Pilot Implementation of the Field Methods and Lessons Learned Using the Vegetation Classification System for South Florida Natural Areas
Cooperative Agreement #H5120040010

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Introduction

The South Florida / Caribbean Network of the National Park Service (NPS) has entered into Cooperative Agreement H5120040010 with The Institute for Regional Conservation (IRC) to collect field data for a quality control assessment of the vegetation map being prepared by Avineon, Inc. (Avineon). Field surveys were started by IRC on August 22, 2006. While the project is still ongoing, this report provides an analysis and discussion of IRC's data collection techniques during the pilot implementation phase (the first three days of flights), at the Florida Panther National Wildlife Refuge (Panther Refuge). A comparison with data collected at the Panther Refuge two months later is also included. Lessons learned from all fieldwork are discussed.

Background

The NPS contracted Avineon to prepare a vegetation map of the western portions of the Big Cypress National Preserve, the Florida Panther National Wildlife Refuge, and the 10,000 Islands area of Everglades National Park (Map 1). The new vegetation map will be cell based, with vegetation classes being defined for cells of 50 x 50 m throughout the mapping area. The vegetation map will be based on "Vegetation Classification System for South Florida Natural Areas" by Rutchey et al. (2006). This is a hierarchical classification with nine primary classifications (e.g., Forest, Woodland, etc.) and up to five additional levels within each primary class.

Methods

Sample Locations: Avineon divided the study area into 4 sections (Map 1). Avineon is to prepare vegetation maps in sequence in each of the four sections (this is still in progress). IRC is to collect data in each section prior to or concurrent with Avineon's mapping. IRC's data is provided to NPS before Avineon is scheduled to provide their mapping product to the NPS.

The NPS provided IRC with 940 randomly selected sampling locations (50 x 50 m cells) in each of the four sections. Sampling intensity was weighted by size of each section. Table 1 indicates the sample size for each section. IRC is to visit the number of indicated cells in each section by helicopter by summer 2007. If upon visiting the cell IRC determined that it was dominated by disturbed areas (e.g., a road, canal, ORV trail, homesite), then another pre-selected random cell was visited to replace it. This report covers the first 97 points surveyed.

Section	# of Sample Cells
1	197[1]
2	259
3	294
4	190

Table 1: Sample sizes for map sections

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[1] 97 cells were initially chosen for sampling. The NPS later requested that an additional 100 points be sampled

Pre-Flight: Prior to helicopter flights the observers reviewed the vegetation classification system by Rutchey et al. (2006). Special attention was paid to memorizing details about transitions between classification types (e.g., 60% cover to differentiate Forest and Woodland). This step was especially important at the beginning of the project, but reviews were also done when there was a time lag of more than a week or two between flights.

ArcGIS Shape files were created to be used in the field. These included: 1) a point shape file containing all sample locations that were to be visited; 2) a polygon shape file with borders of all cells to be visited; and 3) a second set of point and polygon shape files containing 10 backup sample locations. These shape files were uploaded onto a Thales MobileMapper CE GPS unit with ArcPad. This GPS unit can reach submeter accuracy without the aid of an external beacon, and has a color LCD screen that can display multiple shape files and/or rasters.

In the first three days of flights at the Panther Refuge it was found that the Thales GPS unit was unable to display images successfully during fieldwork because of insufficient processor power. Because of the speed of the helicopter and the weak processor of the unit, it took too long for rasters to be redrawn while flying. After this limitation was discovered, we began to print hard copies of aerials to use during the flights. Aerial photographs of all cells were printed using 1-meter resolution 2004 true color DOQQs from www.labins.org. A single map contained 1-3 cells, depending upon their proximity to one another. A flight route was organized and the aerials are arranged according to that flight path so the proper map could be located easily while in the helicopter.

Flight: The flight route was reviewed with the pilot prior to takeoff. Sample locations were navigated to using the Thales GPS and the point shape file, which was labeled with location numbers. When the cell was reached, vegetation data was collected independently by each of two observers (always Keith Bradley and Steven Woodmansee). The observers did not communicate regarding species identification or plant community types. Each observer was on the same side of the aircraft. Vegetation data was recorded in field notebooks following a sampling scheme that was devised by NPS and IRC (described below). The methodology was developed to provide classification-independent vegetation data within the cell. The independent observations were done to allow for error checking of field data, to show which vegetation communities were difficult for observers to classify, and to show which cells had vegetation that was difficult to consistently be assigned to one vegetation type (e.g., transitional between Forest and Woodland).

Upon visiting each cell, the cell was circled, with the pilot flying along the edges of the cell using the GPS to navigate. Observers could easily determine the cell boundaries on the ground because the pilot could fly the helicopter right along the cell edge. The observers first evaluated the vegetation in the cell to determine if more than one vegetation type was present. If more than one was present, then the observers determined which was dominant by visual assessment of cover.

In later flights (after the first three days in the Panther Refuge) assessment of aerial photographs to help determine the dominant vegetation type while flying was added to the methodology. In cases where two or more vegetation classes covered approximately the same area, an aerial photograph (2004 DOQQs) was studied to help make the determination of dominance.

After determining the dominant vegetation type, the cell boundary was flown, ca. 3-10 m above the vegetation line, several times while the observers collected data. Where safe, cells dominated by herbaceous vegetation were landed in, allowing the observers to identify graminoids and herb species while sitting in the helicopter. Observers recorded vegetation height, canopy (or shrub) cover, relative cover of dominant species in each stratum, water or soil cover, presence of exotic species, and presence of periphyton. Manmade features were also recorded. At each cell, a photograph was taken of the dominant vegetation type with a 5-megapixel Sony Cybershot F717 camera, set to take pictures at its highest resolution.

Post-Processing: After data was collected in the field, post-processing was done in the office. The observers reread their field notes and assigned a vegetation class to each cell that was visited, following the most recent version of the "Vegetation Classification System for South Florida Natural Areas" that was available. If necessary, the photo of the cell was reviewed. After this was done, the data was entered into an Access database.

Following data entry, a query was constructed to return cells for which the observers made different class determinations. Where there were differences, the observers reviewed their field notes and aerial photographs together. A final determination of the vegetation class was then made.

Results
Flights were conducted at the Florida Panther National Wildlife Refuge (Section 1) on August 22nd, 23rd, and 24th, 2006. In these three days 97 cells were visited. After field notes were interpreted and a classification for each cell was defined by each observer, results were compared at the lowest level of classification (i.e., the ultimate level reached by each observer). For example, classifications were designated as "in agreement" if both observers classified a cell as MFPcm (sawgrass-muhly freshwater prairie), but not in agreement if one observer recorded MFCPcm and another MFP (freshwater prairie).

There was 44.9% complete agreement (43 cells). There were differences in classification at 55.1% (54 cells). Upon analyzing the 54 cells that were classified differently, four reasons were found to explain differences. At several cells there was more than one reason for a difference. The difference types were:

1) *Classification ambiguity* (n = 27, two with mixed reasons). At these cells each observer found that there was no vegetation type in the existing vegetation classification system that properly represented the vegetation observed in the cell, or, that descriptions of vegetation types were insufficient to allow proper classification. For example, we were not sure about the difference in hardwood cover differentiating

Cypress Strand and Cypress with Hardwoods, because the vegetation classification did not specify the % cover of hardwoods required to differentiate the two (in this case it was later decided that a cover of >40% hardwoods was required for the Cypress with Hardwoods class).

2) *Differences in field data or incomplete field data* (n = 13, one with mixed reason). At each of these cells an observer collected insufficient data in the cell to make a proper classification, or the observers recorded different data. For example, canopy height was not recorded (making it impossible to distinguish between forest and shrubland), or one observer recorded canopy as 50% and another 70%. Differences in data occur when vegetation is transitional between two classes, making it difficult for an observer to visually estimate cover values.

3) *Interpretation differences* (n = 3, one with mixed reason). Because of an initial unfamiliarity with the complicated vegetation classification system, an observer collected good field data, but improperly assigned the cell vegetation to the wrong class.

4) *Interpretation errors* (n = 13). An observer misread field notes and assigned the incorrect vegetation type (e.g., notes clearly said 50% cover, but the cell was classified as forest).

Prior to the next flight three weeks later (September 14, 2006), each of these issues was discussed with the NPS and actions were taken to correct each problem. These are discussed below.

1) *Classification ambiguity.* All classification issues were discussed with NPS and the South Florida Water Management District. New vegetation types were added to the classification system to incorporate vegetation types that had been overlooked. More importantly, many class definitions were clarified to allow the observers to more easily make decisions based on field data. Since the project was initiated, 24 new vegetation classes have been added due to observations by IRC and by others (Table 2). Examples of classes suggested by IRC include Pop Ash Forest, Cabbage Palm Woodland (with 4 subclasses), and Tropical Hardwood Shell Mound.

2) *Differences in field data or incomplete field data.* Several factors have minimized this type of error. Observers are now much more familiar with the vegetation classification system, and know what kinds of data are absolutely necessary for each vegetation type. In addition, the observers have standardized data collection protocol while in the air (see Attachment 1), recording vegetation structure in a uniform order:
    a. Comment on number and types of plant communities and which is dominant
    b. Overall canopy cover
    c. Canopy height
    d. Relative dominance of each plant species in tallest vegetation layer (regardless of whether they are trees, shrubs, grasses, etc.)

e. Notes on understory species, and relative cover if visible under canopy, especially dominants
f. Cover of water and/or bare soil
g. Other comments (e.g., hurricane damage, farming activity, roads and trails, etc.)

3) *Interpretation differences.* Observers are now much more familiar with the vegetation classification system and are more proficient at determining the proper vegetation type from their field notes. Because each observer collects and interprets data independently, this type of error is easily corrected once data sets are compared. It takes 1-2 days of flying and then data processing to become proficient at applying the vegetation classification system. Once observers have gained this experience, collecting the proper data and interpreting it becomes much easier.

4) *Interpretation errors.* Observers misinterpreting field notes will continue to happen, especially when larger data sets are processed at once. However, as with interpretation differences, because each observer collects and interprets data independently, this type of error is easily corrected once data sets are compared. The current rate of this kind of error is less than 5%.

Class ID	Name
AB	Airboat Trail
CStGPm	Cypress Scrub-Muhly Grass
CSWGPm	Hardwood Swamp Scrub-Muhly Grass
FHM	Tropical Hardwood Shell Mound
FSf	Pop Ash Forest
HID	Hole-in-the-Donut
MFPO	Open Prairie
SSaf	Pond Apple-Pop Ash Shrubland
SUH	Tropical Hardwood Shrubland
WMa	Black Mangrove Woodland
WMaG	Black Mangrove-Graminoid
WMaO	Black Mangrove Woodland-Open Marsh
WMaS	Black Mangrove Woodland-Succulent
WMcB	Buttonwood Woodland-Broadleaf
WMcBa	Buttonwood Woodland-Leather Fern
WSs	Cabbage Palm Lowland
WSsG	Cabbage Palm Lowland-Graminoid
WSsGc	Cabbage Palm Lowland-Sawgrass
WSsS	Cabbage Palm Lowland-Shrub
WSsX	Cabbage Palm Lowland-Mixed
WUpFO	Pine Flatwoods - Open Prairie
WUpFSs	Pine Flatwoods - Saw Palmetto
WUpO	Pine Upland-Open Prairie
WUpRO	Pine Rockland-Open Prairie

Table 2: Vegetation Types Added by IRC and Other Observers

After the types of errors were discovered and solutions were found, Bradley and Woodmansee re-evaluated the field data to determine a final vegetation class for each cell. This took into account any new vegetation types and class definitions. When needed, a classification was done at a broader classification level. Where data differed between observers the photograph of the cell was used to help make the decision.

Of the original 97 cells, we agreed on a final vegetation class for each one. There were no cases where a cell could not be assigned any vegetation class. In some cases, we had to use a higher class than preferred (e.g., Upland Woodland). Table 3 shows the number of cells assigned to each level in the vegetation hierarchy. In nearly 66% of cases, we were able to reach a consensus at level 4 or higher. Note that no cells had to be assigned to classes in Level 1.

Level	Cells
1	0
2	4
3	29
4	40
5	17
6	7

Table 3: Number of cells classified in each level of the vegetation classification

Recent Data
In more recent sampling, error rates have continued to decrease. In sampling done in the Panther Refuge on October 4th and 5th, 2006 we had an initial rate of discrepancy of 23% for 100 cells (i.e. 23 cells in which we disagreed), 32.1% lower than the first sampling conducted at the Refuge.

Differences in classification are now restricted mostly to newly discovered classification ambiguities, or, more commonly, observers disagreeing on classifications because the vegetation type is transitional between two classes (e.g., canopy cover about 60%, making determination between Forest and Woodland difficult). There were no cells in the final 100 points at the Panther Refuge where we could not assign a vegetation type.

Once observers have learned the vegetation classification system, the greatest difficulties in applying it using the above methodology are when vegetation types are either not in the vegetation classification or are imperfectly defined, or when visual estimates of vegetation cover or height are not precise enough to determine a vegetation type. This latter issue is the most problematic because issues with the classification system are easily fixed after the fact by discussing the problem with classifiers. When vegetation cover or heights are close to transition limits, then direct measurements on the ground may be required to assign properly a vegetation class.

Conclusions
As this report details, the efficacy of the double-observer system of quality control has improved substantially since the first three days of implementation. Discrepancies have dropped from 55.1% to 23.0% in later flights. The methodology that has been outlined

has proven effective at ensuring that the vegetation in any cell almost always be reliably assigned a vegetation class at level 2 or lower, with confidence assured by two independent observers.

References
Rutchey, K., T.N. Schall, R.F. Doren, A. Atkinson, M.S. Ross, D.T. Jones, M. Madden, L. Vilchek, K.A. Bradley, J.R. Snyder, J.N. Burch, T. Pernas, B. Witcher, M. Pyne, R. White, T.J. Smith III, J. Sadle, C.S. Smith, M.E. Patterson, and G.D. Gann. 2006. Vegetation Classification for South Florida Natural Areas. United States Geological Survey, Open-File Report 2006-1240. 142 pages. St. Petersburg, Florida.
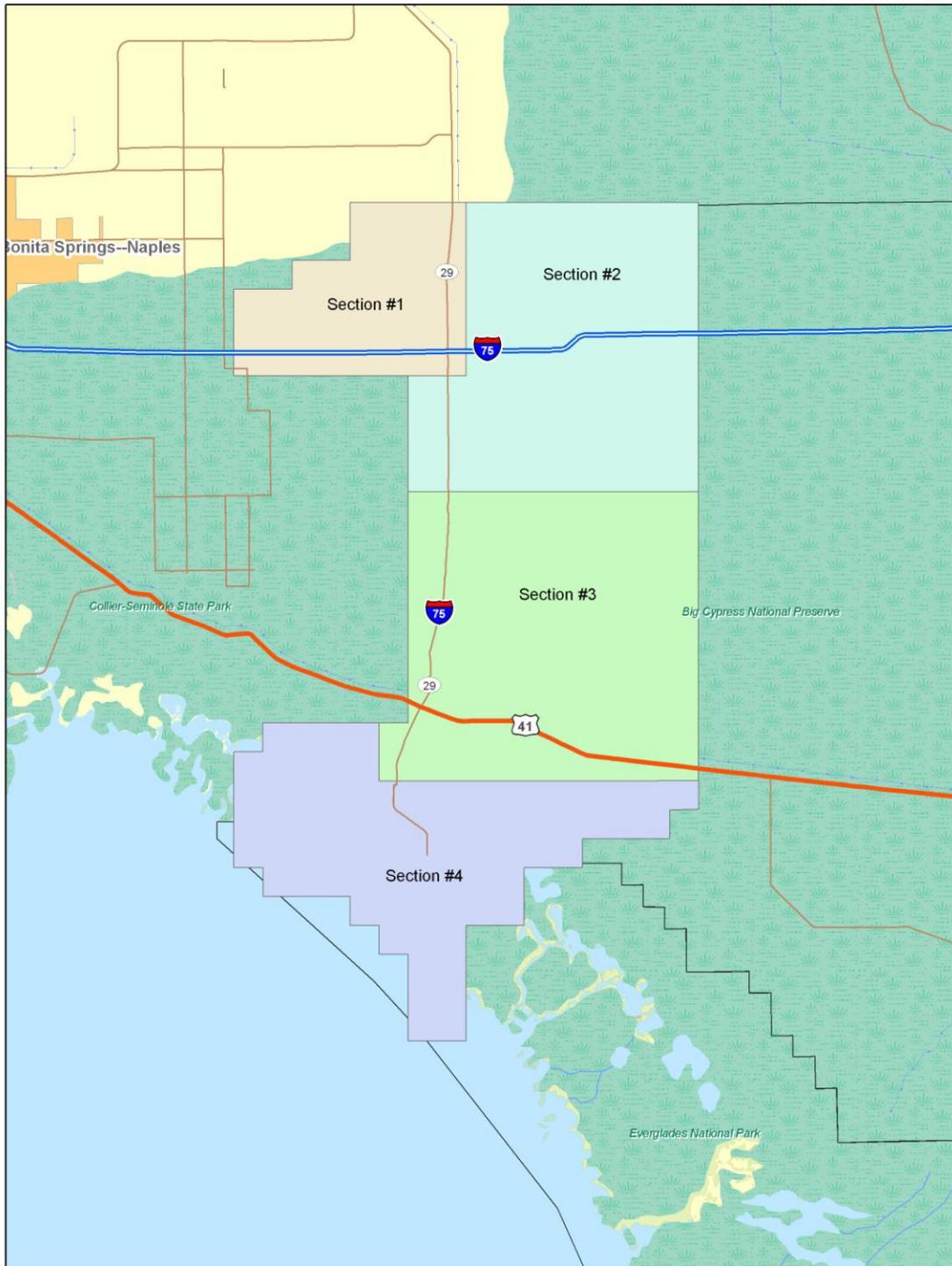
Map 1: Vegetation map sample regions

Attachment 1
Example Data Sheet

Observers_____   **Cell ID**_____
Date_____   **Photo ID**_____

General Description of Cell and Vegetation Types

_____
_____
_____

Dominant Vegetation Type in Cell _____

Overall Canopy Cover (if present) _____

Canopy Height (if present) _____

Relative Cover of Species in Tallest Stratum (should add to ca. 100%)

_____
_____
_____
_____
_____

Description of Understory Species (when visible)

_____
_____
_____
_____

*Water Cover*_____   *Soil Cover*_____

Other Comments (Structures, roads, hurricane damage, etc.)

_____
_____
_____
_____
_____