

## Application of the Soil Taxonomy Key to the Organic Soils of the Everglades Agricultural Area<sup>1</sup>

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Soil taxonomy is the process of describing and classifying soil types. It is analogous to the scientific classification of plants and animals. The soil taxonomy system helps us to understand the types of soils we have, how they were formed, and how they may be changing. By understanding how soils in the Everglades Agricultural Area (EAA) are classified, we can learn more about their properties and can effectively communicate information regarding soil effects on crop and natural resource management. This document provides an overview of the soil taxonomic system in relation to the organic soils found in the EAA. The discussion also addresses recent revisions to the soil taxonomy key and how these modifications affect the classification of organic soils.

The Histosol soils of the EAA were formed over a 4,400-yr period from partially decomposed remains of hydrophytic (water loving) vegetation that accumulated under anaerobic (low oxygen) wetland conditions (McDowell et al., 1969). Consequently, soil organic matter contents are high, ranging

between 80 to 90% across roughly 93% of the region (Snyder, 1994; USDA, 1988). Early soil classification schemes in the EAA focused on the botanical origins of the organic soil material. Remnants of this scheme are still evident, with long-term residents occasionally referring to soils bordering Lake Okeechobee as custard apple mucks, and soils in the central and southeast regions of the EAA as elderberry peaty mucks and sawgrass peats, respectively. The term “peat” was loosely used for soils with notably high fiber composition (and low mineral content) while “muck” was used to describe the more highly decomposed soils (lower fiber and higher mineral content) in the region. Soils of intermediate fiber and/or mineral content were termed “peaty mucks” or “mucky peats”.

The soil taxonomy system employs a specific nomenclature that both classifies the soil and confers a distinctive name to the individual soil. Names are constructed from various “formative elements” (generally originating from Greek or Latin), which are used in specific combinations to provide a highly

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descriptive name to a specific soil type. The six categories in soil taxonomy, in order of decreasing rank (level), are the soil order, suborder, great group, subgroup, family, and series. In this classification scheme, soil characteristics and information about the soil become increasingly more specific as one continues from the highest level (order) to the lowest level (soil series). The following discussion presents each of the six classification categories, and summarizes the logic and major principles underlying both the classification and the names assigned to the different organic soils found in the EAA.

### Soil Order

All soils in the world can be classified within 12 different soil orders (Soil Survey Staff, 1999; Fig. 1). The names of soil orders end with the formative element “sol” (from Latin *solum*, soil or ground) (Table 1). The Histosol soil order includes most of the world's organic soils, with the formative element “Hist” (from Greek *histos*, tissue) indicating the presence of organically-derived soil material. A portion of this formative element (“ist”) is consistently used as a suffix within the names of all Histosol soils. This suffix appears in soil names at the suborder, great group, and subgroup levels. Thus, any soil name ending with “ist” (such as Torrifolist, Sphagnofibrist, Sulfihemist, or Cryosaprist) is an organic Histosol.

In general, soils are classified as Histosols when more than half of the upper 80 cm (32 inches) of the soil is highly organic, or in the case of shallow soils, if organic material of any thickness resides above bedrock or within fragmental material containing voids filled with organic materials. Under the latest taxonomic key (Soil Survey Staff, 1998; 1999), organic soils in extremely cold environments are now classified as Histels, a suborder within the new Gelisol soil order (the suffix “el” in Histel is derived from “Gel”, indicating that the soil is a Gelisol). The organic soils in the EAA are classified within the Histosol soil order, based on high organic matter composition and the absence of consistently frigid conditions.

### Soil Suborder

The 12 soil orders collectively represent 64 soil suborders (Soil Survey Staff, 1999). Histosols can be classified into four different suborders, including Folists, Fibrists, Hemists, and Sapristis (Fig. 1). The suborder Folist (from Latin *folia*, leaf) describes a group of organic soils that have formed under non-flooded conditions, composed of leaf litter and decaying wood fragments that have accumulated over bedrock, a scenario found in some forested environments.

Organic soils that formed under flooded conditions are represented by the remaining three suborders, which differ based on the extent of organic fiber decomposition. Soils composed of organically-derived material that exhibit the least amount of decay are classified as Fibrists (from Latin *fibra*, fiber). Fibrists generally contain three-fourths or more (by volume) fibers that are retained on a 100-mesh sieve (0.15 mm openings). Due to the absence of appreciable decomposition, plant cellular structures are still clearly visible within individual fibers. Fibrists will generally have the lowest bulk densities ( $< 0.10 \text{ gm cm}^{-3}$ ), lowest ash contents (or greatest organic matter contents), and highest saturated gravimetric water contents (850-3000% on an oven-dry basis) (McCollum et al., 1976). At the other extreme are the Sapristis, with soil profiles dominated by soils exhibiting the greatest evidence of decomposition. Fiber contents after rubbing are less than one-sixth (by volume). Sapristis are predominately black in color, with bulk densities generally exceeding  $0.20 \text{ gm cm}^{-3}$  and saturated gravimetric water contents less than 450% (McCollum et al., 1976). Hemists (from Greek *hemi*, half; implying an intermediate stage of decomposition) represent those Histosols that exhibit a decomposition stage that is intermediate between the less decomposed Fibrists and more thoroughly decomposed Sapristis. Physical characteristics (bulk density, saturated gravimetric water content) are also intermediate in value.

The black organic “muck” soils of the EAA are comprised of highly decomposed organic materials, and are thus Sapristis (from Greek *saprose*, rotten; implying a high degree of decomposition) (Table 1).

## Soil Great Group

Descriptions at the great group level seek to identify distinctive differences across various soils found within a given soil suborder. This includes the presence or absence of diagnostic soil horizons and may allude to the general soil temperature or moisture regimes that prevail in the region.

### Former soil taxonomic key

Recent changes in the soil taxonomic key (Soil Survey Staff, 1998; 1999) affect the classification of Histosol soils at the great group level. From the inception of the modern soil taxonomic system (Soil Survey Staff, 1975), the organic soils in the EAA were classified as Medisaprist (from Latin *media*, middle; implying that the soils are located in a temperate climate) (Table 1; Fig. 2).

### Current soil taxonomic key

The latest soil taxonomic key (Soil Survey Staff, 1998; 1999) de-emphasizes the use of temperature regime as a classification criterion for Saprist at the great group level, focusing more on characteristics that are intrinsic to soil properties and horizons present within the soil profile. The Troposaprist, Medisaprist, and Borosaprist classifications have been discontinued. The current soil taxonomy key (Soil Survey Staff, 1998, 1999) includes only four great groups within the Saprist suborder (Table 1). The Haplosaprist (from Greek *haplous*, simple; implying minimal evidence of true soil horizon development) classification is a new great group category for Saprist. The organic soils of the EAA indeed lack strong evidence of horizon development, and are thus all classified as Haplosaprist (Fig. 1).

## Soil Subgroup

The prior three classification levels (order, suborder, and great group) focused on categorizing soils based on major features or geological/environmental processes that dominated

the direction and/or extent of soil development. The subgroup classification seeks to recognize distinctive soil features across different soils within a given soil great group. The subgroup name includes the great group name, modified by one or more descriptive adjectives. These descriptive adjectives fall into three general categories termed typic, intergrade, and extragrade.

### Typic subgroup

The Typic adjective is normally assigned to the soil within a great group that reflects characteristics that are consistent with the diagnostic properties already defined by the order, suborder, and great group to which the soil belongs. A Typic subgroup soil lacks any significant properties that would suggest it is in a transition phase between related great groups or some other soil taxonomic level.

### Intergrade subgroups

Haplosaprist can be classified into four different intergrade subgroups, including Hemic, Fluvaquentic, Halic, and Halic Terric Haplosaprist (Table 2, Fig. 1). Intergrade subgroup soils are those that belong to one soil great group but share various soil properties common to another recognized great group, suborder, or order. For example, a Haplosaprist soil containing appreciably more fibric material than the norm (Typic Haplosaprist) would be classified within the Hemic Haplosaprist subgroup, since the higher fiber content reflects a dominant characteristic of the Hemist suborder of the Histosol soil order.

### Extragrade subgroups

Haplosaprist can be classified into three different extragrade subgroups, including Terric, Limnic, and Lithic Haplosaprist (Table 2, Fig. 1). Extragrade subgroup soils reflect specific properties that are otherwise anomalous to the main concept of the great group. These anomalous properties are also not common diagnostic features dominating the classification of other known soils and thus do not reflect an evolutionary transition phase between one soil type and another. For this reason, adjectives describing extragrade subgroup soils are not derived from the formative elements used in the

nomenclature underlying the names of soil great groups, suborders, and orders.

### Halosaprist subgroup soils in the EAA

With respect to the organic soils in the EAA, the Torry, Terra Ceia, and Okeechobee soil series have the deepest soil profiles, composed of organic material exceeding 130 cm (51 inches) over limestone (Table 3). Both the Torry and Terra Ceia are classified as Typic Haplosaprist (Fig. 1), which recognizes the deep soil profiles dominated by well decomposed saprist material. The Okeechobee soil is the only intergrade soil subgroup in the EAA. Although fairly similar to the Terra Ceia soil, the Okeechobee soil contains a significant presence of less-decomposed hemic materials within the subsurface soil profile (Soil Survey Division, 2001), and is thus classified as a Hemic Haplosaprist (Fig. 1).

The remaining four EAA soil series are classified as extragrade soil subgroups. Soil profiles are less than 130 cm (51 inches) in depth (Table 3). The Pahokee, Lauderhill, and Dania are classified as Lithic Haplosaprist (Fig. 1) due to the presence of a lithic (in this case, limestone) contact within 51 inches (130 cm) of the soil surface (Soil Survey Division, 2001; Table 3). Because the Okeelanta soil series is underlain by sandy material (rather than limestone bedrock) and/or has a significant accumulation of sandy materials within an otherwise organic soil profile (Soil Survey Division, 2001; Table 3), it is classified as a Terric Haplosaprist (Fig. 1).

### Soil Family

The soil family category subdivides soils within a given soil subgroup, based on physical and/or chemical characteristics deemed important to soil management, plant growth, and/or engineering uses. Soil family names are composed of any number of appropriate descriptive terms that identify specific "classes" of soil characteristics. In order of their chronological appearance within a family name, the soil family classes relevant to Histosols include particle size, particle mineralogy, soil reaction (pH), soil temperature regime, and soil depth.

With respect to reaction class, all EAA soils are classified as "*euic*" (whereby soil pH in 0.01 M  $\text{CaCl}_2 > 4.5$ ) due to the consistently elevated soil pH levels found throughout the region. The "*hyperthermic*" temperature regime applies to all EAA soils [whereby mean annual soil temperatures are 22°C (72°F) or greater, and average soil temperatures fluctuate more than 6°C (roughly 11°F) between summer and winter]. The soil depth class applies only to the Dania soil series, classified at the family level as "*shallow*" [whereby a root-limiting layer (limestone bedrock) is found within 18 to 50 cm (roughly 7 to 20 inches) of the soil surface]. The particle size and particle mineralogy classes apply only to the single Terric Haplosaprist found in the EAA, the Okeelanta soil series. The term "sandy or sandy-skeletal" recognizes that the particle sizes within the Okeelanta mineral layer are sands or loamy sands in texture, with less than 50% (by weight) very fine sands. The term "*silicious*" recognizes that these mineral materials are dominated by 90% or more (by weight) silica materials and other durable minerals resistant to weathering (Soil Survey Staff, 1999; Fig. 1).

### Soil Series

Soil series within a family group represent closely related soil units that have narrow but readily observable differences. For example, both the Torry and Terra Ceia are classified as *euic*, *hyperthermic*, Typic Haplosaprist, but the appreciably higher mineral content of the Torry is a distinguishing feature not shared by the Terra Ceia (Table 3). Likewise, both the Pahokee and Lauderhill are *euic*, *hyperthermic* Lithic Haplosaprist, but the Pahokee soil profile is considerably thicker than the Lauderhill (Soil Survey Division, 2001; Table 3).

The soil series name carries none of the descriptive information inferred by the taxonomic nomenclature used to formulate soil names at the higher (order, suborder, great group, and subgroup) taxonomic soil categories. In general, soil series carry names that are highly recognizable within the local area where the soil series was first officially recognized. Names of towns, lakes, counties, and local physical or geographic features are commonly used as soil series names. The complete taxonomic

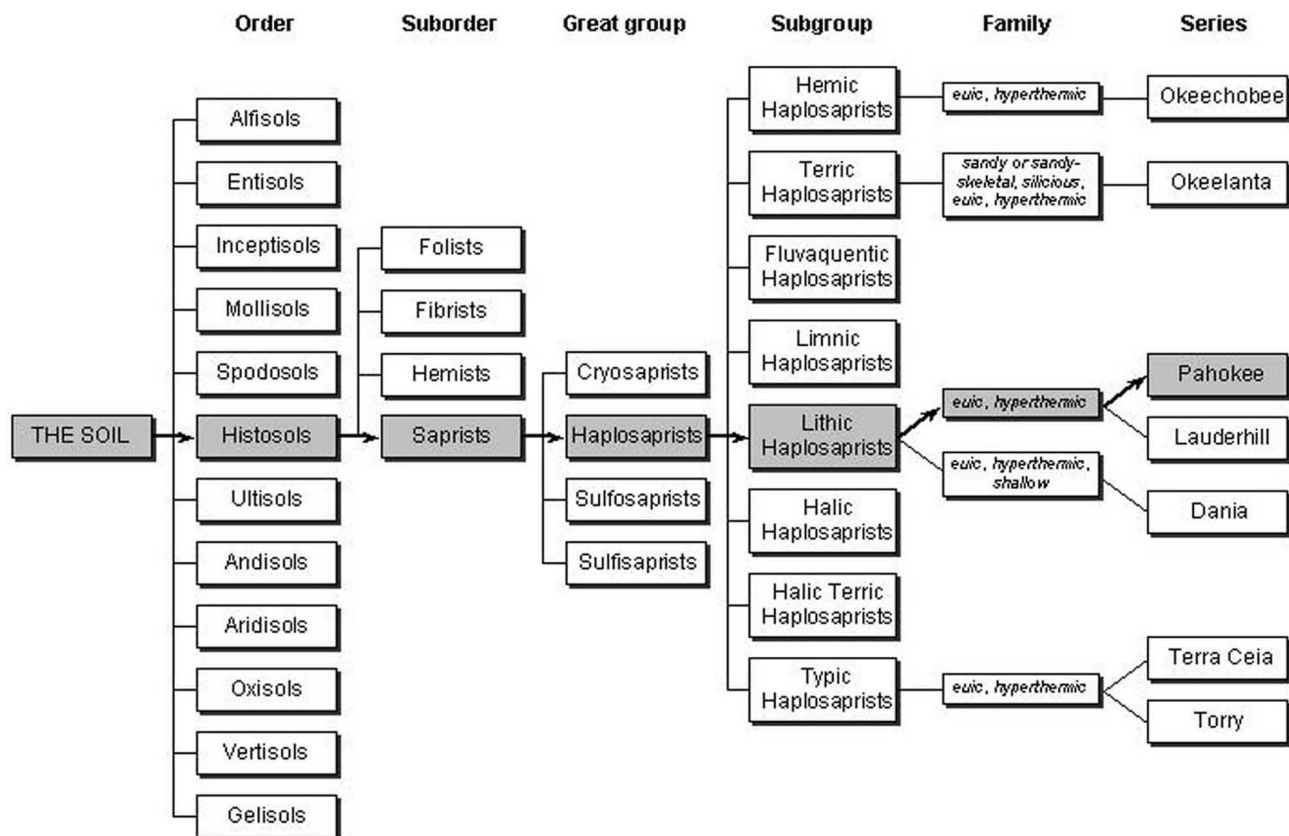
names for the seven organic soil series recognized in the EAA are presented in Table 3.

### Post-script

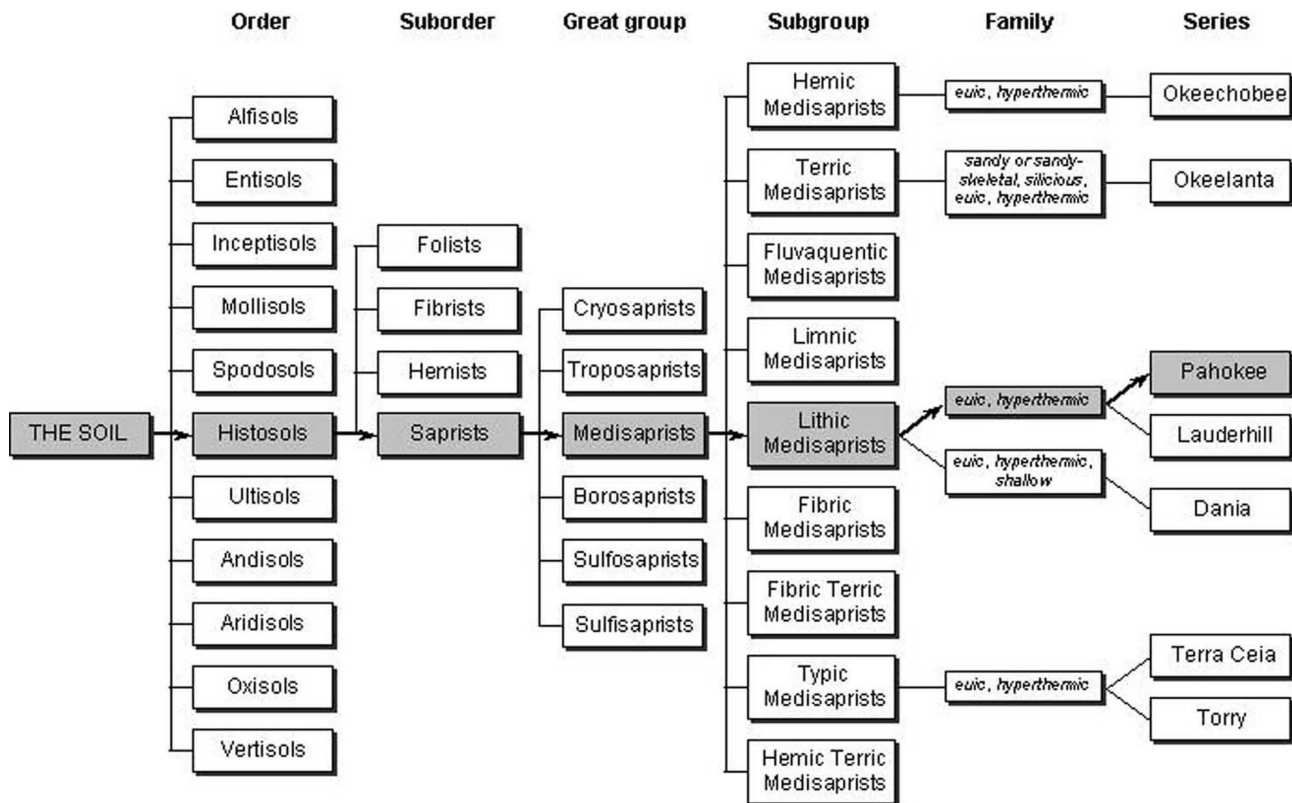
The organic soils of the EAA are continuously undergoing transitional processes, largely due to the aerobic mineralization of organic matter. Expansive areas that once supported the high-fiber “sawgrass peats” in the early-1900s have since decomposed into low-fiber “mucks”. Over time, soil mineralization and subsequent soil subsidence (decline in soil thickness) have resulted in a declining percentage of Torrey, Terra Ceia, and Okeechobee soils, as they transition into the more shallow Pahokee and Lauderhill soils (Table 3). Should soil subsidence continue unabated, it is likely that the highly decomposed organic materials constituting the various Haplosaprists of the EAA will eventually transition into new soil types that would be classified as mineral.

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**Figure 1.** The current (Soil Survey Staff, 1998, 1999) soil taxonomic classification for EAA organic soils, highlighting the Pahokee muck.



**Figure 2.** The former (Soil Survey Staff, 1996) soil taxonomic classification for EAA organic soils, highlighting the Pahokee muck.

**Table 1.** Description of formative elements used in the order, suborder, and great group names of organic soil.

<b>Taxonomic level</b>	<b>Formative element</b>	<b>Derivation</b>	<b>Connotation</b>
<b>Order</b>			
Histosols	Hist	Greek <i>histos</i> (tissue)	Presence of organic materials.
	Sol	Latin <i>solum</i> (soil)	Soil
<b>Suborder</b>			
Fibrists	Fibr	Latin <i>fibra</i> (fiber)	Least decomposed stage (notable presence of plant fibers)
Sapristis	Sapr	Greek <i>sapros</i> (rotten)	Most decomposed stage (notable lack of plant fibers)
Hemists	Hem	Greek <i>hemi</i> (half)	Intermediate stage of decomposition (some plant fibers).
Folists	Fol	Latin <i>folia</i> (leaf)	Mass of leaves, leaf litter
<b>Great group</b>			
Cryosapristis	Cry	Greek <i>kryos</i> (icy cold)	Cold climates
Haplosapristis†	Hapl	Greek <i>haplous</i> (simple)	Minimum horizon development
Sulfosapristis‡	Sulf	Latin <i>sulfur</i> (sulfur)	Presence of sulfides (or their oxidation products)
Sulfisapristis‡	Sulf	Latin <i>sulfur</i> (sulfur)	Presence of sulfides (or their oxidation products)
Troposapristis§	Trop	Greek <i>tropikos</i> (turning)	Continually warm climates (lack of cold temperatures, humid, tropical)
Medisapristis§	Med	Latin <i>media</i> (middle)	Temperate climates
Borosapristis§	Bor	Greek <i>boreas</i> (northern)	Cool climates
†Haplosapristis is a new great group classification introduced in the current soil taxonomic key (Soil Survey Staff, 1998; 1999; Fig. 1). The organic soils of the EAA used to be Medisapristis (Soil Survey Staff, 1975; 1996; Fig. 2) but are now classified as Haplosapristis.			
‡For Histosol great group names, the "Sulfo" prefix refers to soils containing a well-defined sulfuric horizon present within 50 cm of the soil surface while the "Sulfi" prefix refers to soils that lack the well-defined sulfuric horizon but still contain sulfidic materials (which may form sulfuric acid and declining soil pH if and when the soil is aerated) within 100 cm of the soil surface.			
§The Troposaprist, Medisaprist, and Borosaprist great group designations were part of the former soil taxonomic keys (Soil Survey Staff, 1975; 1996; Fig. 2). They have since been discontinued and are not part of the current soil taxonomic key (Soil Survey Staff, 1998; 1999; Fig. 1).			

**Table 2.** Description of adjectives used to identify the different subgroup soils within the Haplosaprist great group. The seven officially recognized organic soil series found in the EAA are all classified as Haplosaprist.

Descriptive adjective	Formative element†	Derivation	Connotation
<b>Subgroup (typic)</b>			
Typic	---	Latin <i>typicos</i> (typical)	Used to identify the subgroup soil that "typifies" the great group. Suggests that there are no other unusual or aberrant properties that need to be specifically recognized with specific adjectives.
<b>Subgroup (intergrade)</b>			
Hemic	Hem	Greek <i>hemi</i> (half)	Intermediate stage of decomposition (some plant fibers).
Halict‡	Hal	Greek <i>hals</i> (salt)	Salty.
Fluvaquentic	Fluv	Latin <i>fluvius</i> (river)	Flood plains, recent sediment deposition.
	Aqu	Latin <i>aqua</i> (water)	Aquic moisture regime.
<b>Subgroup (extragrade)</b>			
Terric	---	Latin <i>terra</i> (earth)	Containing a mineral substratum.
Lithic	---	Greek <i>lithos</i> (stone)	Near stone (presence of a shallow lithic or bedrock contact).
Limnic	---	Greek <i>limn</i> (lake)	Presence of a limnic layer (deposits resulting from aquatic organism activities occurring during the open-water stage of bog development).
†In soil taxonomy, adjectives such as typic, terric, lithic, and limnic are used to distinguish between soils only at the subgroup level. When used alone, these adjectives refer to an extragrade subgroup. Intergrade subgroups are identified with adjectives constructed from the formative elements used to name soil great groups, suborders, and orders. An example is the formative element "Hem", used to name the Hemist suborder as well as the Hemic Haplosaprist subgroup.			
‡The current soil taxonomic key (Soil Survey Staff, 1998; 1999; Fig. 1) introduces the new adjective Halic to distinguish among Haplosaprist. Former soil taxonomic keys (Soil Survey Staff, 1975; 1996; Fig. 2) included the intergrade subgroups Fibric and Fibric Terric to distinguish among Medisaprist subgroup soils, but these classifications have been discontinued with the current soil taxonomic scheme.			

**Table 3.** Histosol soil series found in the Everglades Agricultural Area.

Soil series	Soil name	Mineral content	Thickness of organic material†	Underlying material	Percentage of EAA organic soils
					1978‡
		%	cm ( <i>inches</i> )		%
Torry	euic, hyperthermic Typic Haplosaprist	>35	>130 (>51)	limestone	7.0
					1988§
					%
					7.1

**Table 3.** Histosol soil series found in the Everglades Agricultural Area.

Terra Ceia	euic, hyperthermic Typic Haplosaprist	<35	>130 (>51)	limestone	37.9	9.5
Okeechobee	euic, hyperthermic Hemic Haplosaprist	<35	>130 (>51)	limestone	2.6	2.6
Pahokee	euic, hyperthermic Lithic Haplosaprist	<35	91-130 (36-51)	limestone	43.9	27.4
Lauderhill	euic, hyperthermic Lithic Haplosaprist	<35	51-91 (20-36)	limestone	4.7	39.6
Dania	euic, hyperthermic, shallow Lithic Haplosaprist	<35	<51 (<20)	limestone	0.2	10.2
Okeelanta	sandy or sandy-skeletal, silicious, euic, hyperthermic Terric Haplosaprist	<35	41-127 (16-50)	sand	3.6	3.6
† Soil depth ranges from Soil Survey Division (2001).						
‡ Estimated from Soil Survey Staff (1978).						
§ USDA (1988).						