USFS R3 – Southwestern Region

Engineering

GIS Unit
Candace Bogart

Remote Sensing Unit
Tom Mellin

Photogrammetry
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RS / Digital Processing
Pete Joria

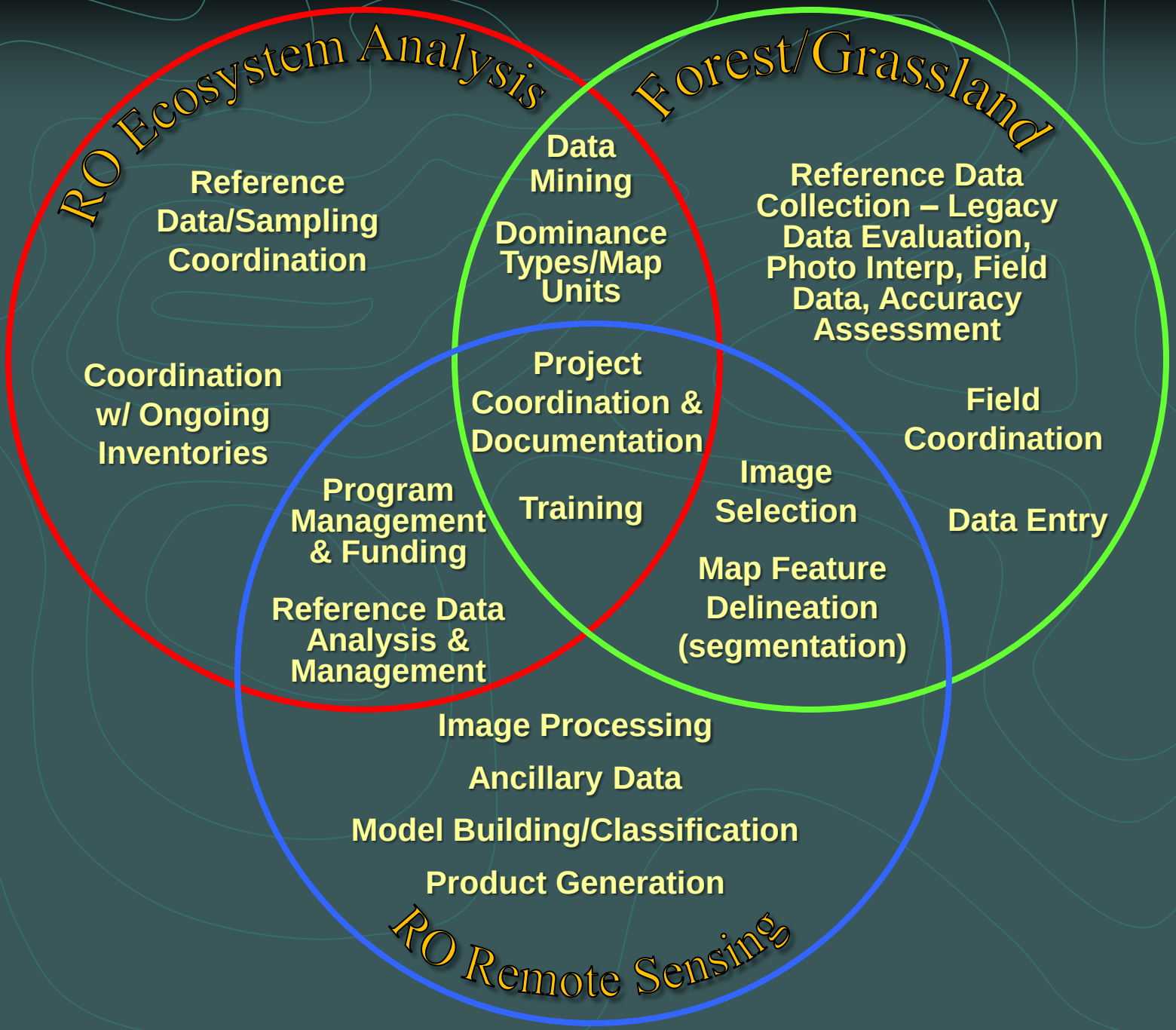
R3 Remote Sensing Unit

Main Projects:

- Midscale Existing Vegetation Mapping (2004 -)
- Pinaleños LiDAR Project (2008 -)

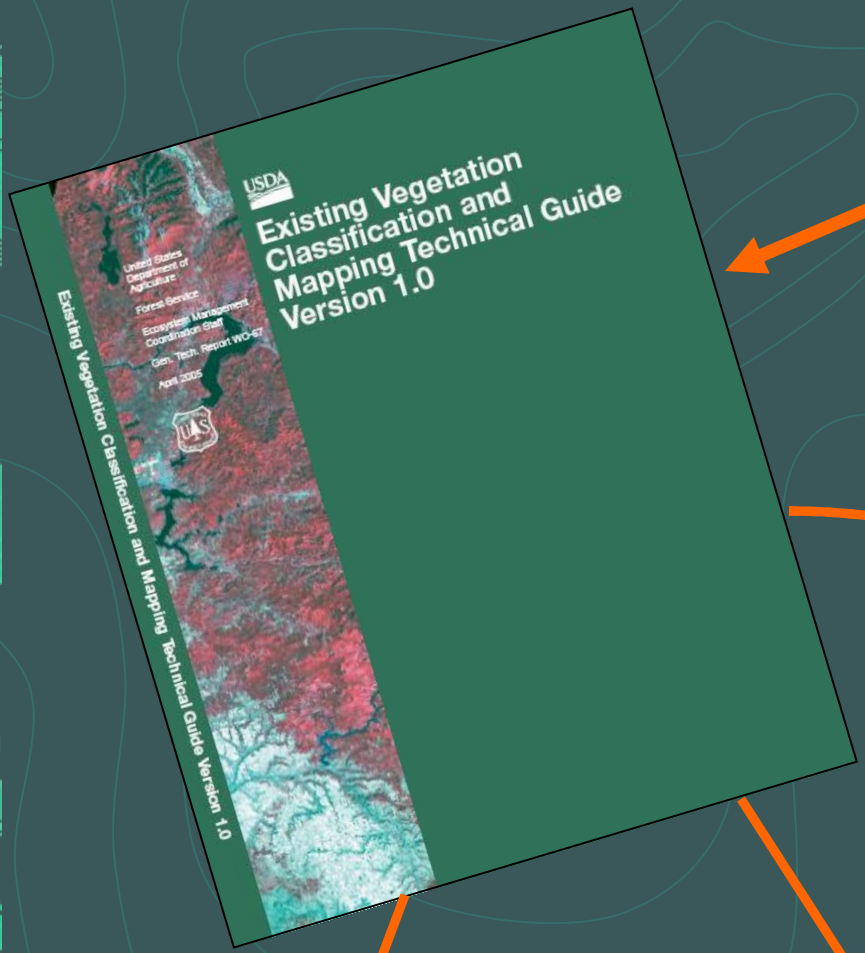
Midscale Existing Vegetation Mapping

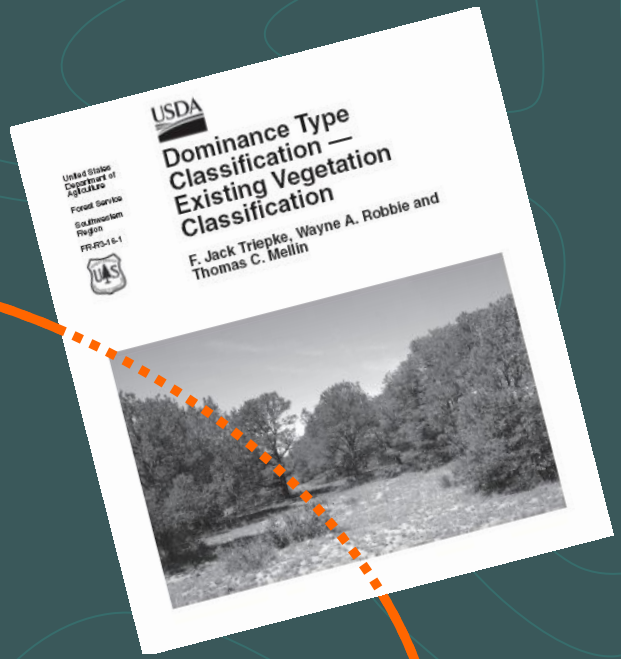
- Develop geospatial data layers for vegetation composition and structure across all NFS lands in R3
- Cooperative effort between Forests/Grasslands and Regional Office (Engineering and Ecosytem Analysis & Planning staffs)
- Key data element for Forest Plan Revision
- Polygon-based, mid-scale (1:100,000) mapping


RO Ecosystem Analysis
Forest/Grassland
RO Remote Sensing
Reference Data/Sampling Coordination
Data Mining
Dominance Types/Map Units
Reference Data Collection – Legacy Data Evaluation, Photo Interp, Field Data, Accuracy Assessment
Coordination w/ Ongoing Inventories
Project Coordination & Documentation
Field Coordination
Program Management & Funding
Training
Image Selection
Data Entry
Reference Data Analysis & Management
Map Feature Delineation (segmentation)
Image Processing
Ancillary Data
Model Building/Classification
Product Generation

Vegetation classifications…

FGDC – National Vegetation Classification System





CANOPY COVER | **SIZE CLASS** | **DOMINANCE TYPE**

Three separate map products…

DOMINANCE TYPE

- One-species types
- Two-species types
- One-genus types
- One-species/One-genus types
- Two-genus types
- Mixed types

TREE / SHRUB CANOPY COVER

- Sparse – 0 – 9.9% CC (= GFB)
- Low – 10 – 29.9% CC
- Open – 30 – 59.9% CC
- Closed – 60 – 100% CC

SIZE CLASS

TREE

- Seed/Sap < 5”
- Small 5 – 9.9”
- Medium 10 – 19.9”
- Very Large 20 – 29.9”
- Giant ≥ 30”

SHRUB

- Low < 0.5m
- Medium 0.5-1.9m
- Tall ≥ 2m

Remote Sensing Image Sources

- Landsat – Basis for image segmentation
  - Affordable, Available
  - Landscape level tool (30m resolution)
- Forest Resource Aerial photography
  - Available
  - Used by Forest staff to PI dom_type, canopy cover and size classes
- Digital Orthophoto quads (DOQs)
  - A georegistered backdrop for segmentation, identify training areas
  - Available for all Forests, but B&W and outdated (1990's) compared to Landsat images

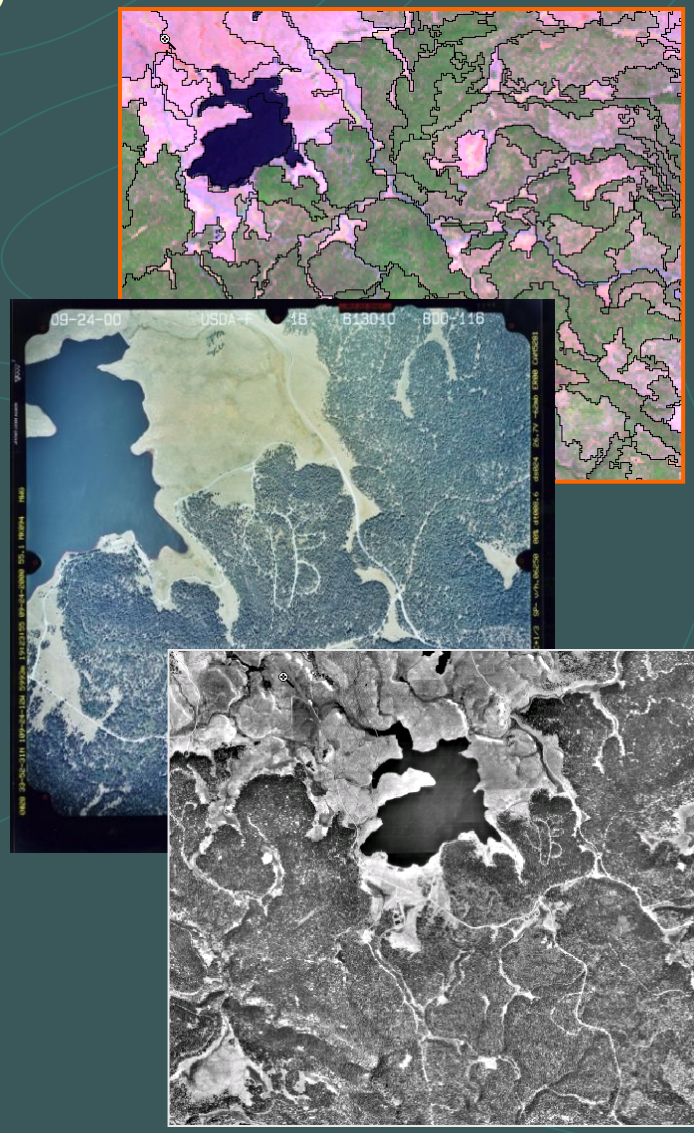
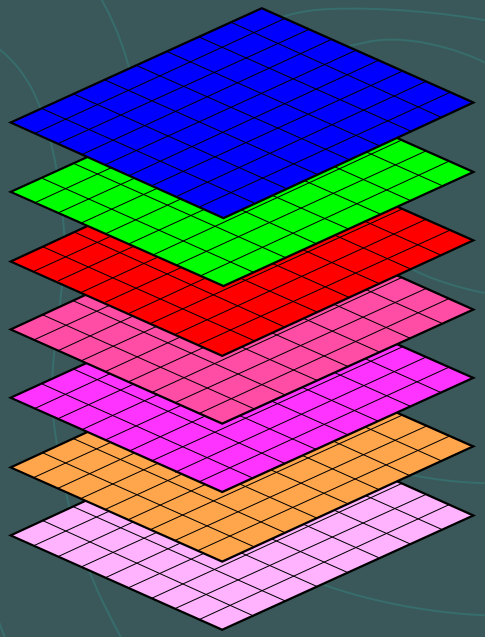


Image interpretation

Identify relationships between training data and modeling variables for each class (using Definiens, Imagine, SEE5)

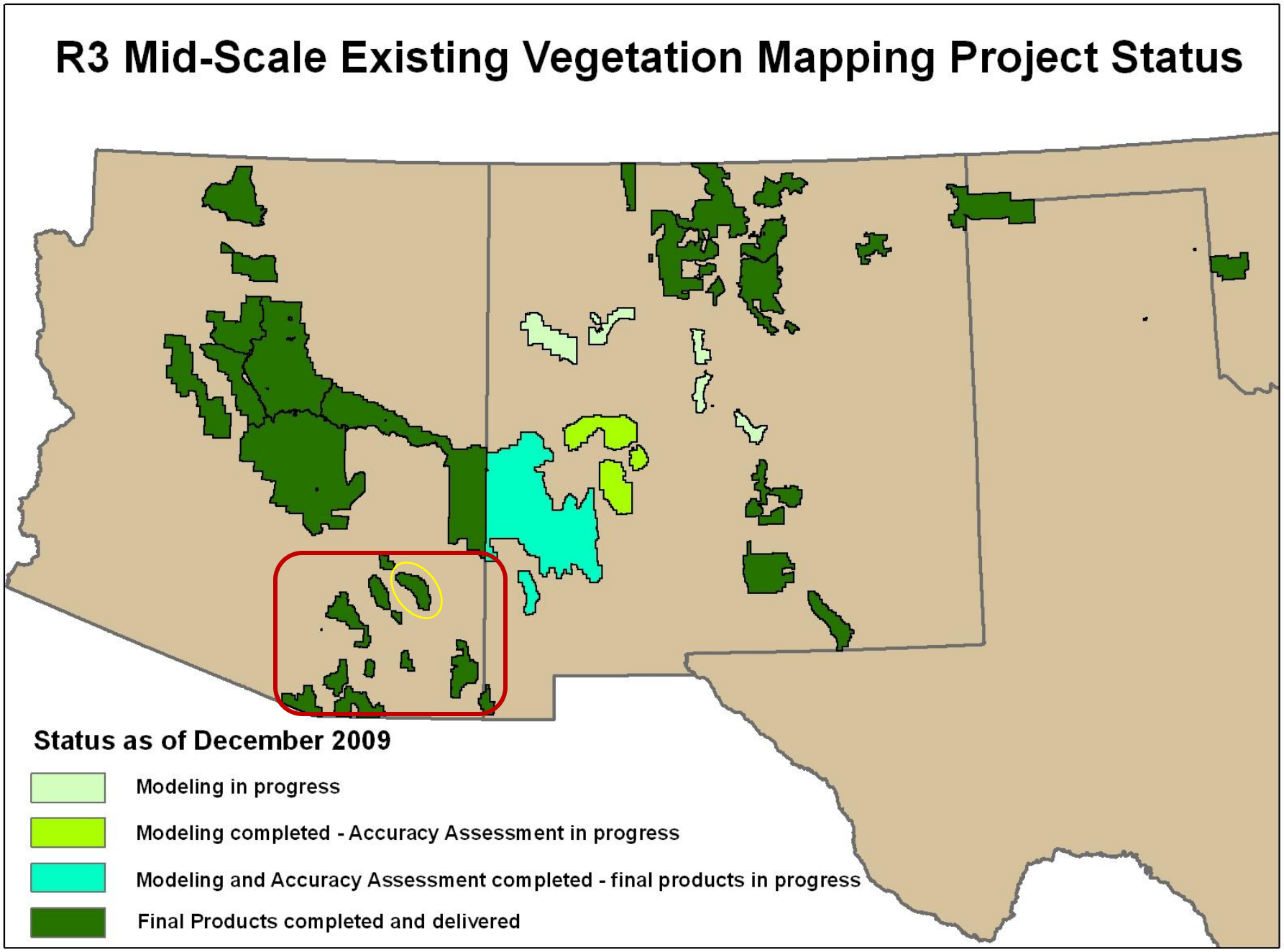
- Spectral variables
- Biophysical variables



-NDVI (Normalized difference veg index)
-6 Landsat TM bands (both dates)
-MSAVI (Modified soil adjusted veg index)
-SI (Structural index - TM4/TM5)
-NIRM (TM4/TM7)
-Tasseled cap (both dates)
-Δ Tasseled cap (leaf-on to leaf-off)
-ND54 (Normalized difference TM5/TM4)
-ND75 (Normalized difference TM7/TM5)
-NBR (Normalized burn ratio TM4/TM7)
Plus others

Elevation
Slope/aspect combinations (insolation)
Soils – TES data
PNVT – TES data
Precipitation data – PRISM, DAYMET
Compound Topographic Index
Heat load

R3 Mid-Scale Existing Vegetation Mapping Project Status



Pinaleños LiDAR Project
(RSSC sponsored)

The objective is to map forest structure in the mixed-conifer and spruce-fir forests…

MGRS photo by Sarah R B King

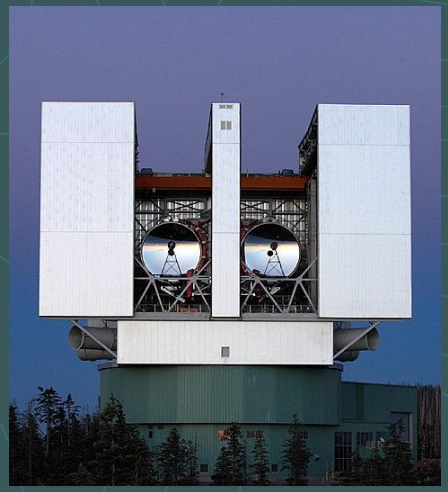
…in part, to help balance:

Implementation and monitoring of the Pinaleño Ecosystem Restoration Project, PERP

with

Protection of Mt Graham Red Squirrel habitat

Mt. Graham International Observatory



Large Binocular Telescope
(2004)

Heinrich Hertz Submillimeter Telescope
(1993)

Vatican Advanced Technology Telescope
(1993)

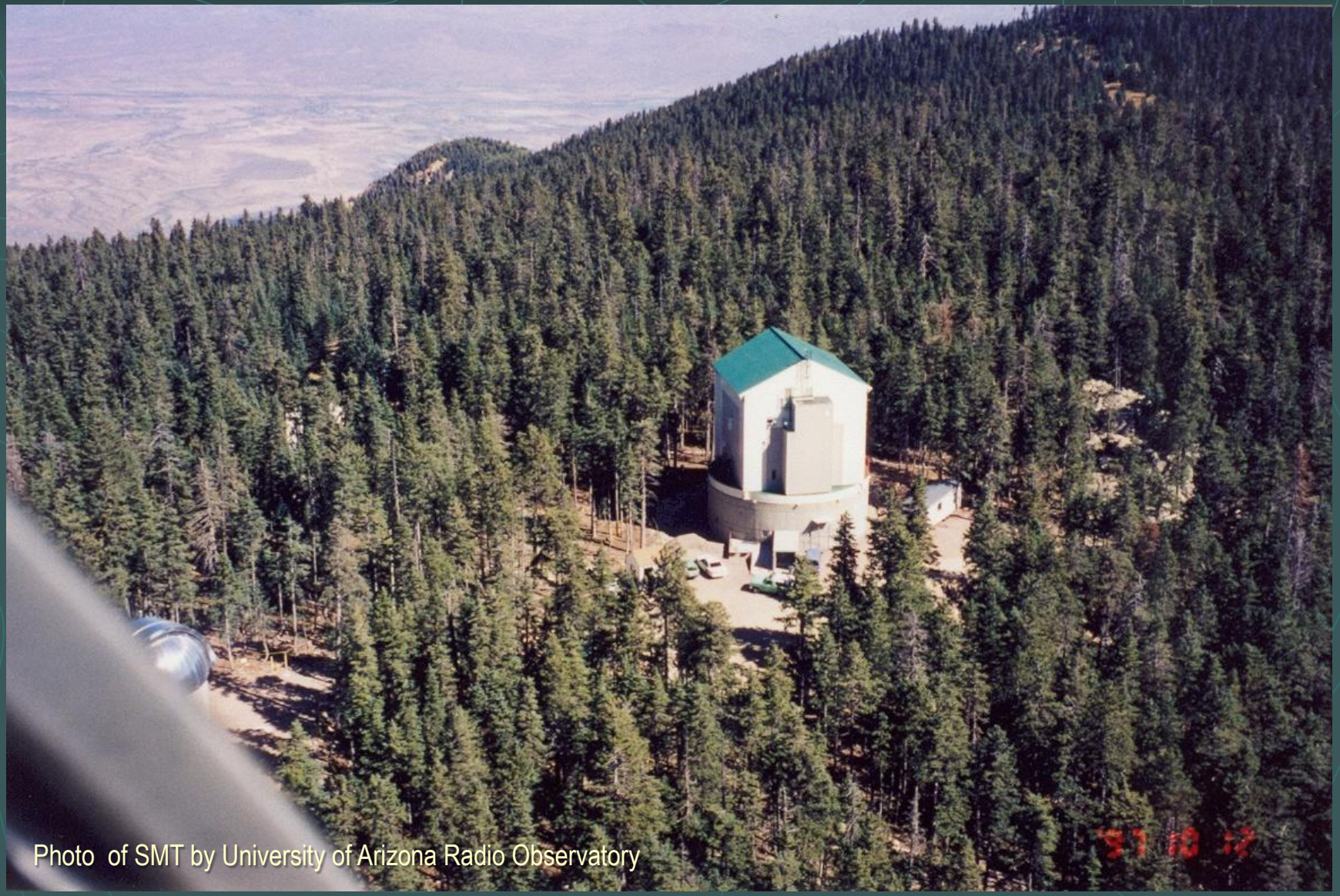


Photo of SMT by University of Arizona Radio Observatory


Photo by University of Arizona Radio Observatory

Photo by Dr. John L. Koprowski, University of Arizona

Phase 1 (2008)

- Develop technical specifications for acquisition and deliverables on the Pinaleños project area
- Produce report documenting specs and providing guidance for similar projects
- Acquire data

Phase 1 Report

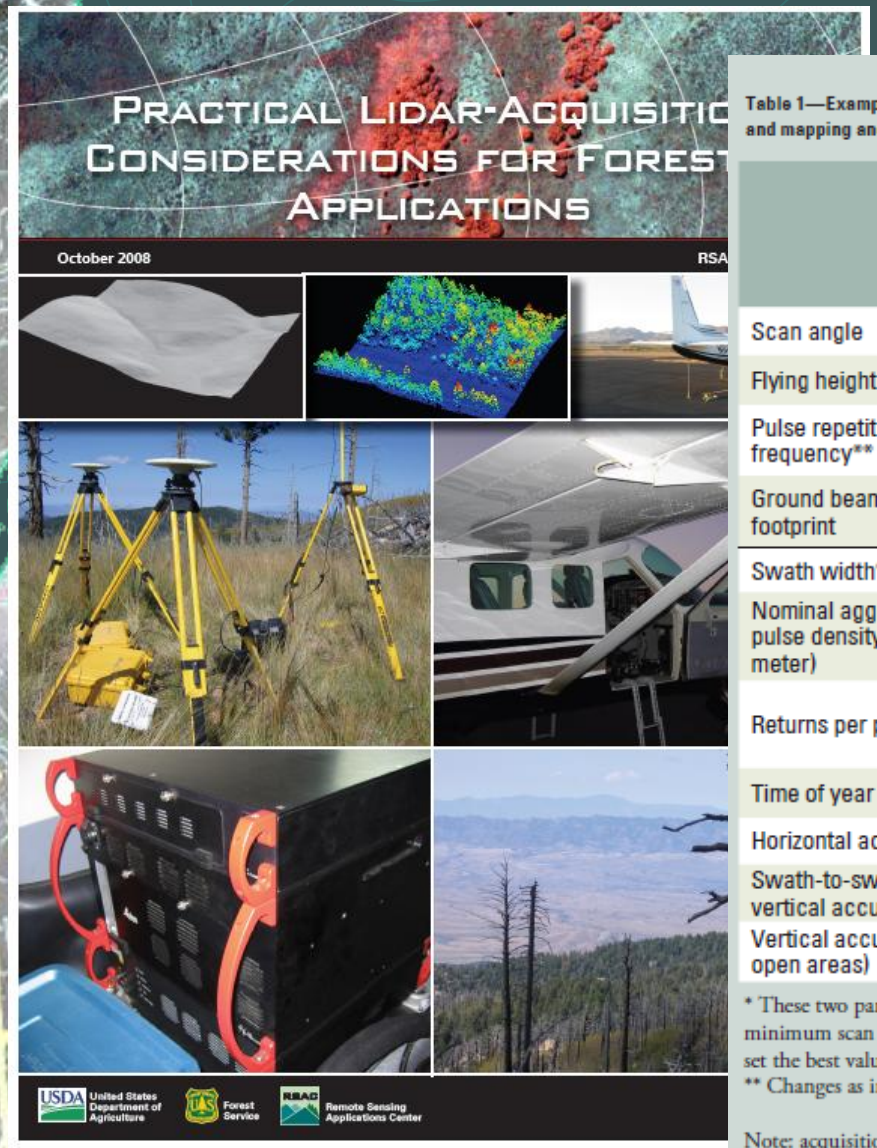


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Table 1—Example of minimum lidar data-acquisition specification guidelines for two projects: topographic mapping in open terrain and mapping and/or vegetation characterization in dense cover (McGaughey and others 2006, Reutebuch and McGaughey 2008).

	Topographic mapping in relatively open terrain (medium-resolution ground model: ≥2-meter grid))	a. Vegetation characterization b. Topographic mapping with dense vegetation cover or for high-resolution ground model (< 1-meter grid)
Scan angle	≤ ±20° of nadir	≤ ±13° of nadir
Flying height (m)*	2,200	1,200
Pulse repetition frequency**	10 to 70 kHz	30 kHz to >100 kHz
Ground beam footprint	< 100 cm	Narrow setting, ≤ 30cm
Swath width*	1600m	500>—<800 m
Nominal aggregate pulse density (per sq. meter)	0.3–1	a. 3 to 8 b. > 4 (for some applications > 8)
Returns per pulse	Last	Minimum 2 (first [surface model] and last [for ground model]) > 4 for vegetation and structure modeling
Time of year	Leaf-off without snow cover	Depends on the project; no snow cover
Horizontal accuracy	25 cm	0.5 m
Swath-to-swath vertical accuracy	10 cm	15 cm
Vertical accuracy (in open areas)	15 cm	50 cm absolute accuracy; relative accuracy can be more important

* These two parameters are influenced by aircraft and project requirements. They are interdependent as well as dependent on minimum scan angle and more. The values in the table are general guidelines only. Discussion between vendor and client will set the best values for these parameters.

** Changes as instrument technology improves

Note: acquisition specification requirements for high-precision lidar measurements may surpass those for projects involving vegetation or dense cover.

Statement of Work

- Define acquisition area
- Potential acquisition problems
- Acquisition specs
- Accuracy
- Spatial Reference
- Deliverables

8. Deliverables:

Contractor shall provide the Deliverables no later than 60 calendar days after completion of flying.

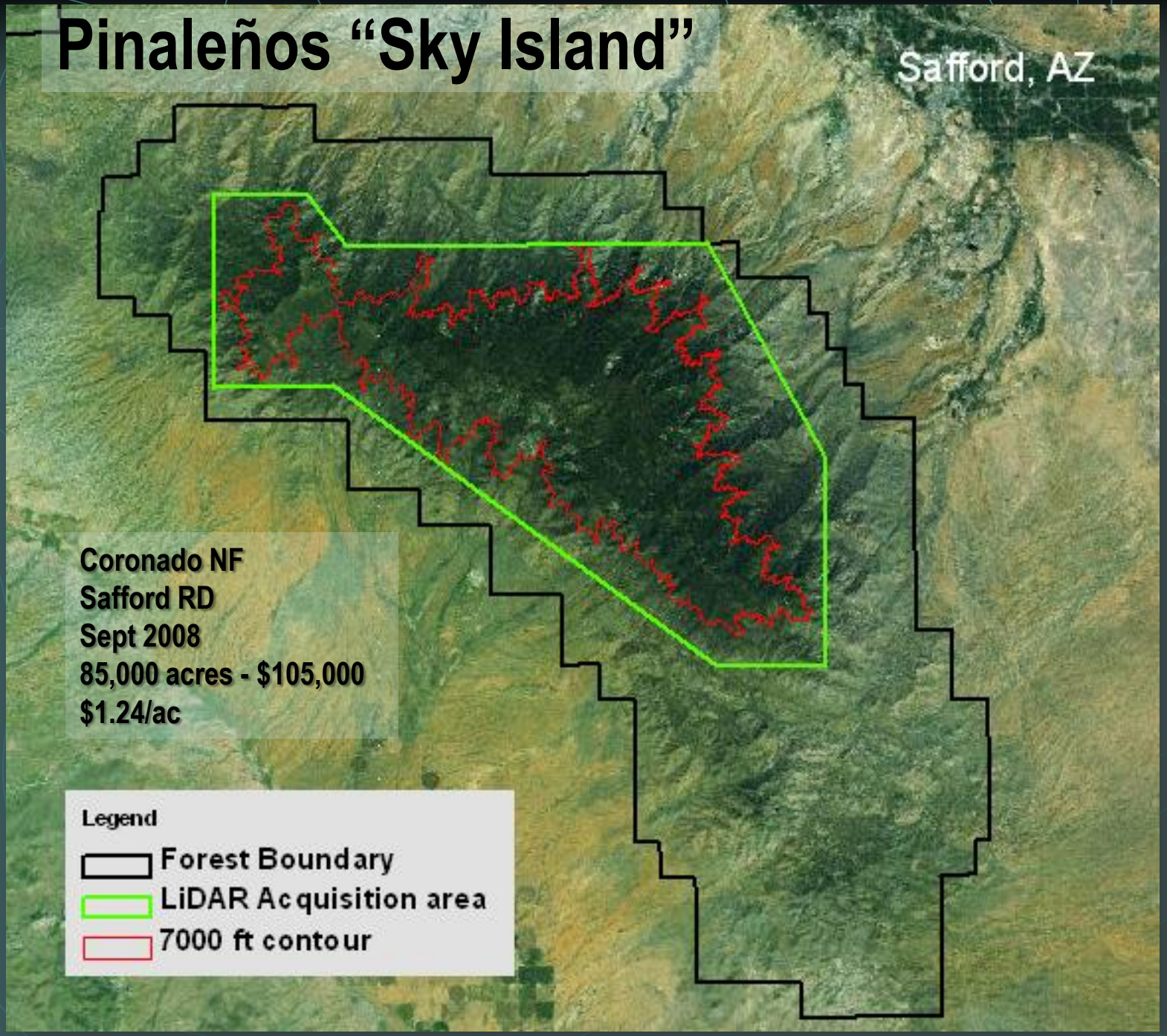
Deliverables: data, reports, processing. media

Report of survey	Text report that describes survey methods; results; vendor's accuracy assessments, including internal consistency and absolute accuracy; and metadata (.pdf, or .doc format).
Aircraft trajectories (SBET files)	Aircraft position (easting, northing, elevation) and attitude (heading, pitch, roll) and GPS time recorded at regular intervals of 1 second or less. May include additional attributes. (ASCII text or shapefile format)
All-return point cloud	List of all valid returns. For each return: GPS week, GPS second, easting, northing, elevation, intensity, return #, retrurn classification. May include additional attributes. No duplicate entries. ASCII text and LAS version 1.1 format 1/64th USGS 7.5 minute quadrangle (0.9375 minute by 0.9375 minute tiles).
Ground point list	List of X.Y.Z coordinate of all identified ground points. ASCII text. 1/4th USGS 7.5 minute quadrangle (0.375 minute by 0.375 minute tiles).
Ground surface model	Raster of ground surface, interpolated via triangulated irregular network from identified ground points. No unavoidable point misclassification. ESRI floating point grid, 2m or 1 m cell size, snapped to (0,0). 1/4th USGS 7.5 minute quadrangle (0.375 minute by 0.375 minute) tiles.
First-return (highest-hit) surface model	Raster of first-return surface, cell heights are highest recorded value within that cell, voids may be filled with ground surface model ESRI floating point grid , 2m or 1m cell size, snapped to (0,0), 1/4th USGS 7.5 minute quadrangle (0.375 minute by 0.375 minute) tiles
Surface models shall have no tiling artifacts and no gaps at tile boundaries. Areas outside survey boundary shall be coded as NoData. Internal voids (e.g. open water, shadowed areas in forest return surface) may be codes as NoData	
Intensity image	Geotiff, 1m pixel size, 1/4th USGS 7.5 minute quadrangle (0.375 minute by 0.375 minute) tiles
Supporting shapefiles	A shapefile of the tiling tessellation (polygon feature) and a shapefile with the tracking of the individual flightlines and flightline swaths (line and polygon features)
Files shall conform to a consistent naming scheme. Files shall have consistent internal formats.	
GPS report	Report on GPS ground control processes including equipment used and location and duration of occupation of base stations
QA/QC statistics and reporting including fieldwork if any was performed	
Descriptive file list documenting the delivered files	
Deliverable media	USB hard drive

Costs and Funding

- Estimates from seven vendors ranged from $0.78 to $4.24/acre
- 2008 Acquisition Funding –
  - $ 45K – Southwest Regional Office
  - $ 25K – Coronado NF
  - $ 35K – Forest Health Monitoring – Interior-West Region
  - Total $ 105K

Pinaleños “Sky Island”



Data Acquisition and Delivery

- Contract awarded to Watershed Sciences in early August 2008
- Data was acquired between September 22nd and September 27th, 2008
- Data delivered early February 2008

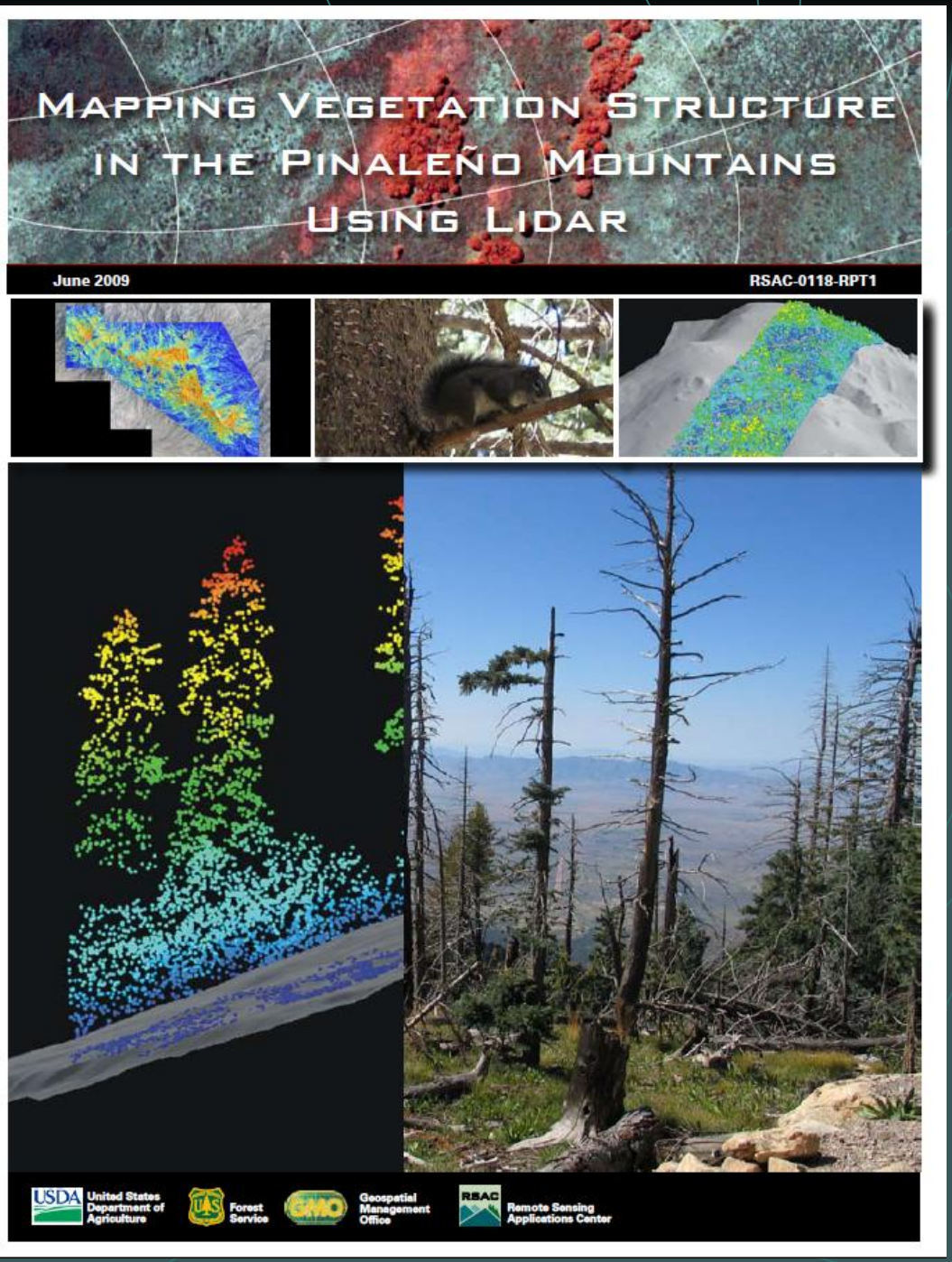
Phase 2 (2009)

Report documents:
Quality Assurance of LiDAR data deliverables (USFS Fusion Catalog, USGS Consistency)

Processing of LiDAR point data to project area grids

(Phase 3)

Link field plots and LiDAR grids to model forest structure

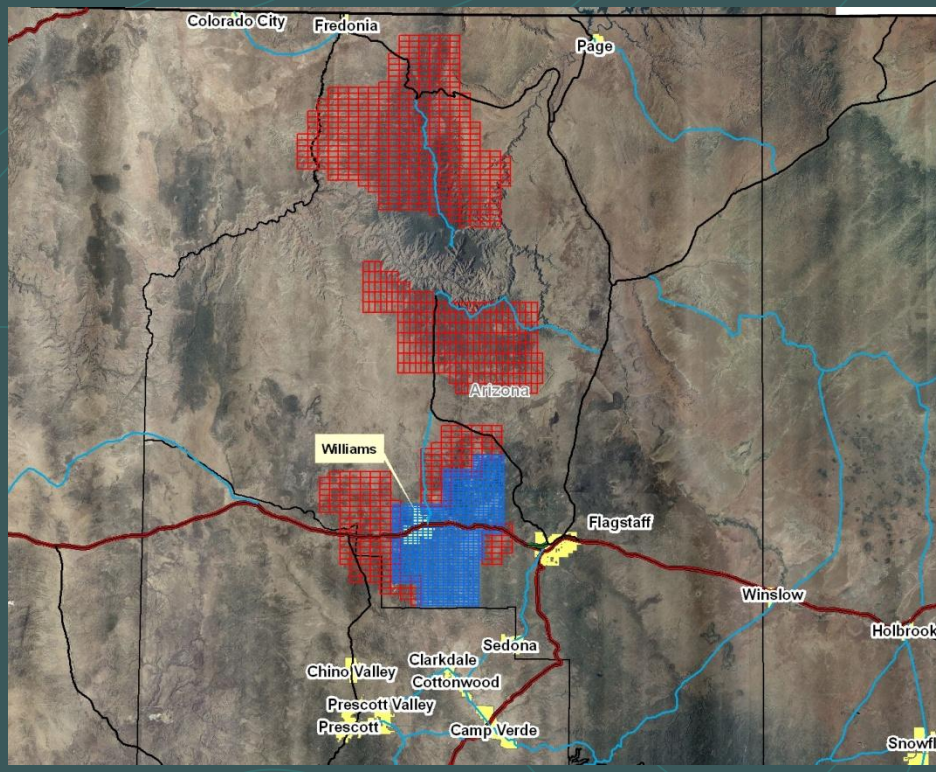


SOUTHWESTERN REGION

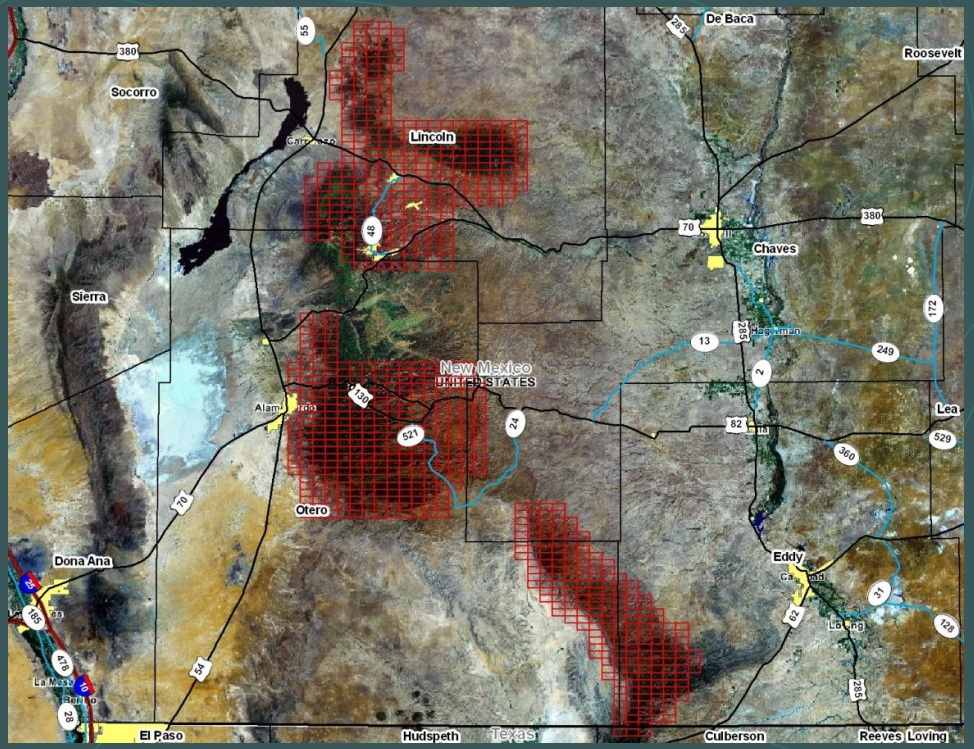
Pete Joria - Remote Sensing
Bart Matthews - Photogrammetry

Photogrammetry Unit

- Resource Aerial Photography
  - Kaibab National Forest
    - 1:24,000 & 1:12,000 Photo Scales
    - 6” Focal Conventional Camera
    - RGB
    - ABGPS
    - 14 Micron scans
    - 1719 Linear Miles Flown
    - 2509 square miles
    - Ordering 1’ and 0.5’ orthos from GSTC

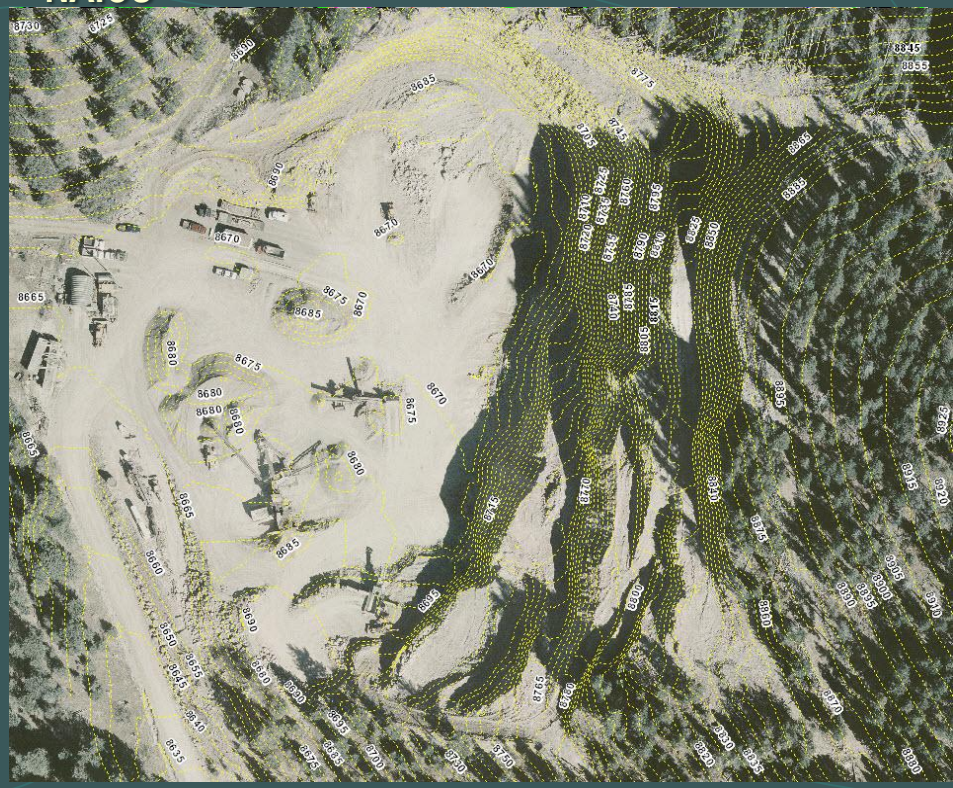


- Resource Aerial Photography
  - Lincoln National Forest
    - 1:24,000 Photo Scale
    - 6” Focal Conventional Camera
    - RGB
    - ABGPS
    - 14 Micron scans
    - 1,223 linear miles flown
    - 1,725 square miles
    - Ordering 1’ orthos from GSTC



- Contracting and Engineering Projects
  - 5 year Indefinite Delivery Indefinite Quantity (IDIQ) for Mapping Services
  - Kaibab Lake Campground Topographic Mapping
  - Flagstaff Center Topographic Mapping
  - Sycamore Canyon Topographic Mapping
  - El Rito Campground Field Survey
  - Apache Gravel Pit Topographic Mapping and Volume Calculations

C -- A&E - Mapping Services
Notice Date
7/16/2009
Notice Type
Presolicitation
NAICS



- Other Projects
  - Large Scale Geodatabase Design Standards
  - 17 roll aerial film indexed and archived at the APFO
  - Legacy photogrammetric project inventory geodatabase dating back to 1990
  - Legacy ground control inventory geodatabase dating back to 1990
  - 2008 NGA/USGS Border Mapping Orthophotography
  - 2009 NAIP of New Mexico Rollout
  - 2005-6 NM CIR DOQQ Forest Lands completed and distributed
  - 2009 NM 10 meter DEM in review for deployment
  - Communication Tower Sites Orthos for Prescott NF – 2005 RO
  - Scanning and rectifying B&W 1936 contact prints of the Lincoln NF
  - Pre and Post Treatment Stands Pilot Studies Orthophotography