Report for 2003FL40B: Characterizing the Spatial Distribution and Connectivity of Wetlands in the Fisheating Creek Basin, Florida

- Articles in Refereed Scientific Journals:
    - Wise, William R., and Raleigh D. Myers, Modified Falling Head Permeameter Analyses of Soils from Two South Florida Wetlands, Journal of the American Water Resources Association, 38(1), pp. 111-117, 2002.

Report Follows

Title: Characterizing the Spatial Distribution and Connectivity of Wetlands in the Fisheating Creek Basin, Florida

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Problems and Research Objectives:

The natural hydrologic settings of the Fisheating Creek and Kissimmee River basins in Glades, Highlands, Polk, Okeechobee, and Osceola counties, Florida (Figure 1), were significantly altered over the last century through wetland drainage. This drainage was done to increase the amount of arable land for cattle grazing, vegetable and fruit production, and tree farms, as well to provide some measure of flood control for the basin. This alteration of the natural hydrologic setting has been successful in providing those benefits, but it has had the undesirable side effect of causing pronounced habitat degradation. Channeling of surface water into networks of artificial ditches and canals, which feed into Fisheating Creek, has sharply increased peak flows in the creek after rainfall events. This results in a more "flashy" hydrograph, in which the time lag between a rainfall event and peak flow occurring in Fisheating Creek is dramatically shortened. This heightened response has the effect of significantly increasing contaminant (particularly phosphorous) loads in the creek, which drains into Lake Okeechobee. During the course of this work, the principal investigators of this project worked with The Nature Conservancy (TNC) on a project that involves describing hydrologic processes at up to the landscape scale in the Fisheating Creek basin. The goal of the TNC project was to investigate how potential changes in land use practices and/or landscape renewal projects will increase watershed storage following rainfall events, which will result in more natural hydrographs and reduced contaminant loads into Lake Okeechobee.

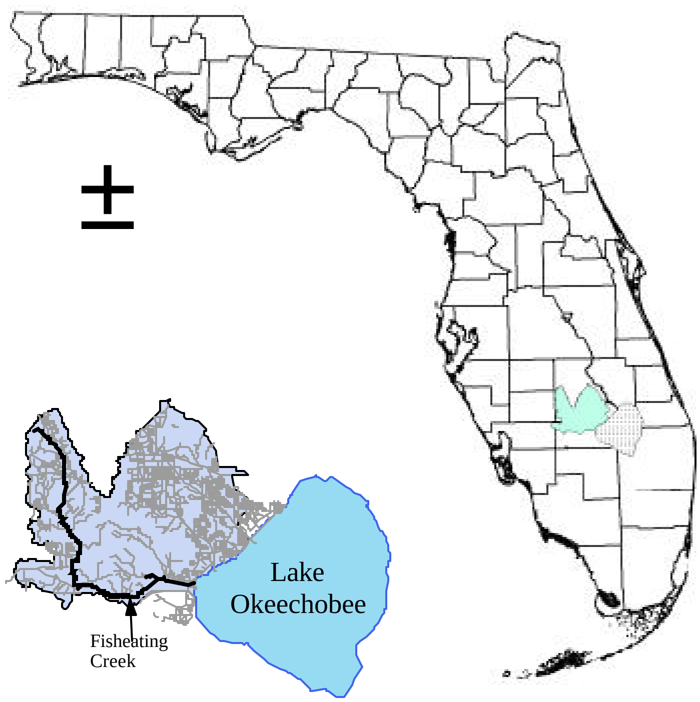

Figure 1. Location of Fisheating Creek Basin.

Methodology:

Impacted wetlands were identified using the Geographic Information System ArcGIS. This identification was done using a modified version of the South Florida Water Management District (SFWMD) soils coverage, which indicates whether soils are hydric in nature or not. In addition, a coverage of wetlands from the National Wetlands Inventory (NWI) was examined as well. Wetlands were determined to be impacted if:

1) A particular wetland on the NWI coverage was indicated to be drained and/or ditched, or

2) An area underlain by hydric soils was classified as "Upland" by the NWI coverage, indicating that the area had historically been a wetland before modification.

After this identification process was completed, the hydrologic modeling system MIKE-SHE was used to develop and model the hydrologic characteristics of the basin. This model addresses many of the physical processes of interest, such as diffusional surface flows, flow through variably saturated media, evapotranspiration, and saturated groundwater flow. After the hydrologic model was constructed and verified, simulations were run with the wetlands in a "restored" condition, meaning that rainfall was allowed to accumulate naturally in wetlands rather than routed through the ditch and canal networks into Fisheating Creek. This was accomplished by using a feature of MIKE-SHE that models agricultural drains. Where an area is specified as being drained, water in the surficial aquifer within a specified distance of the ground surface is drained from the aquifer and routed either to the nearest stream or canal, or to the edge of the model, depending on which is closest. The "restored" condition was simulated by removing the drains. Hydrographs on the main branch of Fisheating Creek (at Palmdale, where a USGS gaging station is located) were compared using the current ("unrestored") and "restored" settings.

In concert with this, the spatial distribution of wetlands within the basin was determined using the freely available program FRAGSTATS (McGarigal and Marks, 1994.) To do this analysis, the SFWMD soils coverage was used. A new coverage was derived containing only soils that are hydric in nature. From this coverage, an ArcGRID file (raster) was created and classified according to the SFWMD Landscape Position Classification for soils occurring within the district. This classification contains four general categories of hydric soils, three of which occur in the Fisheating Creek basin:

- Landscape Position (LPOS) Classification 5: Muck Soils.
- LPOS Classification 6: Sand Depression soils.
- LPOS Classification 7: Flats Soils.

Generally, the muck soils are found underlying areas that are under water for most or all of the year, while the sand depression soils are frequently found in drainage areas or adjacent to some muck soils. Flats soils are located between depressional landscapes and upland areas, and are generally regarded as transitional areas that experienced only seasonal inundation. Those wetland areas that were usually flooded year-round and are underlain by muck soils are isolated in extent and form a patchy, disconnected map pattern (Figure 2). These soils commonly occupy the "core" of a wetland complex, which is fully or partly surrounded by transitional areas underlain by flats soils. The transitional areas form larger, better connected areas. Figure 1 shows the ArcGrid map. Note that the sand depression soils and the muck soils tend to form somewhat more "blotchier" areas than the flats soils, which are better connected. The major exception to this is along the main branch of Fisheating Creek as well as along numerous smaller tributaries, which are almost entirely underlain by soils classified as sand depression, making long, continuous corridors.

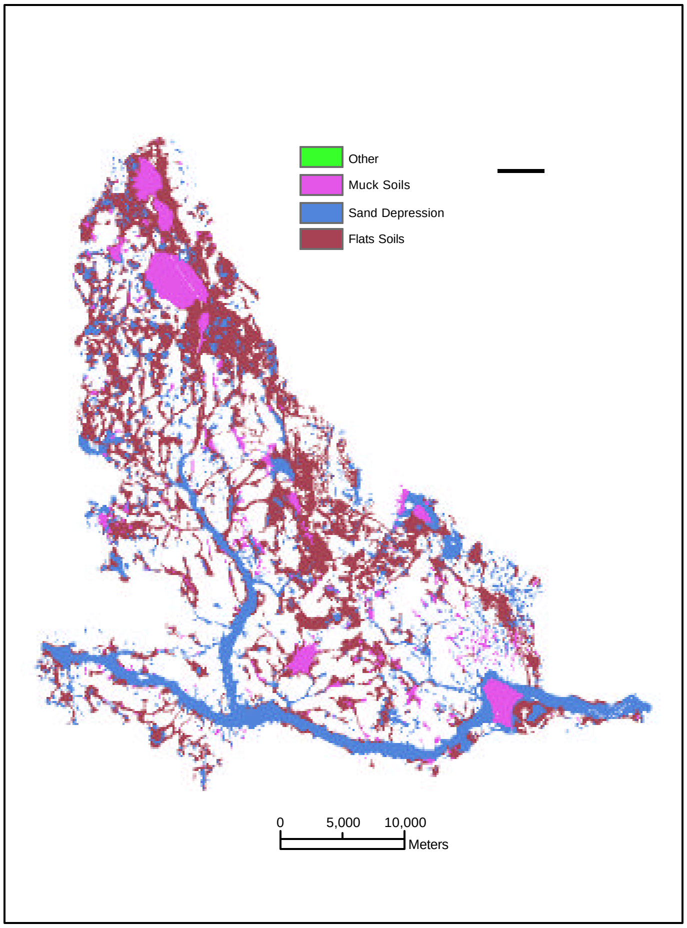

Figure 2. Hydric Soils in Fisheating Creek Basin

Principal Findings and Significance:

During the identification process, it was determined that approximately half of the areas in the Fisheating Creek Basin underlain by hydric soils are no longer classified as wetlands, and thus are potential candidates for remediation. Remediation was simulated in the hydrologic models using the technique discussed in the previous section, i.e., removal of agricultural drains. Hydrographs of model years 1995, 1997, and 2000 are shown in Figures 3a-c, respectively. For the model year 1995 (above average precipitation), restoration resulted in a significantly lower amount of water (approximately 78,600 acre-feet) passing the gage at Palmdale. For the model year 1997 (precipitation was influenced by El Nino), restoration resulted in a savings of approximately 113,000 acre-feet, while for model year 2000, restoration resulted in a savings of approximately 60,000 acre-feet.

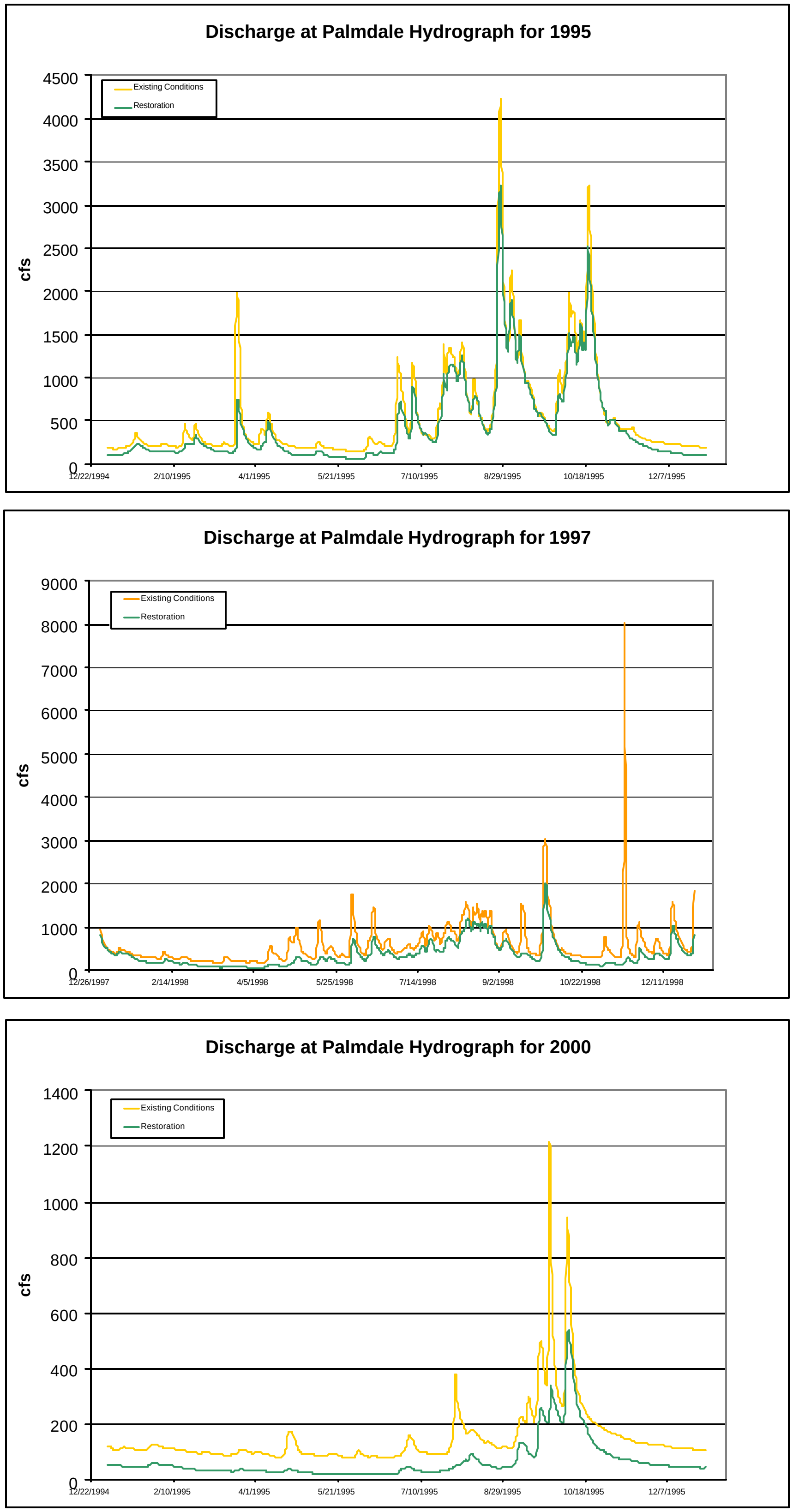

Figure 3. Hydrographs for Simulation Years 1995, 1997, and 2000

Results from FRAGSTATS show that there are significantly more patches of sand depressional soils than either muck soils, or flats soils. The Landscape Shape Index (LSI in Table 1) for flats soils is higher than for either muck soils (the lowest), or depressional sands, indicating that the landscape pattern of flats soils is somewhat "clumpier" than depressional soils, and significantly moreso than muck soils. The mean of the perimeter-to-area ratio (PARA_MN) is higher for flats as well, indicating that distributions of flats soils tend to be more stretched out (rather than circular or nearly so) than the other types of soils. The "core area" of flats soils (measured in hectares) is higher than depressional soils, and significantly higher than muck soils, indicating that each patch of flats soil tends to be larger than the other types of soils. This is also reflected in the mean of the core area (CORE_MN) which is simply the total core area divided by the number of patches. The parameter CLUMPY is another measure of disaggregation of patch types, i.e., a lower value of CLUMPY (the parameter ranges between -1 and 1) indicates that the class type is more disaggregated. This measure is inversely related to LSI. Lastly, COHESION measures the physical connectedness of the particular soil type; higher values indicated greater values of connectedness. By this measure, areas underlain by flats soils have a slightly greater degree of connectedness than depressional soils, and a significantly greater degree of connectedness than muck soils.

TYPE	**NP**	**CA**	**LSI**	**PARA_MN**
Flats	319	29063	49.7302	335.3471
Mucks	364	6328	20.1787	285.5429
Sand dep.	1277	17117	42.813	320.2862

TYPE	**TCA**	**CORE_MN**	**CLUMPY**	**COHESION**
Flats	17939.5	56.2367	0.679	99.407
Mucks	4315.25	11.8551	0.8617	93.4783
Sand dep.	10281.75	8.0515	0.7617	98.1592

Table 1. FRAGSTATS Output for LPOS Classes

Student Involvement:

One master's student was involved in this effort.