦ Triathlon Ltd now MDA
- ✦ Vargis L.L.C.

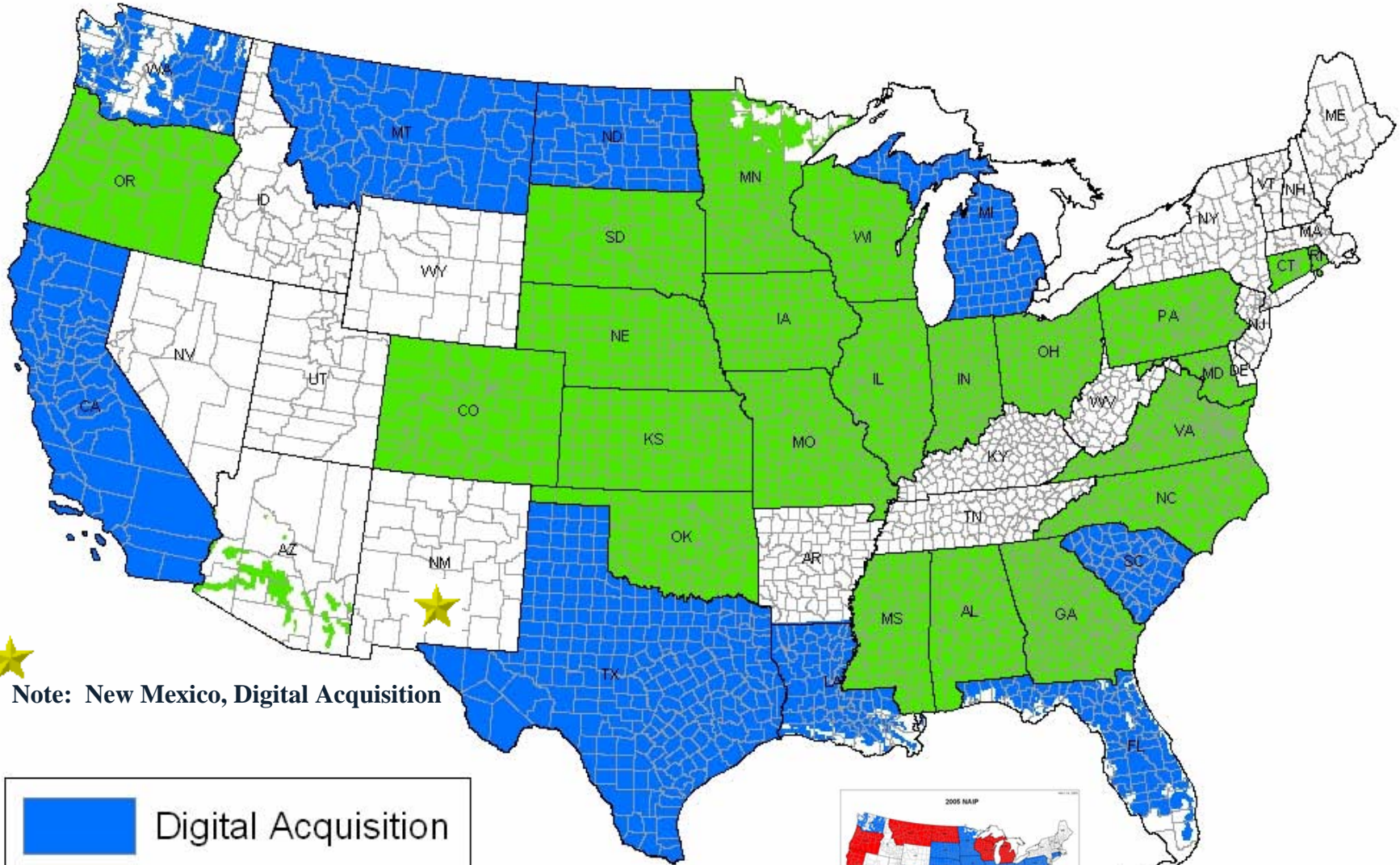
Subcontractors

- ✦ Airborne Sensing Corp
- ✦ Delorme
- ✦ EarthData
- ✦ Great Lakes Aerial Surveys
- ✦ Groupe Alta
- ✦ James W. Sewell
- ✦ Keystone Aerial Surveys
- ✦ MD-Atlantic Technologies
- ✦ Pixxures
- ✦ Richard Crouse & Associates
- ✦ Tim Tyler Surveying and Mapping
- ✦ Tuck Mapping Solutions
- ✦ Woolpert, Inc

Prime Contractors were also Subcontractors



2005 NAIP DIGITAL OR FILM ACQUISITION AREAS



★
Note: New Mexico, Digital Acquisition

	Digital Acquisition
	Film Acquisition



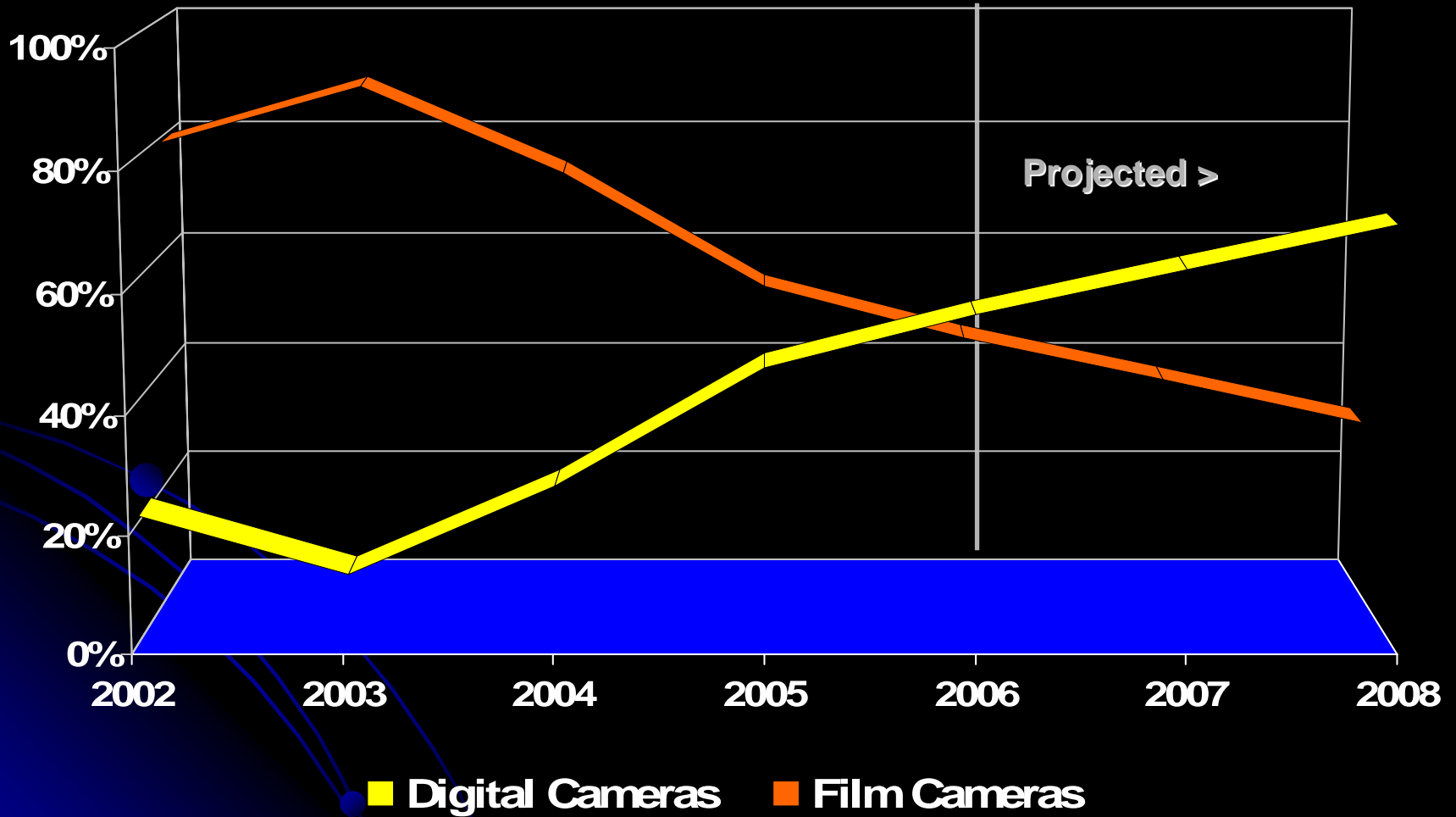
Digital Sensors

- ◄ NAIP 2003 – 2004
 - ◄ Leica ADS40 Airborne Digital Sensor
- ◄ NAIP 2005
 - ◄ Vexcel UltraCam™ Digital Aerial Camera
 - ◄ Intergraph's Z/I Imaging Digital Mapping Camera (DMC)
 - ◄ Leica ADS40 Airborne Digital Sensor



NAIP Trends

Digital vs. Film Cameras



What Does NAIP Provide?

🌀 Yearly Coverage of CONUS Ag Areas (Goal)

- ✦ Two Meter, Natural Color or CIR

🌀 Base Map Updates Every 5 Years (Goal)

- ✦ One Meter, Natural Color or CIR

🌀 Deliverable Products:

- ✦ Digital Orthorectified Imagery

- ✦ Compressed County Mosaics (CCM)

- ✦ Fielded 30 days after acquisition (Goal) ★

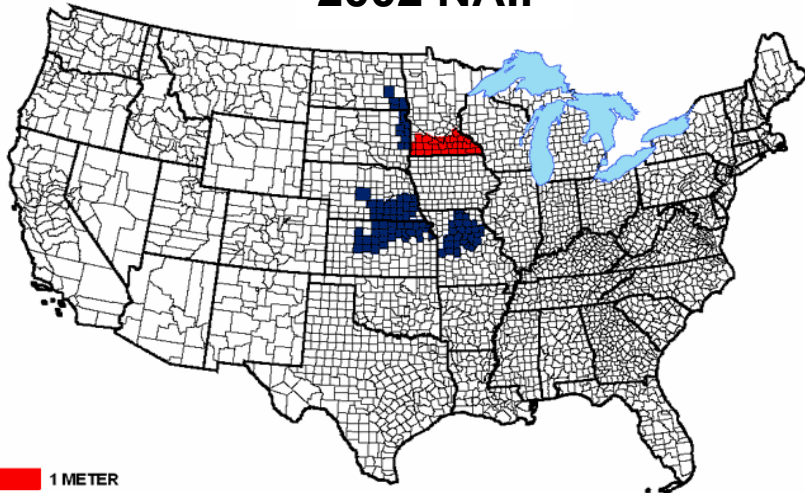
- ✦ MrSID MG3 format → JPEG2000 (Future)

- ✦ Compression Ratios: 50:1 2004 → 15:1 2005

- ✦ 1 or 2 meter Quarter Quads GEOTIFFS

- ✦ Film

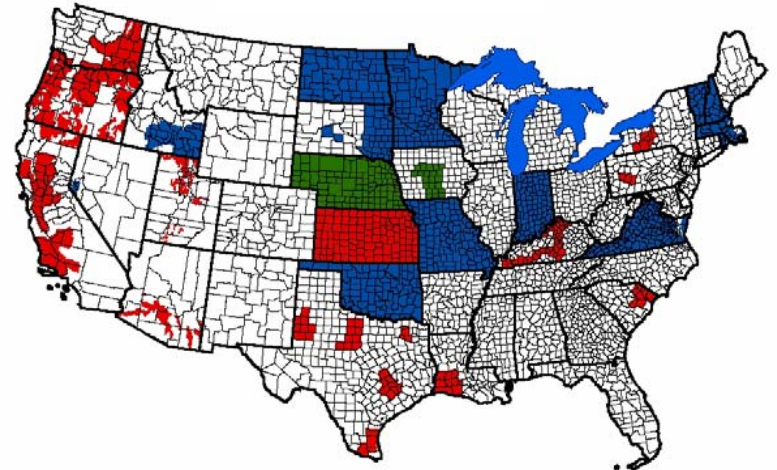
2002 NAIP



1 METER
2 METER

121 Counties

2003 NAIP



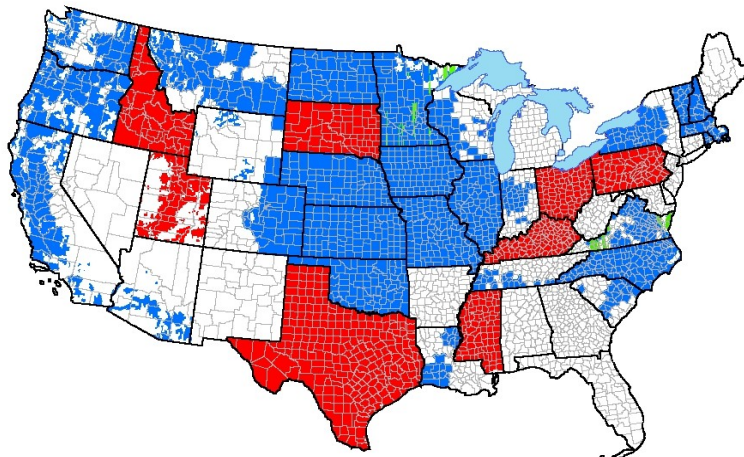
1 METER 2 METER DIGITAL

1,038 Counties



2004 NAIP

May 27, 2004



1 METER STATES
2 METER STATES
1 METER REPLACEMENT IMAGERY

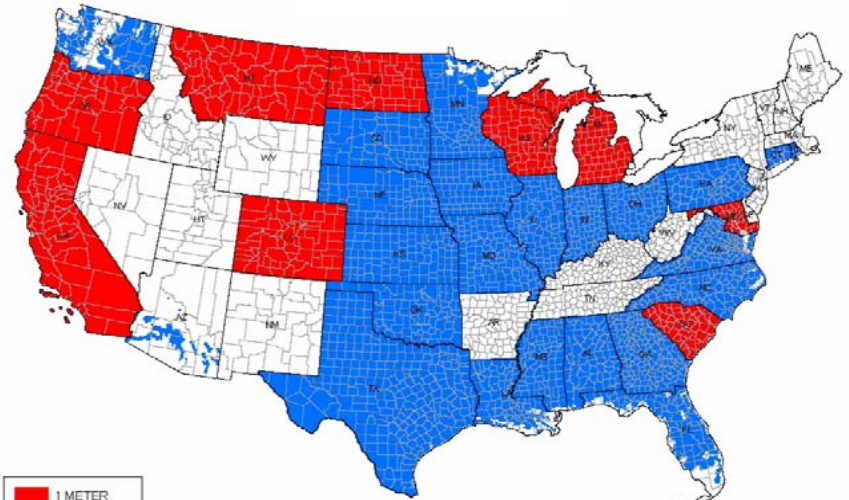
2,089 Counties

U.S. Department of Agriculture
NATIONAL AGRICULTURE IMAGERY PROGRAM
SOLICITATION NO: USDA-NAIP-3-04
NATIONAL COVERAGE MAP

USDA-FSA-APFO-Salt Lake City, Utah

2005 NAIP

MAY 24, 2005

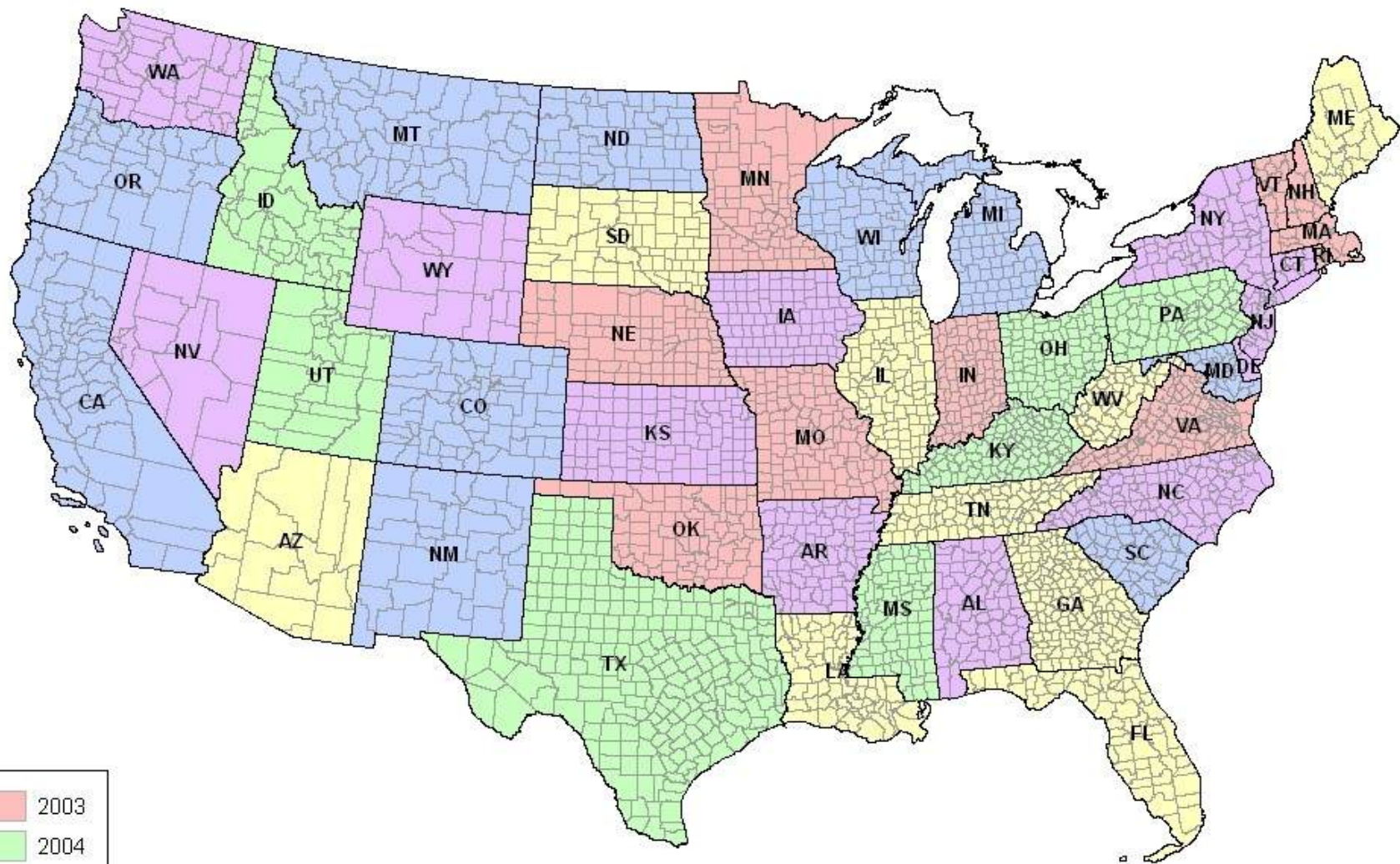


1 METER
2 METER
NOT FLOWN

2,445 Counties

USDA FSA APFO

NATIONAL AGRICULTURE IMAGERY PROGRAM PROPOSED 5 YEAR 1 METER CYCLE



NAIP Compressed County Mosaic (CCM)

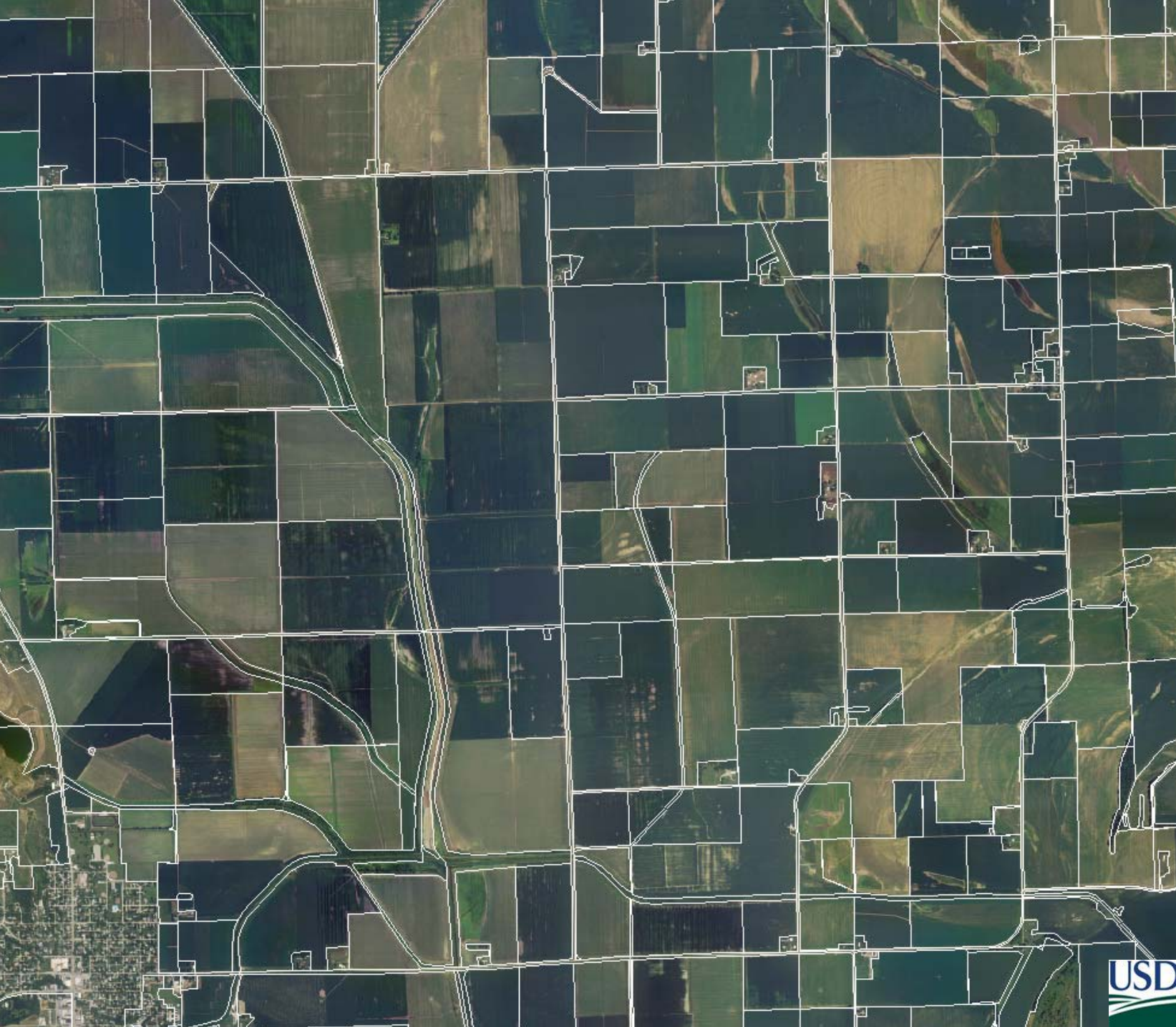


CCM + Common Land Units (CLU)



CCM





CCM
CLU

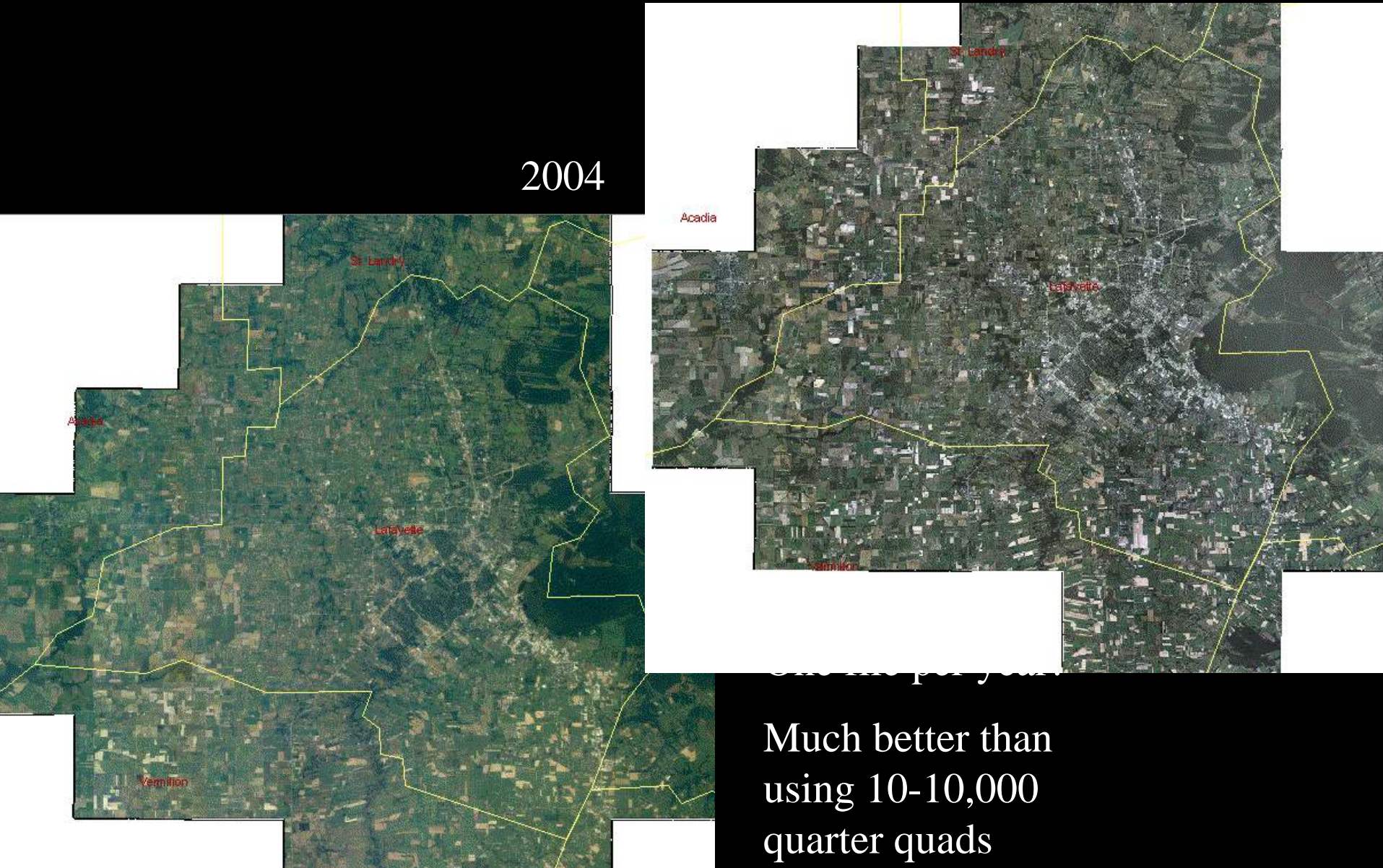


CCM
CLU
Crop Report

Example NAIP Mosaics for Lafayette Parish, LA

2005

2004



One tile per year
Much better than
using 10-10,000
quarter quads

2-meter imagery
still provides great
information!



2004 Lafayette Parish, LA

Specification Changes

■ 2004 season:

- ⬆ Radiometric correction required (CCM)
- ⬆ Satellite vendors allowed (subcontracts)
- ⬆ One year product warranty added
- ⬆ Vendors allowed to resell “derived” material

■ 2005 season:

- ⬆ Pan-sharpen sensors allowed on 1m products
- ⬆ Changed compression ratio from 50:1 to 15:1
- ⬆ 1m accuracy changed from $\pm 3m$ to $\pm 5m$

□ 2006 season:

- Require CCM samples for color balance
- Divide several states in multiple project areas

Contractor Resale of NAIP Derivative Products

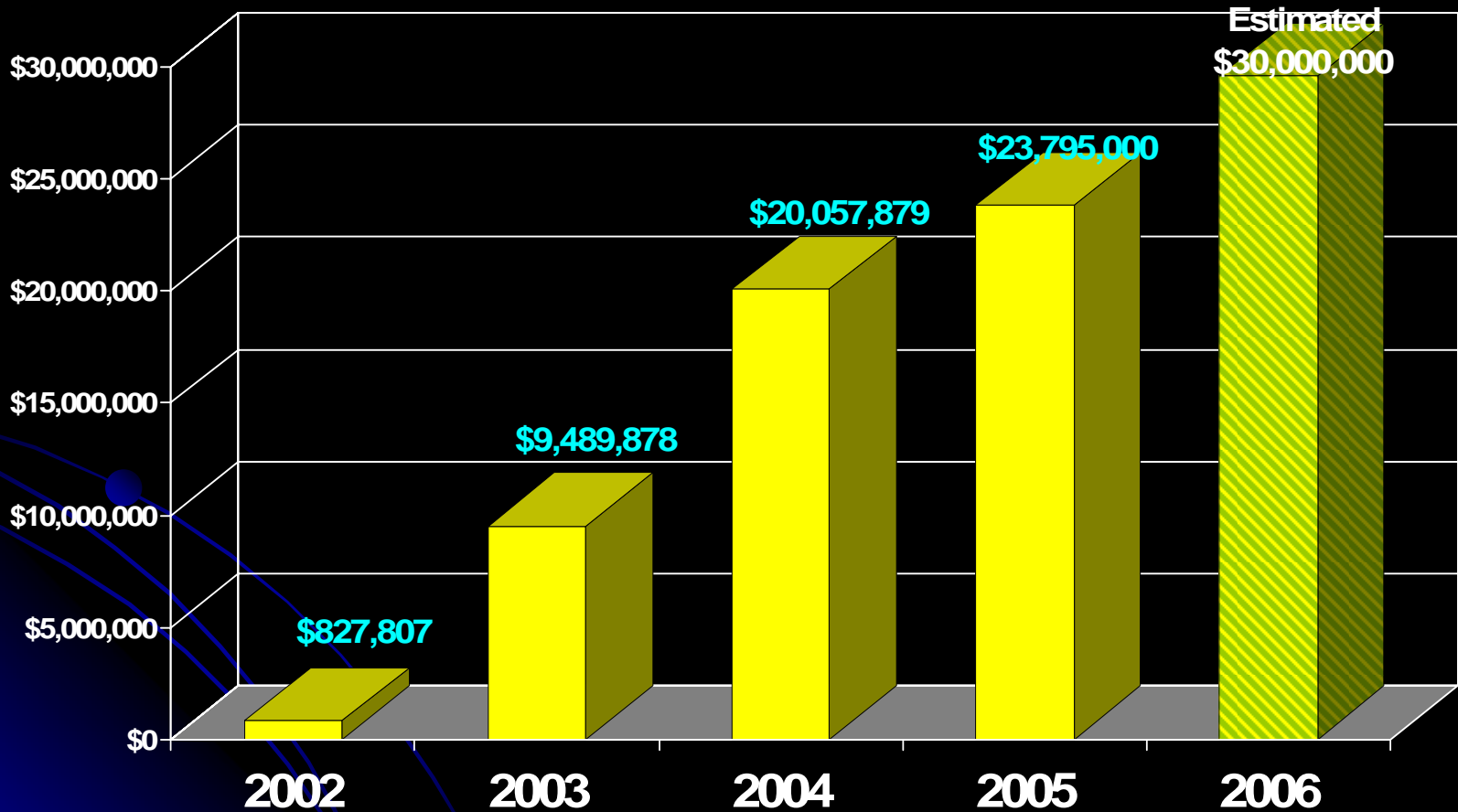


Contractor may Sell "after contract" products:

- Image Type:
 - ✓ Color Infrared vs. Natural Color
- Projection System:
 - ✓ State Plane vs. UTM
- Higher Resolution:
 - ✓ Sub-meter vs. 1 meter

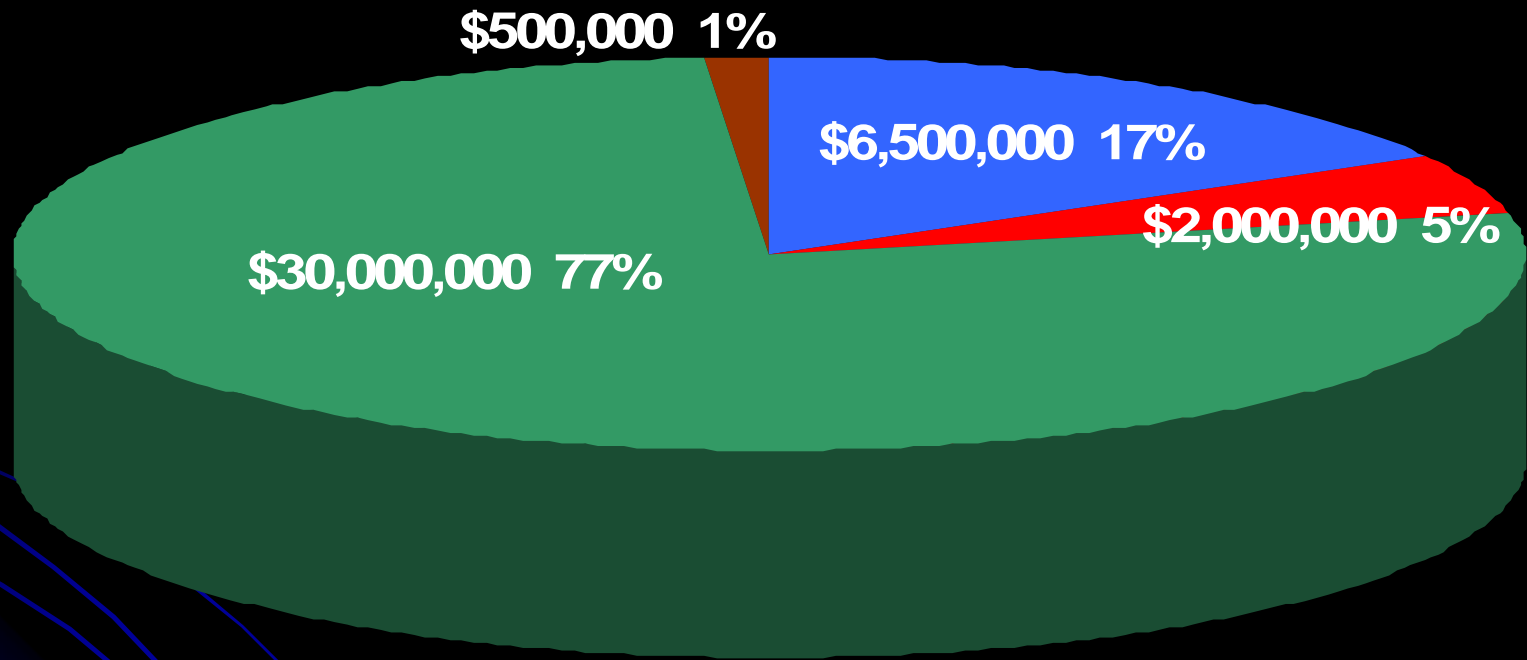
NAIP History

Contract Awards Past & Future



USDA Contract Awards

FY 2006 FUNDING ESTIMATES: \$39,000,000



■ Small Area Contract (NRI)

■ USFS & Other Resource

■ USDA NAIP IMAGERY

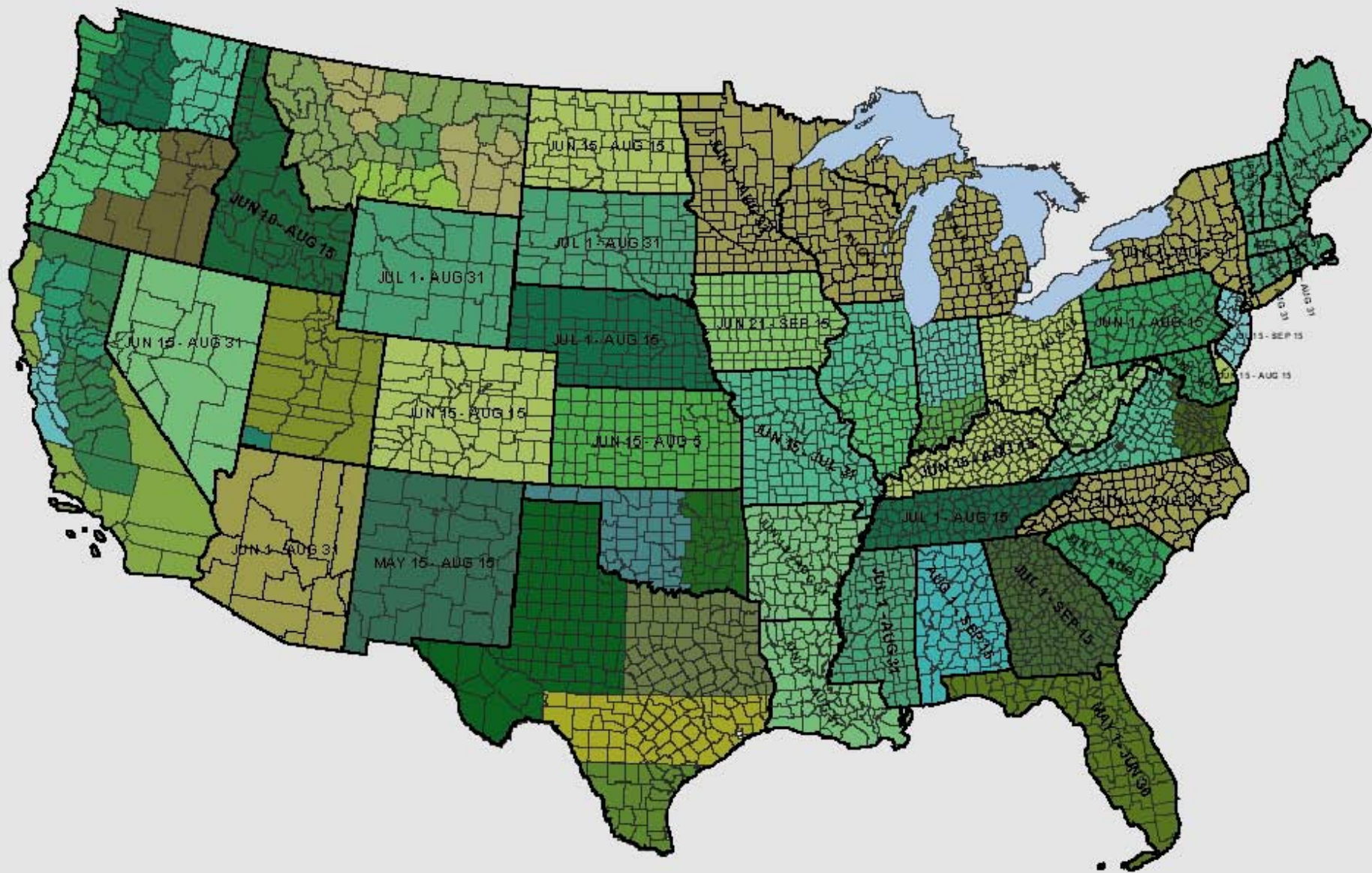
■ Other Purchases

Estimated 2006 Funding Sources

USDA Agencies	\$4,400,000
Other Federal Agencies	\$2,250,000
State/County Gov't Agencies	<u>\$700,000</u>
Estimated 2006 Cost Shares:	\$7,350,000
Estimated FSA Funding	<u>\$22,200,000</u>
<i>2006 NAIP Funding Total:</i>	<i>\$29,550,000</i>

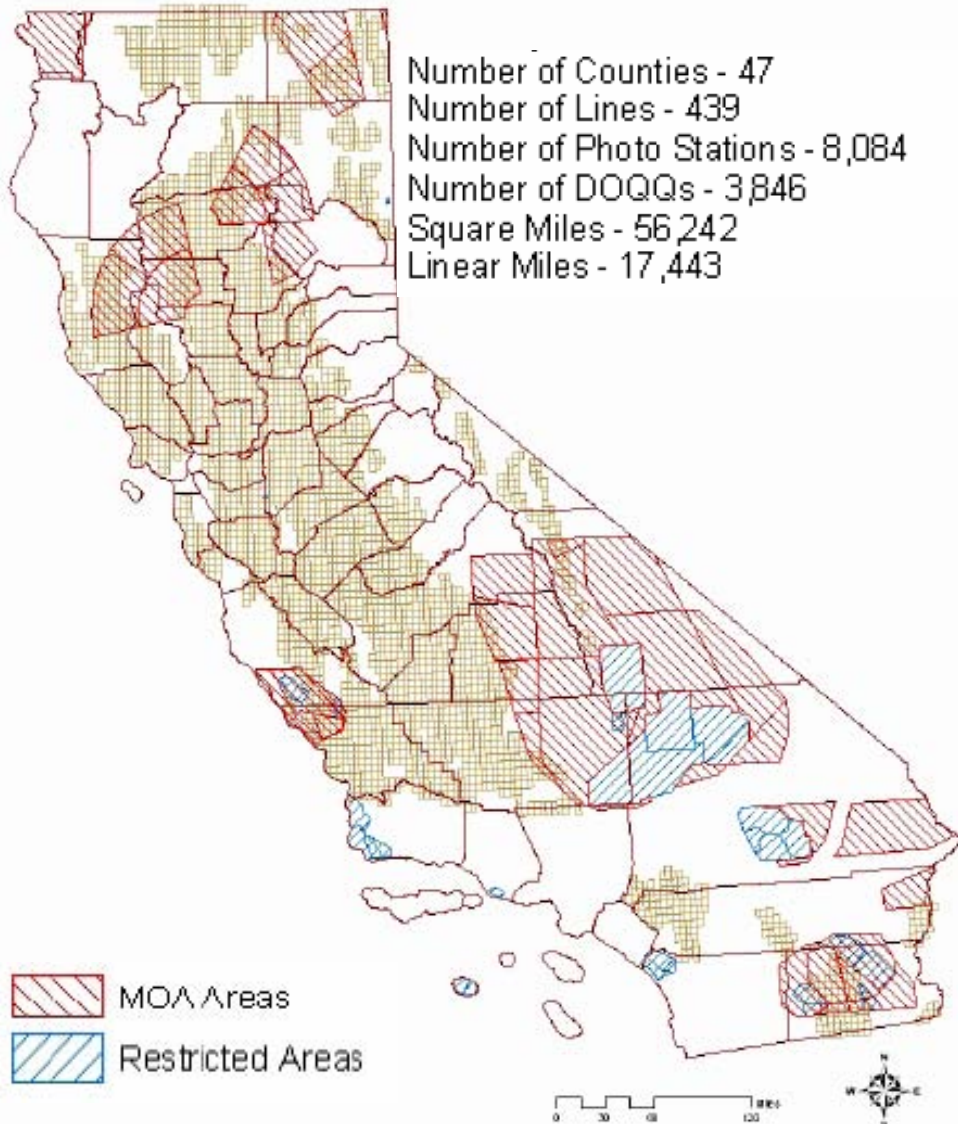


2006 NAIP ACQUISITION PERIODS

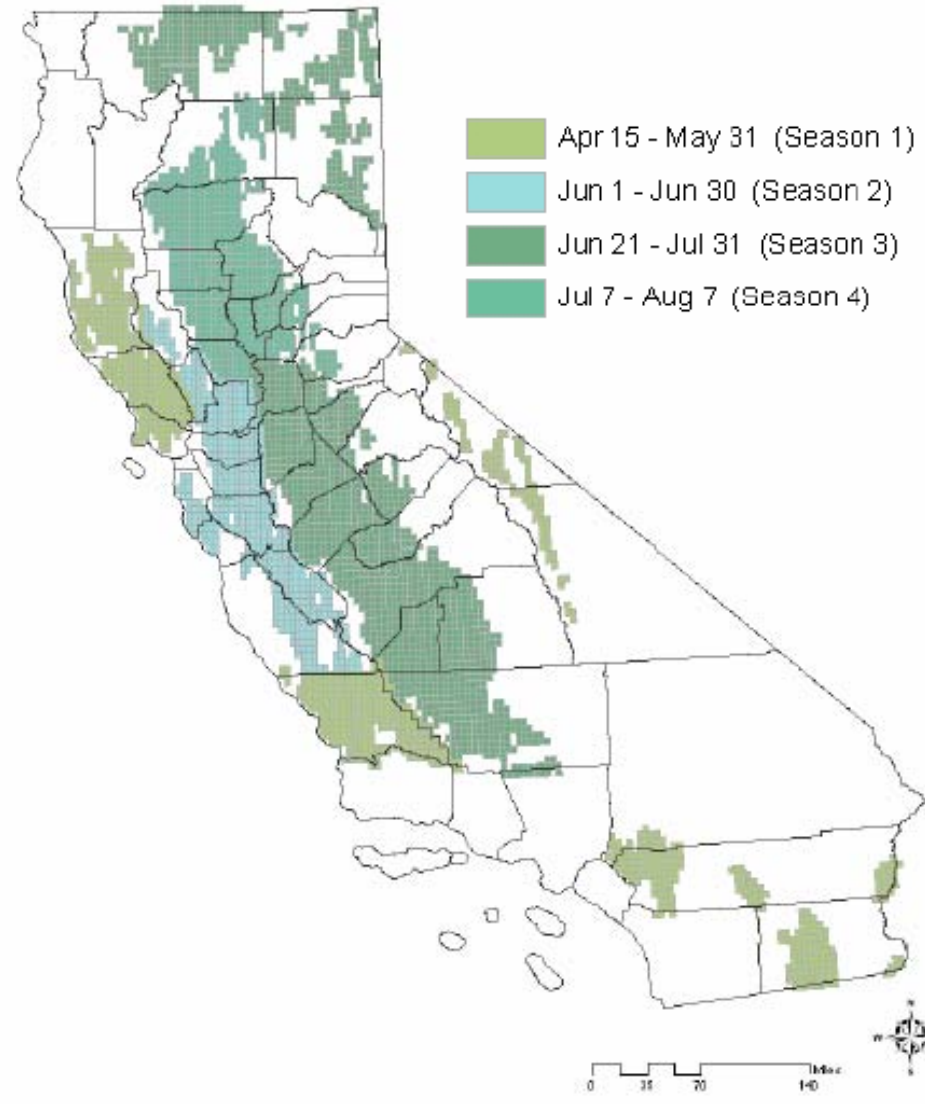


8,084 Photo Stations, 3,846 DOQQs, 4 Photo Seasons

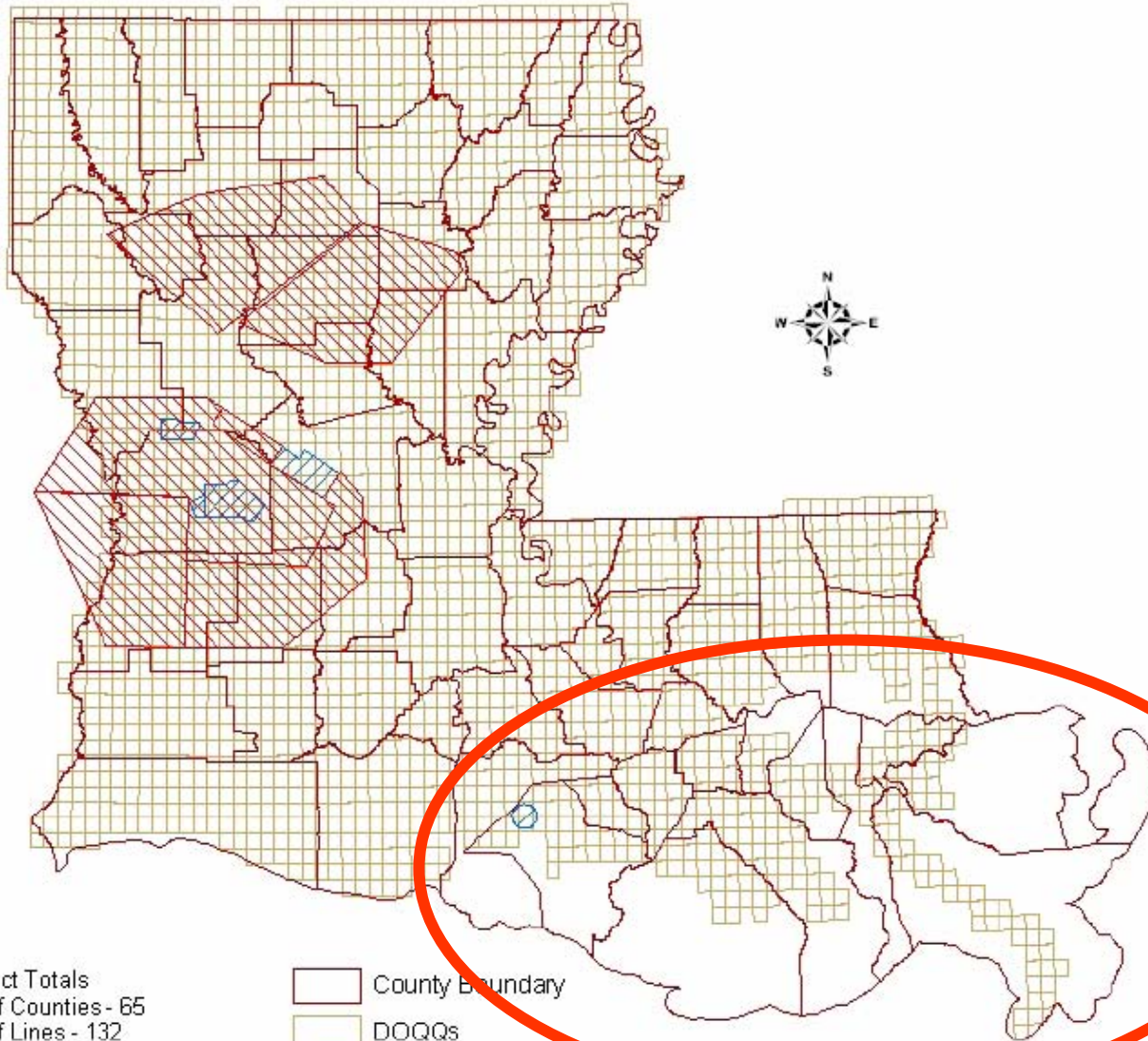
2006 State Project Map
CALIFORNIA



2006 State Acquisition Periods
CALIFORNIA



2006 Louisiana



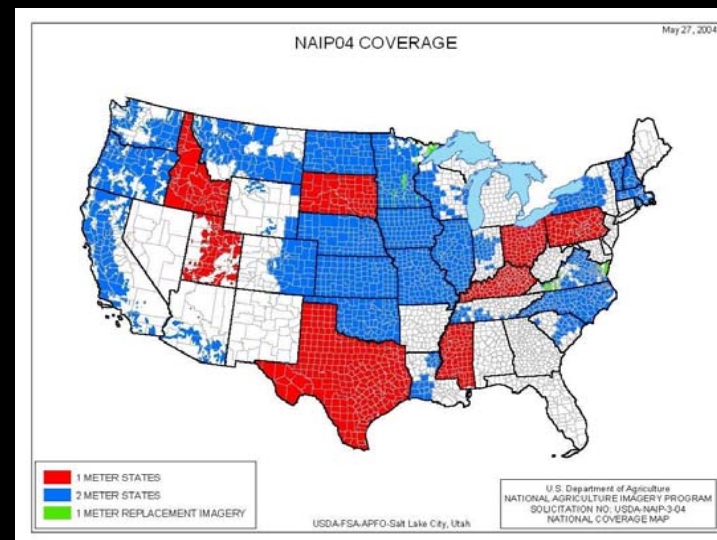
Areas not funded

Project Totals
Number of Counties - 65
Number of Lines - 132
Number of Photo Stations - 5,776
Number of DOQQs - 2,819
Square Miles - 45,010
Linear Miles - 12,464

- County Boundary
- DOQQs
- MOA Areas
- Restricted Areas

Search for Best Available Pre-Hurricane Imagery

- ◄ 1 meter or better
 - ◄ LA: NDOP/NAPP 2004
 - ◄ MS: NAIP 2004
 - ◄ TX: NAIP 2004
 - ◄ FL: NDOP and State Agencies
- ◄ Obtain and package imagery not in-house
- ◄ Inform response community of imagery availability. Package and deliver imagery.



Issues/More Analysis Required

◆ Future Deliverables

- ◆ When to take delivery on original digital collections?
- ◆ Rectification Solution / enhancement as a deliverable?
- ◆ Additional bits. (8 bit → 11 bit → 16 bits)

◆ Frame based vs. Line Scanner Cameras

- ◆ GPS/IMU vs. GPS/IMU and AT solutions.
- ◆ 4-band image creation.
- ◆ During technical evaluation, can we rate the value of one camera vs. another?

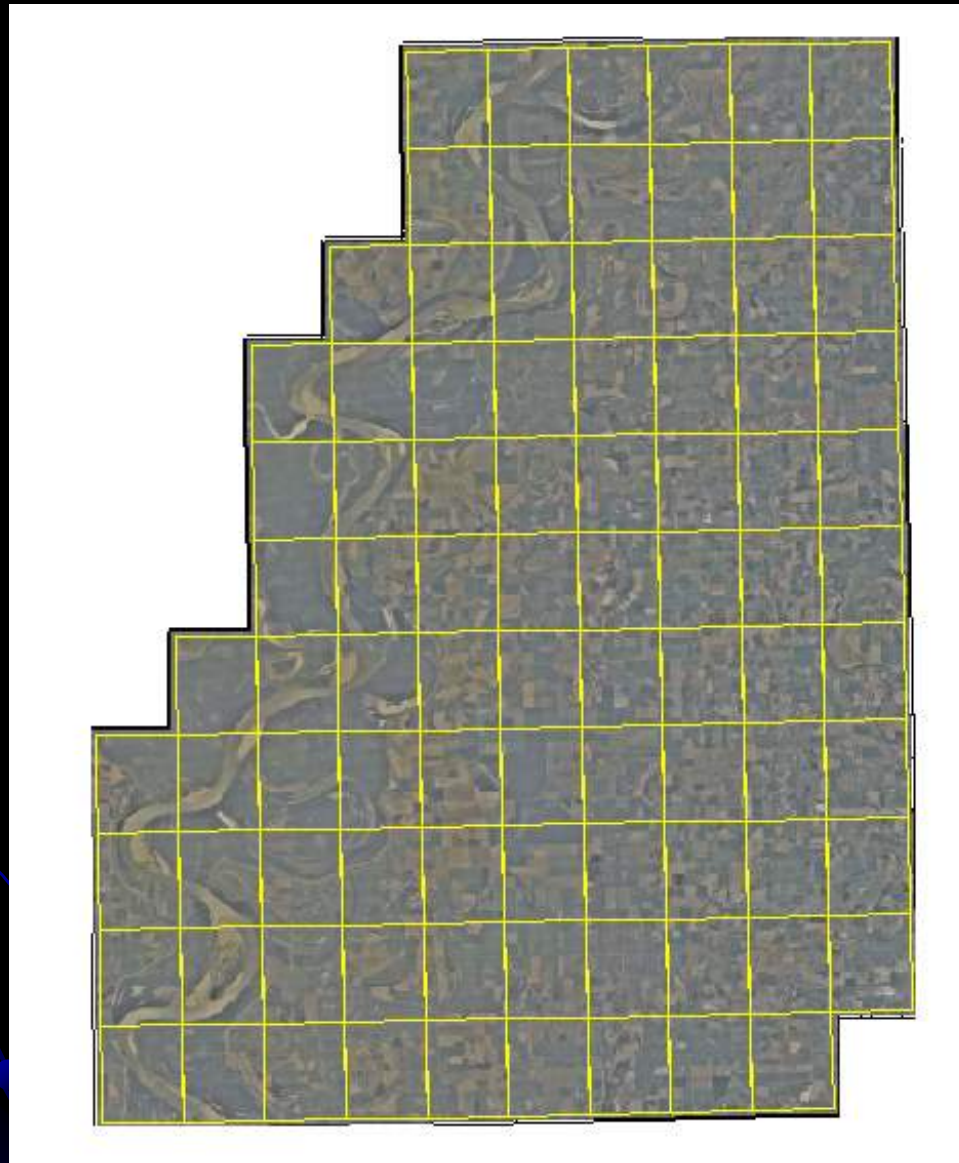
◆ What are the Maximum Pan Sharpening ratios that should be allowed?

- ◆ 1 meter true color image
 - ◆ all three bands be acquired at 1 meter or less

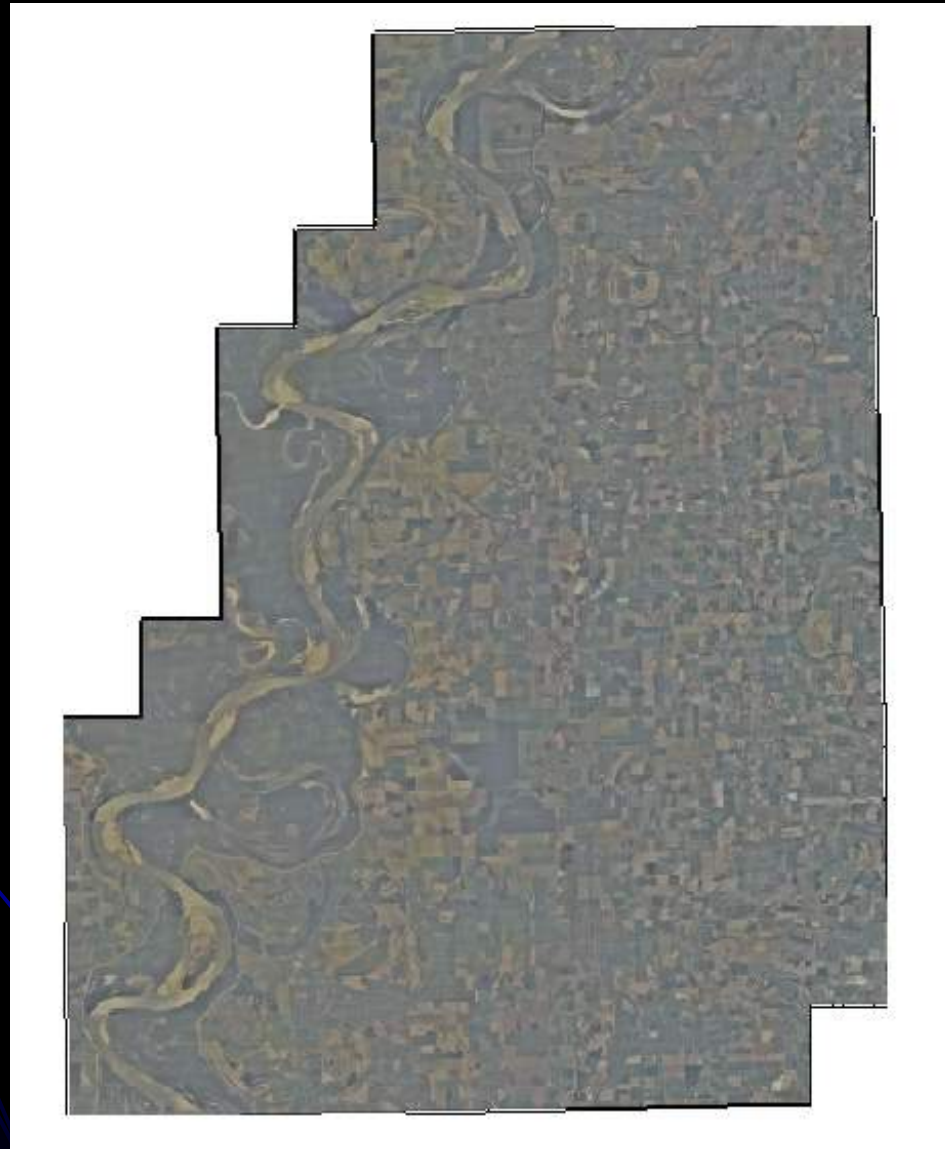
Issues/More Analysis Required

- ◆ Standards that can be quality controlled:
 - ◆ Tone balancing mosaics
 - ◆ Consistent Color (image to image, year to year)
 - ◆ Post Processing Haze Reduction
 - ◆ 16 bit or 11-bit to 8 conversion
 - ◆ Detail loss at one or both ends of the histogram
 - ◆ Automation of Quality Control to the Maximum Practical Extent
- ◆ During technical evaluation of a contract proposal, can we rate one camera vs. another?
 - ◆ Framing vs. push-broom.

Mosaic Issues: Washed out, Haze ...



Mosaic Issues: Washed out, Haze ...



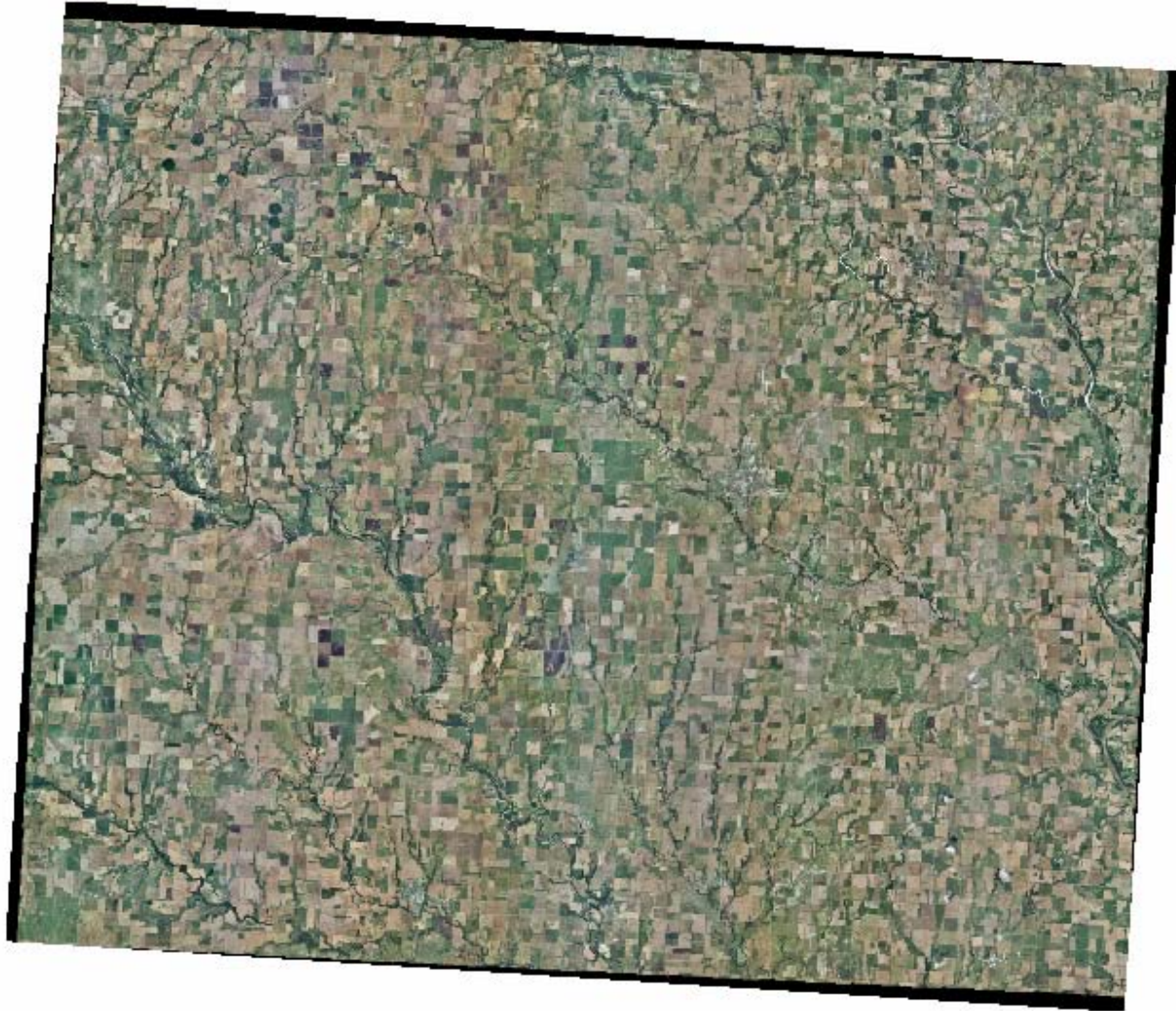
Mosaic Issues: Washed out, Haze ...



Mosaic Issues: Washed out, Haze ...



Mosaic Non-Issue:



Mosaic Non-Issue:



Mosaic Non-Issue:



Mosaic Non-Issue:





Links for Future Information and Data

- **USDA Aerial Photography Field Office**

- NAIP and USDA Aerial
 - <http://apfo.usda.gov>
- Web Mapping Services
 - <http://gdw.apfo.usda.gov/naip/viewer>
 - <http://gdw.apfo.usda.gov/mdoq/viewer>



- **USDA Data Gateway**

- Data products packaged by county
 - <http://datagateway.nrcs.usda.gov>



- **Forest Service geospatial data clearinghouse**

- Data for National Forests
 - <http://svinetfc4.fs.fed.us/>



- **Forest Service's Remote Sensing Applications Center (RSAC)**

- Fire Mapping, Resource Information
 - <http://www.fs.fed.us/eng/rsac/>

- **Foreign Agricultural Service Crop Explorer (Global imagery, weather)**

- <http://www.pecad.fas.usda.gov/cropexplorer/>



Questions?



2005.09.20 12:37