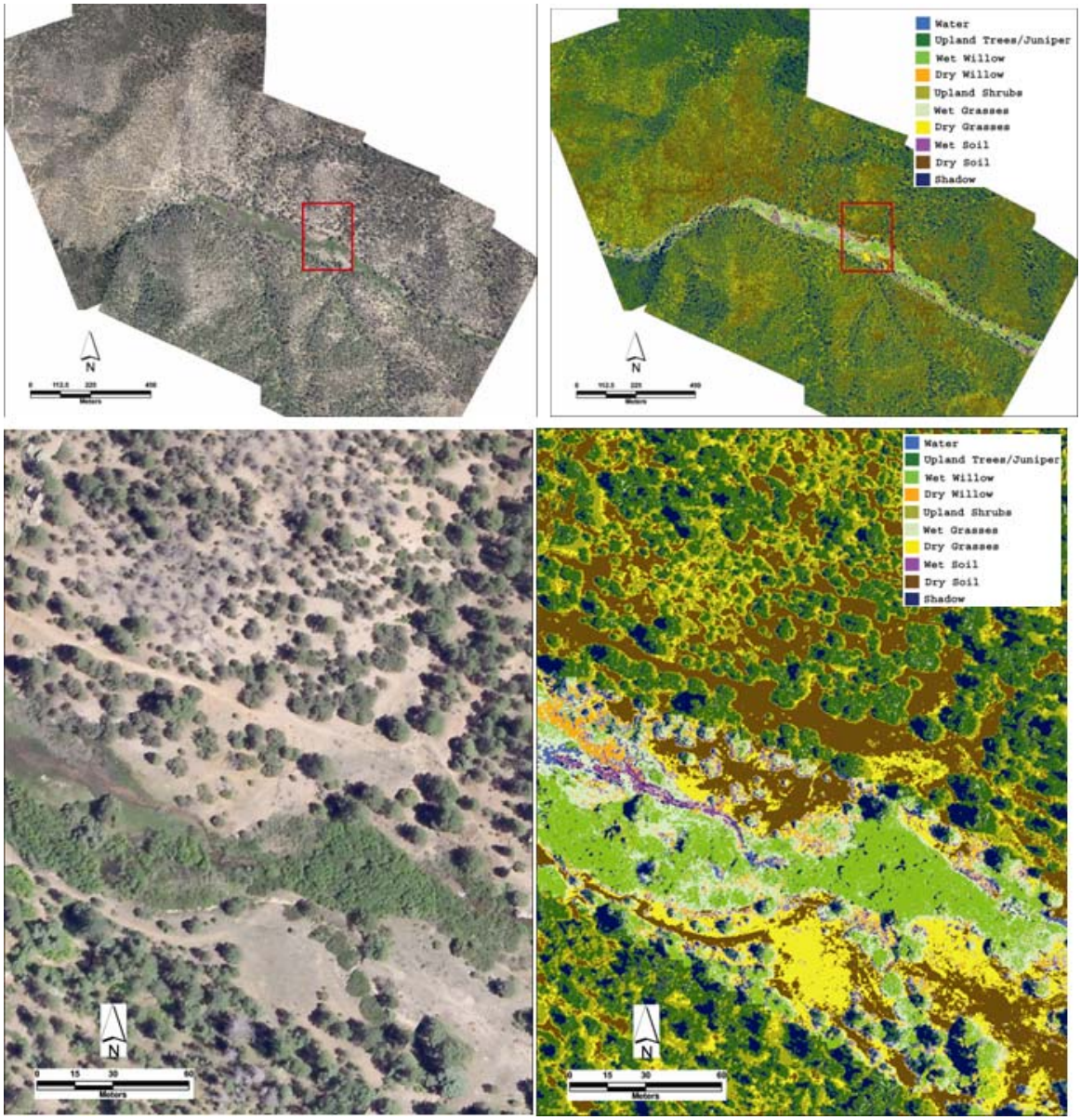
Final Report
June 2010
Hyperspectral and Multispectral Imagery of 30 Reference Wetland Sites in the Upper Rio Grande Watershed Project
Assistance Agreement No. CD-966558-01-0 (FY2007)



Multi-spectal image (left) classified hyperspectral image (right)

Project Description and Location

The NMED Surface Water Quality Bureau (SWQB) Wetlands Program is developing a rapid assessment methodology (NMRAM) for assessing wetlands throughout New Mexico. NMRAM development began with a focus on the Upper Rio Grande watershed as our reference domain**.** We have greatly augmented the development of our regional models by using hyperspectral and ultra-high resolution multi-spectral imagery to help understand macro-topographic features and aerial extent and type of cover classes for our NMRAM reference wetland sites. This imagery covered 45 riverine reference sites-15 more than planned and nearly complete representation within the subclass, within the Upper Rio Grande geographic area north of Velarde, NM (Figure 1). NMRAM development requires precise and scientifically sound measurement of existing conditions of its reference set in order to develop models that distinguish between naturally occurring variables and changes that result from human activities. This imagery greatly improved our on-the-ground data collection, our existing reference wetland data, and provided the demonstration of a significant tool for understanding hydrodynamics, variability, and connectivity within the floodplain environment. This imagery will also be available and greatly enhance our Vegetation Index of Biotic Integrity that is being developed for the Upper Rio Grande reference domain.

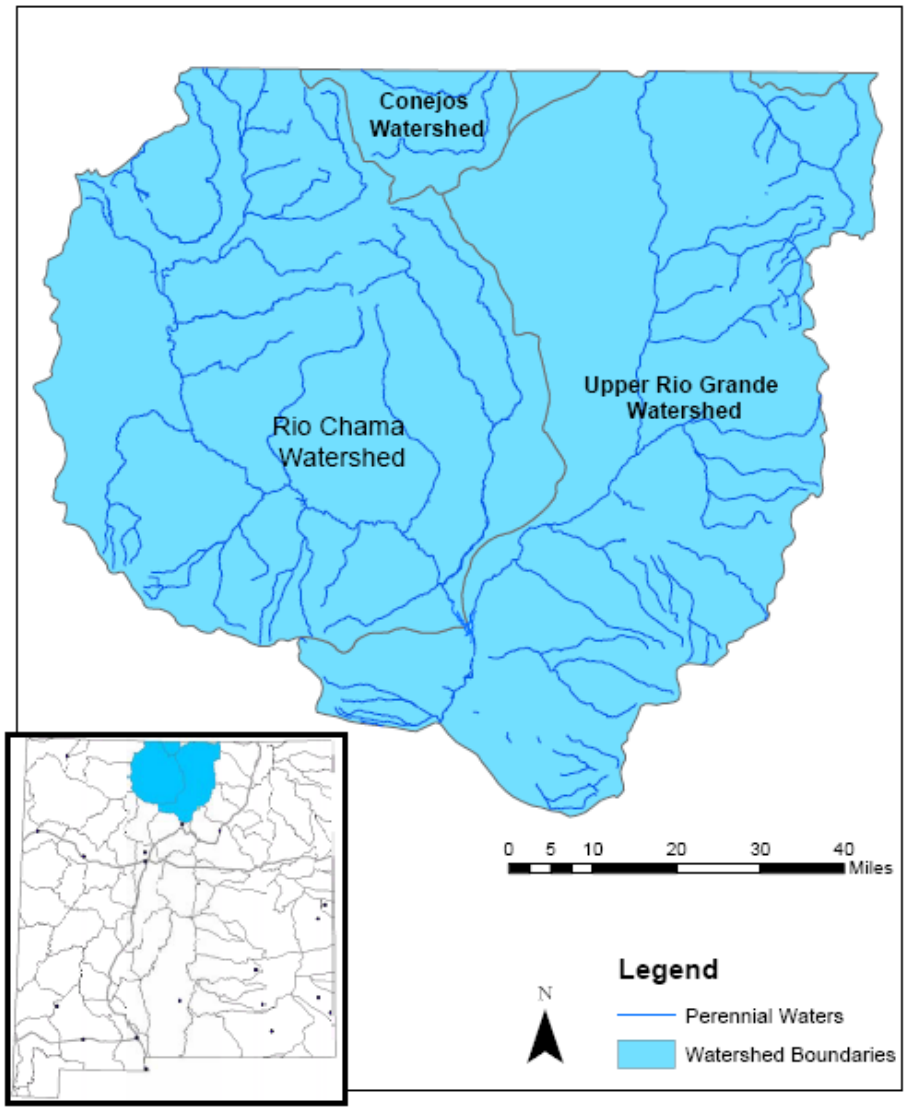


Figure 1. Study Area

The project area is located in central northern New Mexico and comprises the watershed of the Rio Grande from the Colorado-New Mexico border to the confluence of the Rio Embudo with the Rio Grande near Velarde (Figure 2). The subclass of riverine wetlands that were the focus of this project reflect mostly 3rd or 4th –order drainages of tributaries to the Rio Grande. Thirty-one riverine reference sites for the subclass were sampled as part of the NMRAM Assessment project.

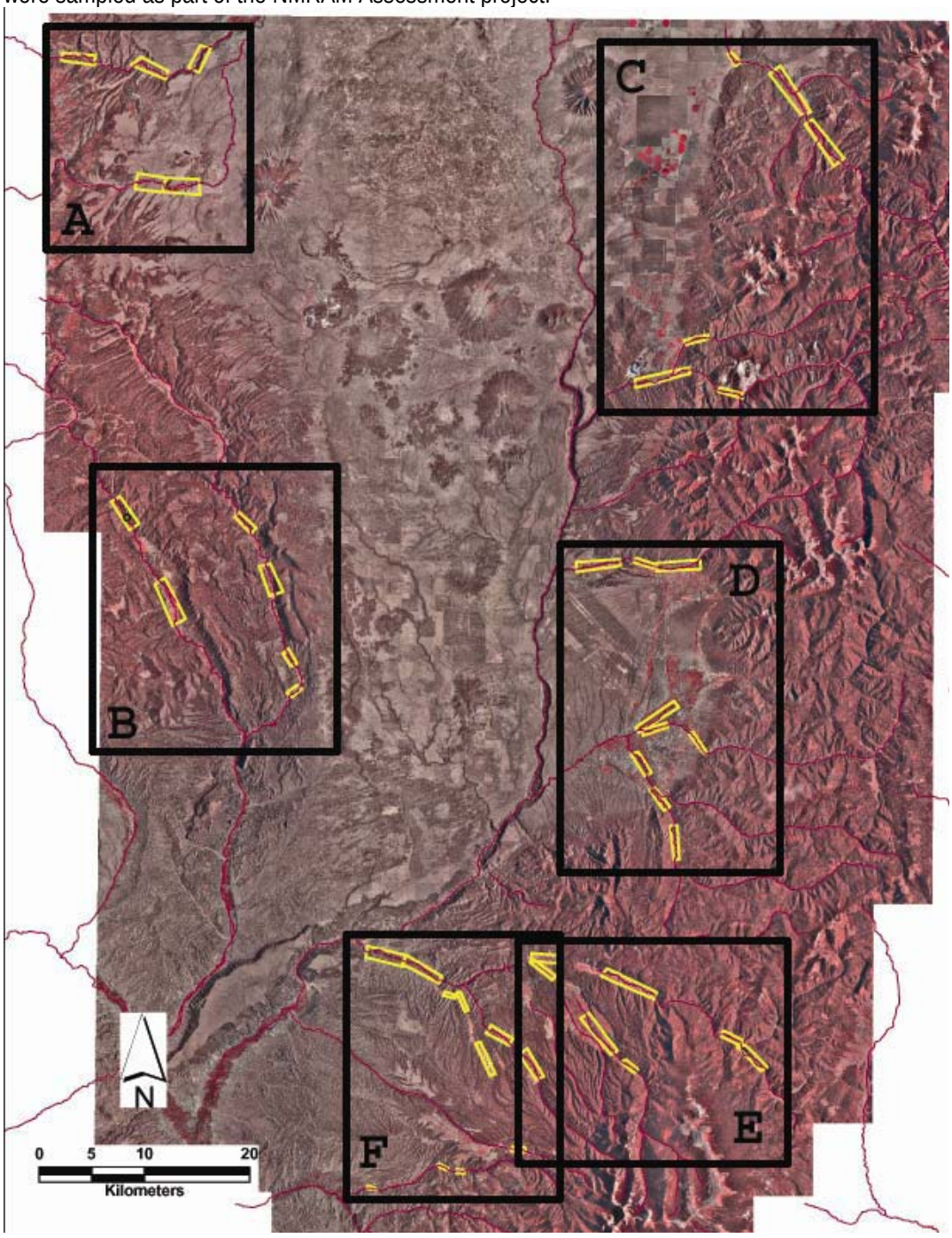


Figure 2. Assessment site polygons flown for Hyperspectral and multispectral Imagery.

Project Goals and Objectives

The goal of this project was to collect high resolution hyperspectral and multispectral imagery from 30 reference wetland sites within a subclass for which the first New Mexico Rapid Assessment Method would be developed (We collected imagery for 45). The ultra-high resolution multispectral imagery would be used by the data collection team as high quality base maps for landscape level (office based) and field data collection during NMRAM development (Figure 3).

Figure 3. Portion of multispectral mosaic for floodplain polygon. This is an example of where the original channel was shifted to the floodplain margin and straightened to make room for larger agricultural fields and the old meander scars of the original channel position are still clearly evident. Irrigation ditches, roads, trails, vegetation, buildings, upland boundaries, agricultural fields are all visible in this multispectral photo. Even more details, such a cows, fences, the river thalweg and trash, are evident when you zoom in.

The hyperspectral imagery was used to develop accurate depiction of plant communities and cover of each wetland subclass polygon beyond the assessment area sampled for the NMRAM, and helped to easily determine vegetation mosaics and percentages of cover types within the subclass. In addition, National Wetlands Inventory (NWI) digital vector data is currently not available for the Upper Rio Grande area, and 1:100,000-scale scanned (not-geo-referenced) NWI maps exist but are 1980's era data. The quality of existing aerial imagery was not nearly as powerful a tool as the imagery collected for this project. The New Mexico Resource Geographic Information System (RGIS) has digital ortho photo quads (DOQs) for the project area flown in 2005-2006 at a scale of 1 meter resolution. Where high resolution imagery was not collected, these images were used and proved to be a poorer tool for easily and accurately recording the condition of the assessed wetland sites. However, the DOQs were good enough to scan to conduct a preliminary selection of wetland sites to be flown for the higher resolution imagery.

Types of information gained from the ultra-high resolution imagery included identification of cover types and accurate percentages of cover, habitat and hydrologic connectivity, and macrotopographic features; help identifying features within an assessment area and defining assessment area boundaries; helping to assess buffer area and describe buffer condition; help choosing sampling sites within cover types; delineating flooplain and upland boundaries and hydrologic boundaries, determining influences of anthropogenic features such as irrigation ditches, bridges, roads and development; determining where to place cross-sections and determining stream type. This project helped achieve EPA National Objective 4.3 by focusing on high quality assessment of wetland condition to be used as a tool for protecting wetlands and mitigating wetlands impacts, and for a clearer understanding of natural processes to be considered as wetland restoration goals. The outcome of this project contributed to improved ecosystem understanding and information that can be used for long-term protection actions. This project contributes to wetland mapping and data collection and provides accurate, up-to date and refined wetland spatial information facilitating the development of New Mexico's Wetland Monitoring and Assessment Program.

Other project goals included information and technology transfer. Presentations, poster sessions and handouts were primarily used to transfer information to other wetland professionals, and to local colleges and school students.

Original Timeframe: A timeline was created for this project that began in May 2008 and was completed by June of 2010. All sites were selected and imagery data collected by Fall 2008. Multi-spectral images were used for NMRAM data collection during the growing season in 2009. The hyperspectral images were classified after data collection from which a legend was developed and classification was completed in April 2010.

Cooperators involved: University of Montana Flathead Biological Station (Dr. Ric Hauer) was the principal partner in this project. UNM Natural Heritage was the lead in developing the NMRAM and used the imagery for that effort, provided the classification legend and reviewed the final classification product. SWQB Wetlands Program was involved in every aspect of project and conducted most of the outreach. Dr. Ric Hauer presented this project at the NM Wetlands Roundtable in June 2010.

Other project partners included:

SWCA Environmental – Subcontractor for the development of the NMRAM
Gonzales Middle School – Project outreach
Santa Fe Watershed Association – Project Outreach
Western New Mexico University –Project Outreach
University of New Mexico – Project Outreach

A number of other participants in NMRAM development including the Advisory Team were provided information from this project. The New Mexico Wetlands Roundtable consists of federal, state, and local government and tribes also were introduced to this project. NGOs were also present at the meeting where this project was presented. A Poster Session and handouts explained this project to other states at the Region 8 Wetlands Conference in Boseman, Montana in September 2010 as continuing outreach after the project was completed.

Funding
The original Federal amount was $122,175 which was spent. The final match amount was **$51,673.44 ($1,373.44 overmatched).** See quarterly and semi-annual reports for details.

Major Project Highlights and Chronology:

- Signatures on the Cooperative Agreement between NMED and EPA were completed November 1, 2007 which commenced the project.

- A contractor workplan and contract between NMED and University of Montana Flathead Biological Station were completed on May 9, 2008.
- A meeting to select sites and outline the reference domain was conducted May 12-13, 2008.
- The Project QAPP was completed May 25, 2008.
- A flight plan was developed and the 45 selected reference polygons were flown for multi-spectral imagery in June 2008.
- JPEGs of all multi-spectral images were transferred to the Wetlands Program Coordinator in July 2008 for project verification.
- The multi-spectral images were used for the NMRAM pilot study in September 2008 (Figure 4).

Figure 4. Each participant had a packet with the multi-spectral images of the reference sites.

- Each site was again flown to obtain hyperspectral imagery in September 2008.
- A timeline amendment was approved by EPA in February 2009, to extend this project until June 30, 2010 to complete the image classification verified by using vegetation data collected by the NMRAM team in late summer 2009.
- A draft vegetation classification was developed by UNM Natural Heritage in April 2009. However this classification was not based on any field data. University of Montana used it to complete draft classification of 10 polygons by May 2009.
- All georectification and mosaiking was completed by April 2009 and transferred to UNM Natural Heritage to our GIS formatted NMRAM database for NMRAM development.
- The images were used extensively for NMRAM data collection during September 2009. Multi-spectral images were printed and included as part of the NMRAM data collection packet. Potential AAs were delineated and a grid placed on the image to help characterize spatially the AA and buffer areas. Multispectral images were also used to determine the extent of plant communities and physical features that determined AA boundaries including hydrologic breaks (Figures 5, 6 and 7.)

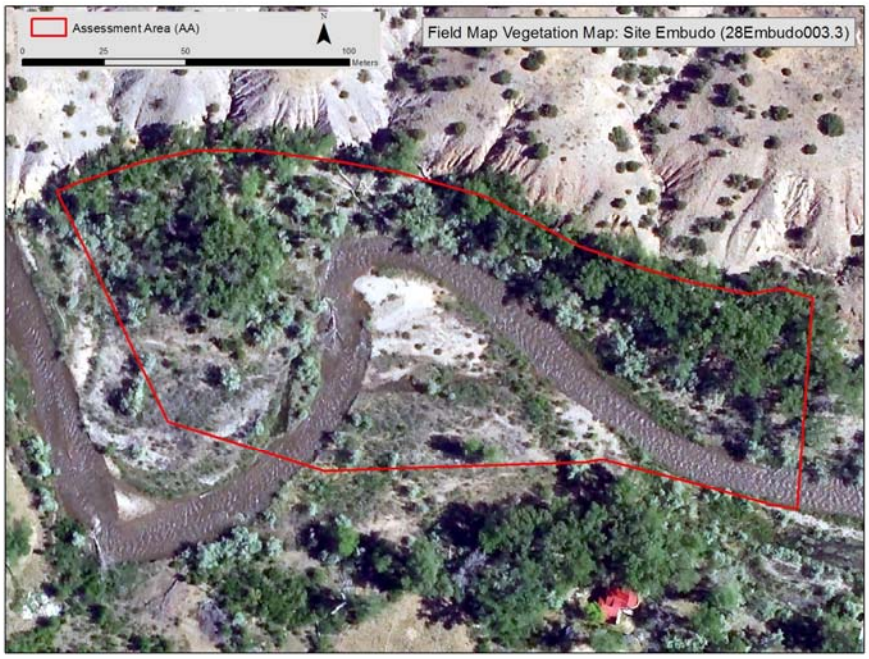


Figure 5. Assessment Area outlined on multispectral mosaiked and georectified image.

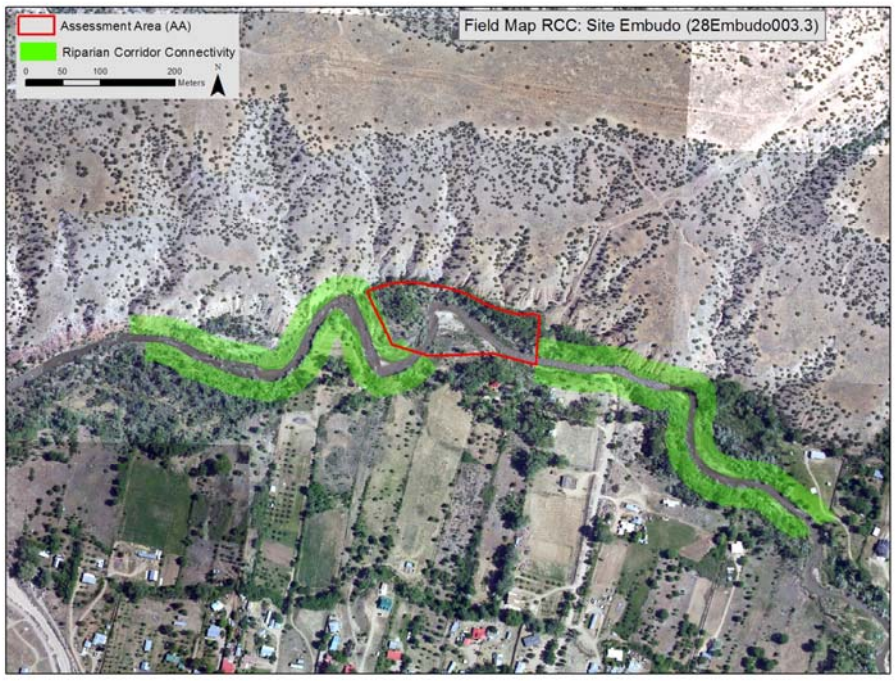


Figure 6. Riparian corridor connectivity outlined on mosaiked and georectified multi-spectral image.

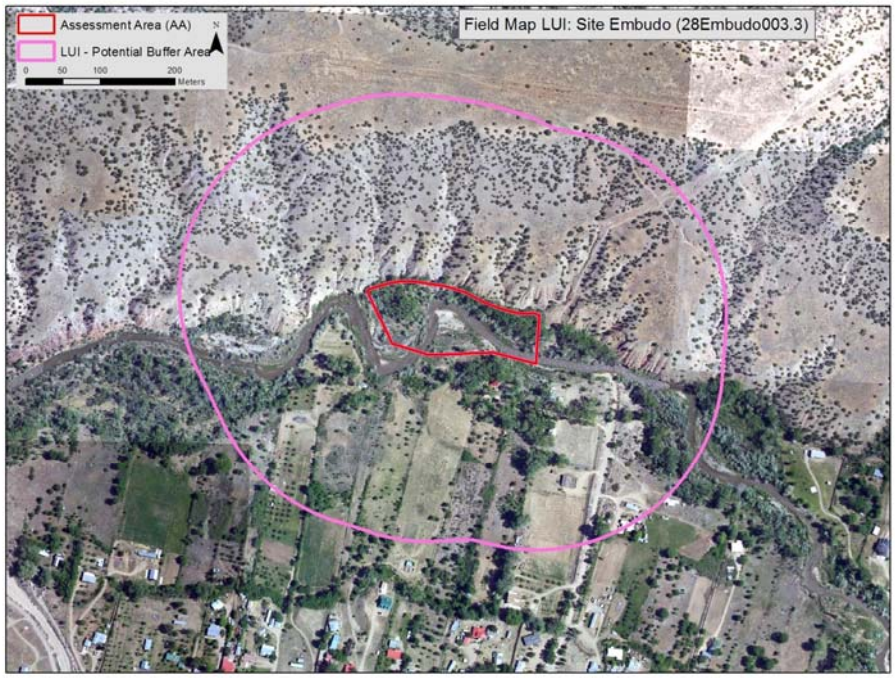


Figure 7. Land Use Index and Buffer Integrity data for NMRAM development taken from multispectral images like this.

- The draft classification for the hyperspectral images was ground-truthed using the data collected.
- A revised master classification was transferred to University of Montana from UNM Natural Heritage in March 2010 for revision and completion of the hyperspectral image classification.
- The Wetlands Program Coordinator made the first College presentation at UNM Sustainability Expo on April 22, 2010 (Figures 8 and 9.)(outreach)

Figure 8. Base map and mosaiked figure used for demonstrating to the public at the Sustainability Expo at UNM.

Figure 9. UNM Sustainability Expo Wetlands Table Exhibit.

- On April 28, the Wetlands Program Coordinator and NMED Administrative Assistant staffed a Wetlands science table at the Gonzales School Careers and Curiosity in Math and Science Day (Figure 10) (outreach).

Figure 10. Gonzales Elementary Wetlands Career Day Table (April 28, 2010) staffed by Maryann McGraw. Julie Roybal assisted and took the photograph.

- A conference call was conducted in April 2010 by SWQB Wetlands Program with UNM Natural Heritage and University of Montana to complete the classification by June 2010.
- Maryann McGraw (Wetlands Program Coordinator and Jenny Griffith (WNMU Student) had poster presentations and table exhibits about New Mexico Wetlands at Western New Mexico University on May 4, 2010 (Figure 11)(outreach). The poster/handouts examples are attached.

Figure 11. WNMU Career Fair poster session and table exhibit with handouts.

- The classification was completed by University of Montana on and all metadata related to data acquisition was transferred to the SWQB Wetlands Program on a portable hard drive by June 2010.
- Maryann McGraw had an exhibit table at the Santa Fe River Water Festival on June 4, 2010 (outreach).
- Dr. Ric Hauer made an excellent presentation to the NM Wetlands Roundtable on June 10, 2010 (outreach).
- It was concluded that both the classified hyperspectral images and the multi-spectral images will be a great asset for the development of a Vegetation IBI for the project area (Figure 12) (future).

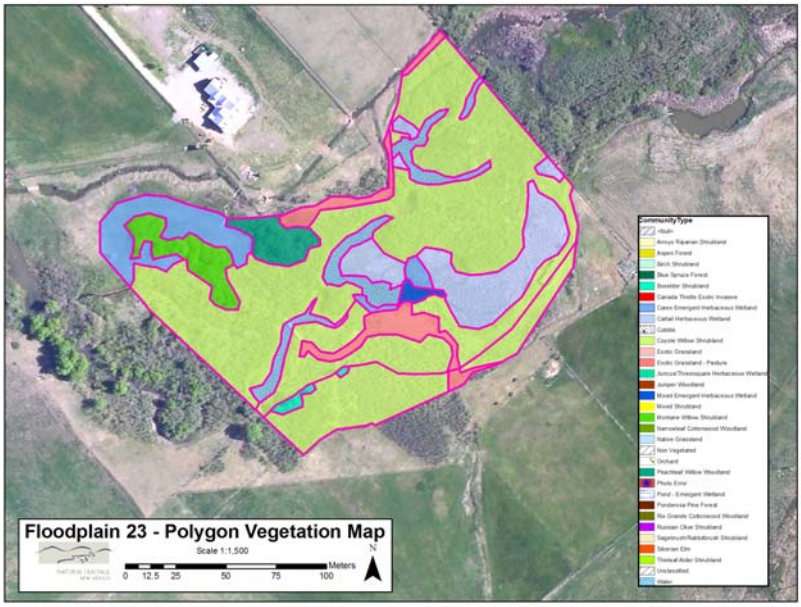


Figure 12. Vegetation classification superimposed on multi-spectral image.

- The project poster session will be presented at EPA Region 8 Wetlands Conference in Boseman, Montana in September, 2010 (future).
- This Final Report was submitted on February 15, 2011.

List of Major Deliverables:
JPEGS of Multi-spectral Images
Mosaikied and georectified multi-spectral images
Hyperspectral images with draft classification
Hyperspectral images with final classification
Meta-data (Note: the Imagery and metadata comprises over 150 gB and is on file at SWQB, UNM Nat. Her., and U Montana Flathead Biological Station)
Handouts
Posters
Presentations
Semi-Annual and Final Reports, Match reporting

Lessons Learned
What made the project successful?
The project was most successful in providing ultra-high resolution multi-spectral images of nearly complete representation of the subclass. This made the development of NMRAM more confident and the data collection from our reference sites much higher quality.
What made the project not so successful?
Because there was no previous vegetation data from the project area, the classification of the hyperspectral images took more time and were redone when veg. data was eventually available from the NMRAM data collection.
What would you do differently in terms of effectiveness?
The next time we are going to use the multispectral images for the classification as well thereby reducing the costs of flying the sites twice.

Technical Transfer
What information can you pass along to other agencies, cooperators or local landowners in other watersheds about this project?
These images will be available to other agencies for additional applications including to USFWS to complete National Wetlands Inventory mapping for the area which presently does not exist.

EPA Feedback Loop
What would you suggest that EPA do differently to improve the process in regard to this project? What about other federal partners, if any?
Nothing to report.

Future Activity Recommendations
Collect multi-spectral imagery for additional sites that will be used to develop NMRAM for other subclasses, especially where other imagery and data are not available.

Attachments: Outreach Handouts