# Geographic Information System (GIS) Research – Image Acquisition and Processing

Contract Number: BDK# 83 WO 977-06

April 2010

Final Report

# DISCLAIMER

"The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation."

**Technical Report Documentation Page**

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle<br>GIS Research - Image Acquisition and Processing | | 5. Report Date<br>April 2010 |
| | | 6. Performing Organization Code<br>Florida State University |
| 7. Author(s)<br>Stephen W. Hodge | | 8. Performing Organization Report No. |
| 9. Performing Organization Name and Address<br>Florida State University<br>296 Champions Way - FREAC<br>C 2200 University Center<br>Tallahassee, Florida 32306-2641 | | 10. Work Unit No. (TRAIS) |
| | | 11. Contract or Grant No.<br>BDK83 WO 977-06 |
| 12. Sponsoring Agency Name and Address<br>Florida Department of Transportation<br>605 Suwannee Street, MS 30<br>Tallahassee, Florida 32399 | | 13. Type of Report and Period Covered<br>Final Report<br>April 1, 2009 – June 30, 2010 |
| | | 14. Sponsoring Agency Code |
| 15. Supplementary Notes | | |

16. Abstract

The GIS basemap is primarily an Arc/INFO coverage comprised of arcs, nodes, and a route system that geographically represents the roadways maintained in the Roadway Characteristics Inventory (RCI). Because of Florida's continued rapid growth, up-to-date imagery is constantly needed to help maintain the road system and plan for the future. The purpose of this project is to research the existence of the most recent digital aerial imagery available statewide, and to acquire, process, and provide the imagery to the Florida Department of Transportation (FDOT) Transportation Statistics Office.

As a result of this project the FDOT has been able to acquire updated high resolution imagery for 34 of Florida's 67 counties. The master inventory of the acquired imagery was updated, the imagery processed and finally reformatted for use in the FDOT's Transportation Statistics Office and throughout other offices as well.

The FDOT can now more effectively manage the basemap, which is used for many purposes, including the following:

- Providing a QA tool for RCI feature lengths
- Dynamic segmentation - the creation of GIS data layers from RCI features
- Map production
- Creation of the state's city-to-city mileage matrix
- Modeling

By utilizing the imagery in conjunction with the basemap, FDOT can also accomplish the following:

- Derive information that would otherwise have to be derived in the field, such as road curvature, intersection direction, and others.
- Conduct historical analysis, especially with regard to realignments, roads that may no longer be used, and other characteristics.

| 17. Key Word | 18. Distribution Statement |
|---|---|
| GIS, Imagery, DOQQ, Orthoimagery | No Restrictions |

| 19. Security Classification. (of this report) | 20. Security Classification. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 17 | |

**Form DOT F 1700.7** (8-72) Reproduction of completed page authorized

## Executive Summary

The 2025 Florida Transportation Plan (FTP), developed in 2005, provides the framework for how the state will meet the various transportation needs of not just its citizens, but also tourists and businesses. Federal, state, regional, local, and private entities will invest over $161 billion in this system over the next two decades. These investments will be a key determinant of whether Florida is able to meet its economic and livability goals. The plan provides goals and objects for all aspects of transportation planning and also offers guidance on how transportation funds should be directed during constrained funding times.[1]

Visualization of existing transportation infrastructure, land use, and population growth patterns is essential to planning for an effective Strategic Intermodal System in Florida.[2] Up-to-date aerial photography serves as a vital tool for planners, statisticians, and others involved in looking ahead for what is needed to ensure the mobility of people and commerce in an ever changing and evolving future.

In planning for future road improvements and development, the Florida Department of Transportation (FDOT) often uses aerial photography. Although the older United States Geological Survey (USGS) one meter imagery is still used for some planning and retrospective views, the one foot high resolution imagery county datasets have become a vital part of FDOT's planning activities. Due to budget constraints, the USGS no longer has a work program to capture imagery on a state-wide effort but is willing to partner with organizations capturing imagery for strategic US cities.[3] During this contract period, Florida was able to secure over $240,000 for image acquisition projects.

The Florida Department of Revenue (DOR) has as one of its mandates the requirement to supply aerial photography to each of Florida's counties every three years. For the most part, DOR has been coordinating the contracting of these projects and paying for them with state allocated funds. A handful of the more populous counties handle their own projects and have slightly different products to work with but follow the DOR specification fairly closely. Recent legislation changes the level of funding for this effort and may affect the availability of imagery in the future.

As budgets continue to be squeezed in this economic climate it will be interesting to see if there is any attempt to acquire imagery less often or to use more relaxed standards in the future. A bill during the 2010 session in fact attempted to change the interval for imagery acquisition for the smaller less populated counties to five years, but it did not pass. Either one of these would impact the ability of the FDOT to effectively plan for the future.

This project addresses the process of finding the most accurate and up-to-date imagery available in Florida and supplying it to the Transportation Statistics Office for use in assessing Florida's road

[1] 2025 Florida Transportation Plan, http://www.dot.state.fl.us/planning/ftp/2025FTP-LowRes.pdf

[2] Florida's Strategic Intermodal System, A transportation system to guide strategic investments linked to Florida's future economy, http://www.dot.state.fl.us/planning/sis/

[3] The 133 Urban Areas initiative is part of the Homeland Security Information Program (HSIP), and has its origins in the Nunn-Lugar-Domenici Act (Defense Against Weapons of Mass Destruction Act 1996) where the Department of Defense was tasked to assist state and local governments in preparing for and responding to chemical, biological and nuclear incidents in 120 major cities. After 9-11, National Geospatial Intelligence Agency (NGA) and USGS expanded the list to 133 by adding the remaining state capitals not on the original list.

systems and planning for the future. An inventory of imagery was produced and used to track the process of modifying the imagery to meet the GIS needs of the FDOT. Imagery for 34 counties has been made available as a result of this project.

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## Introduction

With Florida continuing to lead the nation in many growth areas, there is often need for the most up-to-date and accurate imagery in order to keep up with the dynamic nature of Florida's roads. Accurate and up-to-date imagery is needed to better understand what the true situation is on the ground. From new road planning, to intersection improvements, being able to see exactly what the ground conditions are from an office environment saves the department both time and money. Aerial photography has always played an important role at the Florida Department of Transportation (FDOT), but with improvements in quality and timeliness of the imagery more detailed work can now be accomplished without field work and in an expedited manner.

The Transportation Statistics Office GIS Support Section at the FDOT is responsible for maintaining the Florida official GIS basemap. The basemap is an ArcInfo (ESRI) route coverage of the State Highway System, and is a geographic representation of the roads maintained in the Department's Roadway Characteristics Inventory (RCI). The format used to store the roads is currently being updated by FDOT employees to take advantage of ESRI's newest software release, ArcGIS 9.3. The basemap is modified daily by the Transportation Statistics Office GIS Support Section utilizing the high resolution (better than one meter) imagery provided by previous research projects as the source for these editing tasks.

## Inventory

The inventory of available imagery has been maintained with a system developed from previously funded projects. Florida Resources and Environmental Analysis Center (FREAC) continues to work with the Florida Department of Revenue (DOR) as the main point of contact. Detailed lists were obtained that indicated the schedules for imagery acquisition planned for a three years horizon. The list included what organization was in charge of acquisition, resolution, and miscellaneous other relevant data.

Only true color imagery was considered for this project. Most of the imagery acquisition projects in Florida are coordinated through either DOR or the water management districts. True color imagery works best for the majority of the needs of these agencies and their constituents. All of the imagery used for this project was captured using digital camera technology rather than film. Digital imagery is more accurate, less expensive, and eliminates the scanning and associated film issues (scanner calibration, film development, etc) that had to be dealt with previously.

Other state departments were contacted concerning the availability of imagery. Many of them had image data sets, but because this project is specifically looking for ortho-rectified imagery and complete county coverage, no other state agency contacted was able to provide additional data sets.

Figure 1 shows the three year plan that covered this contract period.

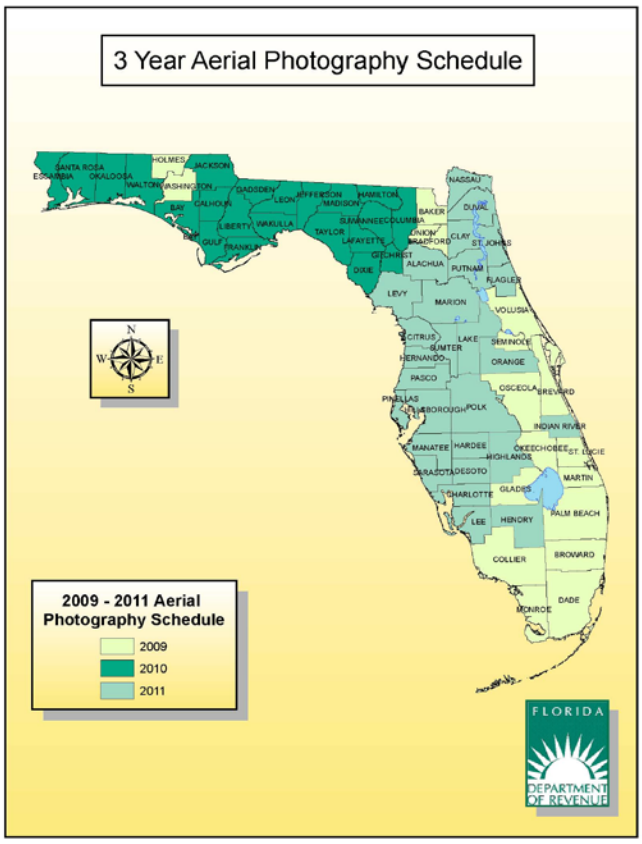


Figure 1. Three Year Image Acquisition Plan

## Documentation - Metadata Collector and Data Retrieval

The importance of metadata (data/information about data) is becoming more and more important as there are an ever increasing number of image data sets available in Florida. Descriptions of the imagery are necessary not only to keep up with what data is available, but also knowledge of details about that imagery is essential for understanding exactly what the data represents.

The concept of metadata has been around for a long time but is something that is often ignored by many data managers. Metadata is now a required part of all ortho-photography collected for Florida government agencies. The metadata must pass the Federal Geographic Data Committee's (FGDC – http://www.fgdc.gov) validation (http://geo-nsdi.er.usgs.gov/validation/) routines before FREAC will begin processing the data for FDOT.

FREAC continues to catalog all new image data sets in the Florida Geospatial Metadata Index (http://clearinghouse.labins.org). Figure 2 below shows the home page for the Clearinghouse. The system will allow the user to search for specific image datasets or browse through all that have been entered.

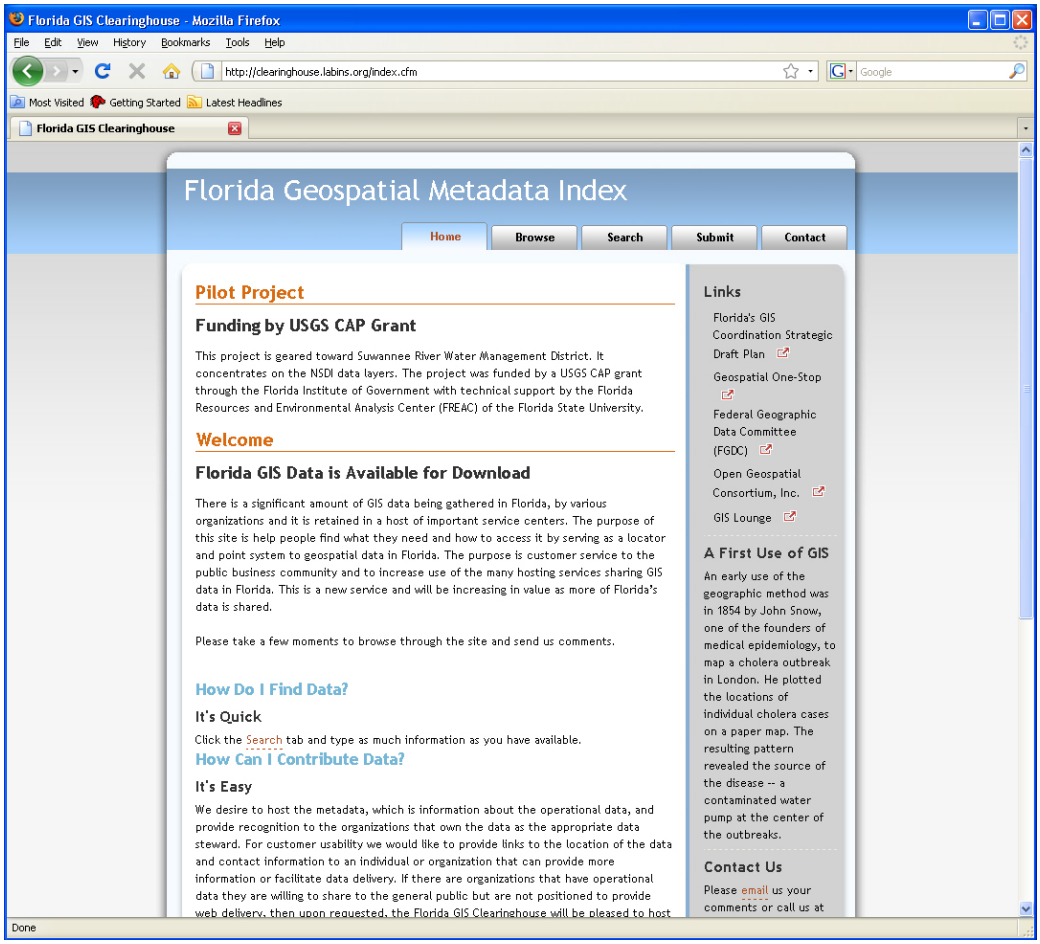


Figure 2. Florida Geospatial Metadata Index Home Page.

For more details about this system please see the final report for contract number BD# 543 WO 11. This system continues to feed the national metadata portal referred to as Geospatial One Stop or GOS (http://www.geodata.gov).

Figure 3 below shows the front page for the GOS.

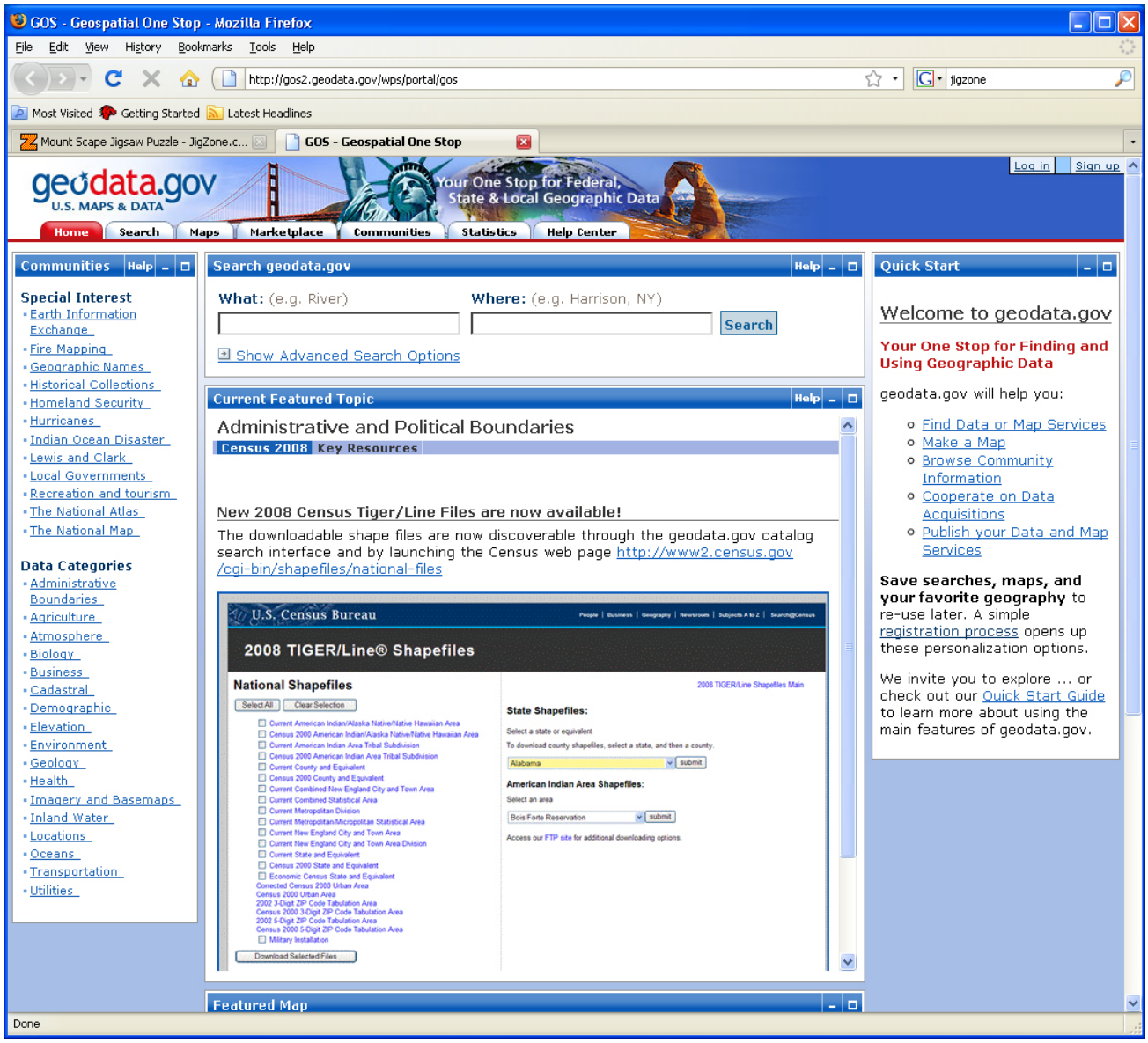


Figure 3. The National Geospatial Clearinghouse.

Additionally FREAC worked with three water management districts to develop a new inventory tool that is designed specifically for imagery. The website allows users to sort and search all of the high resolution imagery datasets acquired since 2006 and has easy access to both the metadata and a

footprint that describes the extent of the dataset. The site can be found on the front page of LABINS (http://www.labins.org) or directly with this link: http://mumrah.freac.fsu.edu/SWFWMD/imageryhome/.

Figure 4 shows a typical results page for a query of Broward and Palm Beach Counties and any year.

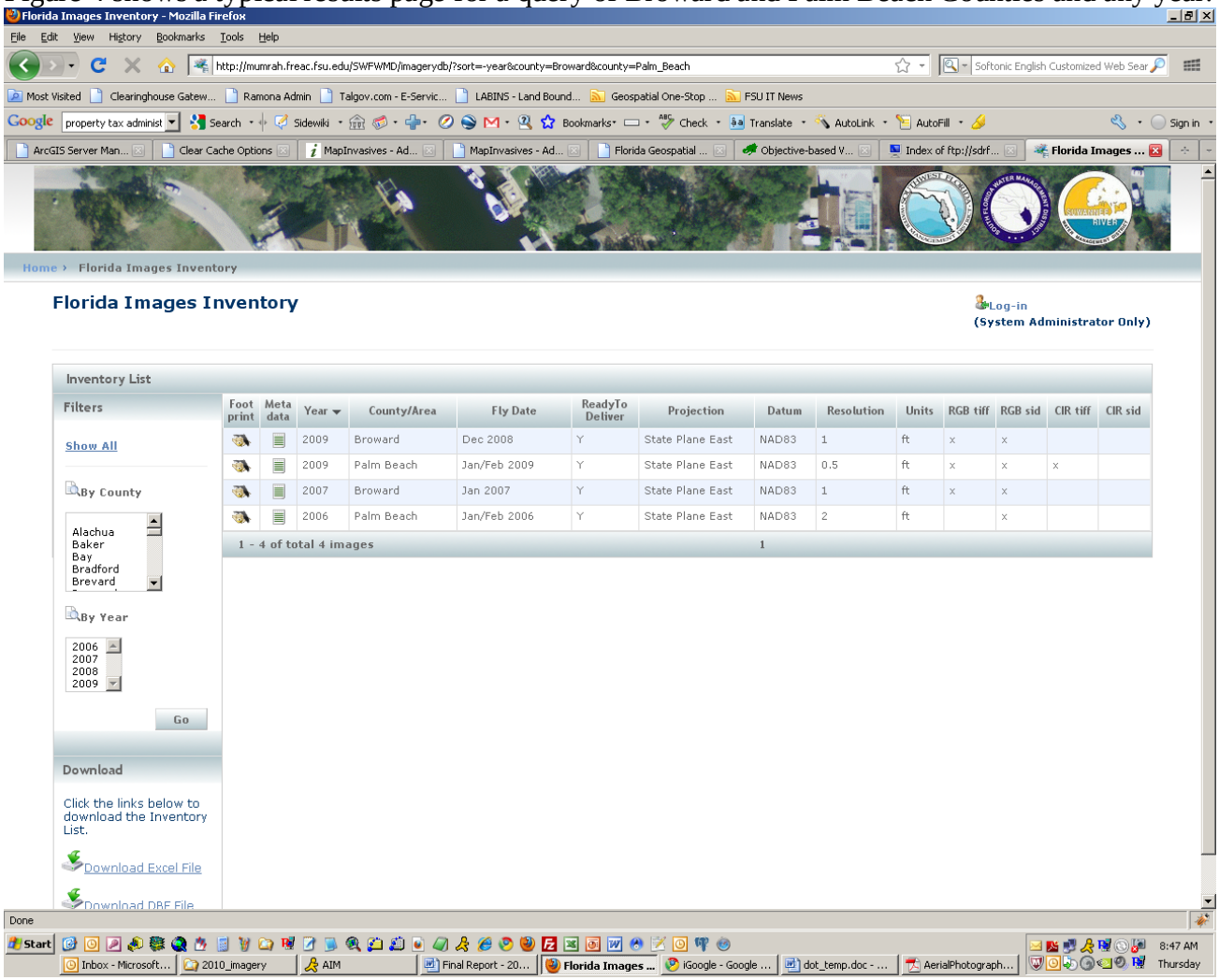


Figure 4. Florida Image Inventory Website.

## Data Management

The gridding and naming convention used in past contracts was continued without changes for this contract.

### The Grid

All vendors supplying data for this project used the state of Florida's agreed upon LiDAR and imagery grid to deliver individual tiles of imagery. This helps speed the processing because certain custom routines can be used again to process the same county imagery from different years.

FREAC continued to use the 2,000 meter grid agreed upon in an earlier contract. A point in the Gulf of Mexico was strategically chosen so as to ensure that the lower left coordinates of each grid or cell would always be whole numbers and ending with the last three digits of "000." This would be critical to the naming convention explained in the next section. Figure 5 below shows a small section of the grid in Escambia County.

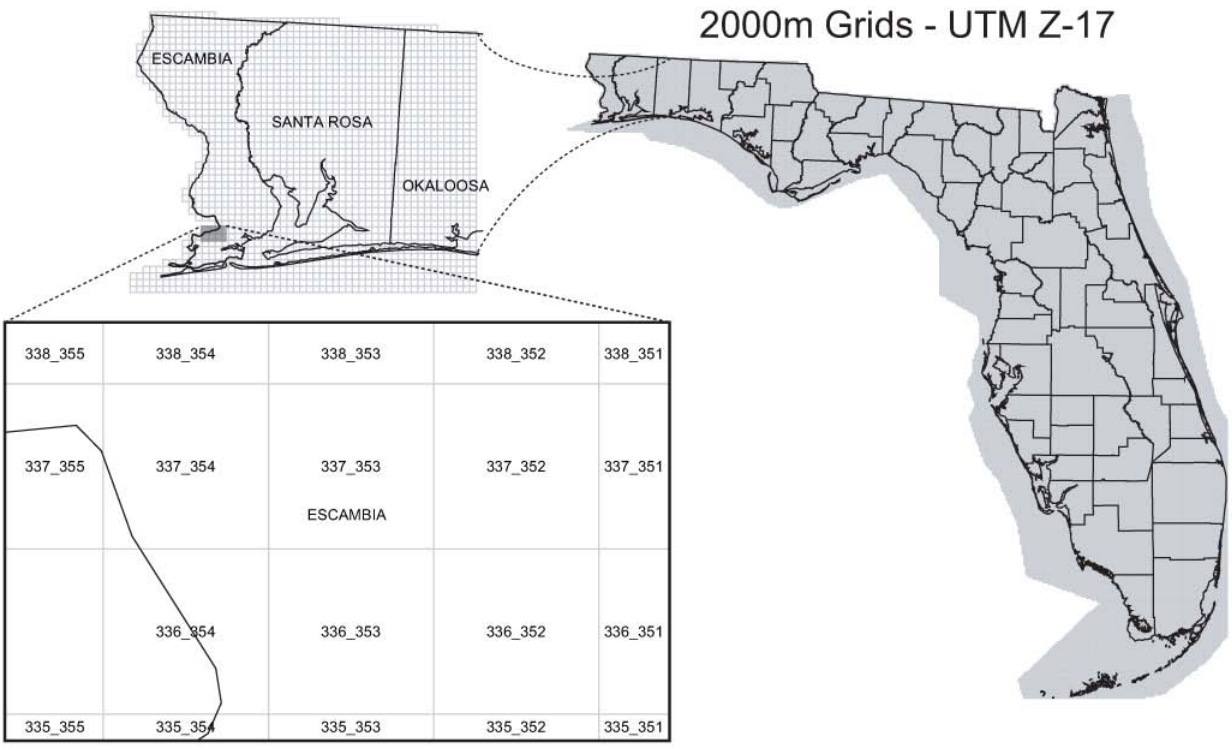


Figure 5. 2000 Meter Grid Naming Convention.

**The Image Name**

The image naming convention developed in an earlier contract was used to name the tiled images in this contract as well.

Example:

7_262_067_2009_002.jpg

7 – Projection is UTM
262 – Row number
067 – Column number
2009 – Year the images was captured
002 – Image collection number

**(IMPORTANT NOTE: A typical flying season for Florida is from late November to late March. For example imagery for a county may have been collected during late December of 2007 and early January of 2008. Another example might be that imagery was completely captured in February of 2008. Up until 2008 the year portion of the name would have been 2007 in both previous examples. For the 2007-2008 flying season and beyond the year portion for the examples will be the later of the two years (2008 for the examples). The original strategy led to some confusion with users of the imagery. The users might find out that a particular county had 2008 imagery and that only the 2007 imagery was loaded into the DOT system. In fact DOT had the latest imagery, it was just named differently. This new naming strategy will produce what looks like a gap (no 2007 imagery) in the image datasets that in fact doesn't exist.)**

## The Process

The objective of this project is to re-project high resolution aerial photos of Florida counties to a Universal Transverse Mercator (UTM) Zone 17 projection using the North American Datum (NAD) for 1983 (GRS80) and clip them to a 2000 meter grid. The final product is a JPG image with 25% compression and second order standard deviation stretch.

Since the resolution of the photos ranged from one quarter of a foot to two feet, to keep a realistic file size for the output image, a new grid of 2000 meter quadrates for the entire state was created (Figure 5.) The re-projected aerial photos were then clipped to this new grid. The output files are named using the naming convention established in a previous project.

During the contract period several counties were acquired at one half foot resolution rather than the more standard one foot. This meant that there were four times as many images to process, dramatically increasing processing time and increasing storage requirements by the same factor of four. FDOT has decided that the increased storage requirements are not worth the added resolution. All imagery less than one foot was resampled up to one foot.

Processing was done using ERDAS Imagine 9.3, ArcGIS 9.2 and 9.3, and Microsoft Access 2000 software packages. Processing the imagery was performed using guidelines and procedures developed in previous contract work. Minor modifications were made as needed.

More details of strategies that were developed as part of previous contract work to deal with specific issues such as black edges and image resolution can be found in the final report for contract number BD# 543 WO# 11.

## Other Activities

FREAC continues to work with various state agencies, water management districts, and counties in an effort to ensure that orthoimagery is collected in a consistent manner and that agreed upon standards are used throughout the collection process. A draft document has been developed as a result of these efforts that can serve to guide organizations with the management of orthophotography acquisition projects. This document will become more and more important in the future as counties opt out of a DOR managed project for one that is run by the county itself. The document will hopefully help these projects produce imagery that will successfully feed into the processes that are a part of FDOT imagery contracts.

Table 1 shows the counties that were processed for this contract. The Sequence ID column is what is used to link back to the metadata for the particular county image data set.

**Counties Processed**

| County | Sequence ID |
|---|---|
| Bradford | 2009_010 |
| Brevard | 2009_020 |
| Broward | 2009_009 |
| Charlotte | 2009_016 |
| Citrus | 2009_021 |
| Clay | 2009_030 |
| Collier | 2009_005 |
| De Soto | 2009_022 |
| Glades | 2009_002 |
| Hardee | 2009_023 |
| Hernando | 2009_024 |
| Highlands | 2008_018 |
| Hillsborough | 2009_017 |
| Hillsborough | 2008_019 |
| Holmes | 2009_006 |
| Indian River | 2009_014 |
| Lake | 2008_020 |

| County | Sequence ID |
|---|---|
| Leon | 2009_018 |
| Manatee | 2009_025 |
| Martin | 2009_007 |
| Miami-Dade | 2009_003 |
| Monroe | 2009_004 |
| Okeechobee | 2009_027 |
| Palm Beach | 2009_019 |
| Pasco | 2009_028 |
| Pinellas | 2009_015 |
| Santa Rosa | 2006_024 |
| Sarasota | 2009_026 |
| Seminole | 2009_001 |
| St Lucie | 2009_013 |
| Sumter | 2009_029 |
| Union | 2009_011 |
| Volusia | 2009_012 |
| Washington | 2009_008 |

Table 1. Processed Counties and Their Respective Sequence IDs.

## Appendix A. Processed Counties by Quarter

The following is a list of counties processed for contract BDK83 – WO 977-06.

A particular county that appears near itself chronologically in the list does so for several reasons. A problem may have been discovered with the processing of the imagery or problems with the original imagery have at times caused counties or parts of counties to be re-processed. Various strategies were used to look for problems with imagery both before and after the images were processed. The sixteen (ten full and six partial) counties in the Southwest Florida Water Management District have been on an acquisition schedule of every year since 2006. As a general practice, FREAC pushes these counties to the end of the priority order knowing that the oldest data set that DOT would have would be about one year old whereas the other 57 complete counties are on an approximate three year acquisition schedule.

All of the imagery is 2009 unless stated otherwise.

Quarter 1
April 1 – June 30, 2009

a. Glades
b. Holmes
c. Washington
d. Seminole
e. Hillsborough (2008 - half foot)
f. Lake (2008 - half foot)
g. Hendry
h. Highlands (2008 - half foot)

Quarter 2
July 1 –September 30, 2009

a. Bradford
b. Broward
c. Collier (half foot – Urban area only)
d. Collier (two foot)
e. Miami-Dade
f. Monroe
g. Pinellas (half foot)
h. St. Lucie
i. Union
j. Volusia

Quarter 3
October 1 – December 31, 2009

a. Martin
b. Indian River

c. Charlotte
d. Brevard
e. Citrus
f. De Soto
g. Hardee
h. Hernando
i. Sarasota
j. Manatee
k. Hillsborough (2009)
l. Santa Rosa (2007)

Quarter 4
January 1 – March 31, 2010

a. Clay
b. Manatee
c. Okeechobee
d. Palm Beach (half foot)
e. Pasco
f. Sarasota
g. Sumter
h. Leon