National Cooperative Soil Survey Newsletter

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## Editor's Note

Issues of this newsletter are available at http://soils.usda.gov/. Under the Soil Survey tab, click on Partnerships, then on NCSS Newsletters, and then on the desired issue number.

You are invited to submit articles for this newsletter to Jenny Sutherland, National Soil Survey Center, Lincoln, Nebraska. Phone—(402) 437–5326; FAX—(402) 437–5336; email—jenny.sutherland@usda.gov. ■

## Upcoming NCSS Regional Conferences

The regional conferences will meet this year starting in May. The location and dates for each are as follows:

South Region—Fayetteville, Arkansas, May 18 to 21
North Central Region—Columbia, Missouri, June 8 to 11
Northeast Region—Blacksburg, Virginia, June 22 to 25
West Region—Albuquerque, New Mexico, July 20 to 24

One feature at each of this year's conferences will be the presentation of updated material for the next edition of Agriculture Handbook 296 (*Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*). The material is being made available for discussion and comments.

For more information on the conferences, visit: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/partnership/ncss/?cid=nrcs142p2_053541

### Southern Regional Cooperative Soil Survey Conference

This conference will be held at the Don Tyson Center for Agriculture Sciences in Fayetteville, Arkansas. The theme is "Soil Survey for Soil Health and Water Quality: Applications in the Natural State." It is hosted by the University of Arkansas, the Arkansas Agricultural Experiment Station, and the Natural Resources Conservation Service in Arkansas, along with Arkansas Partners in Conservation and Soil Survey. The conference will start at 1:00 p.m. on Monday, May 18, and will conclude at 12:00 p.m. on Thursday, May 21.

The purpose of the NCSS is to investigate, inventory, document, classify,

interpret, and disseminate information about soil and ecological resources of the United States. In the southern U.S., areas of greatest resource concern—and the areas for greatest potential impact of the NCSS—involve coastal zone soils, urban soils, and ecological sites. These areas of critical need, along with the digital soil mapping tools that deliver soil and ecological site information to the user, provide the principles that will guide discussion and planning for NCSS partners at the 2020 Southern Regional Cooperative Soil Survey Conference.

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## Soil Survey Interpretations Focus Team

The National Cooperative Soil Survey (NCSS) faces the dilemma of increased value and usage of soil survey data in a time where fewer soil scientists are available to interpret the data scientifically. Subjects addressed in interpretive models range from crop productivity to vertebrate habitat to physical processes to fungal habitats. The usefulness of the interpreted data is well known. There is further need for model development and refinement for topics such as conservation practice standards, soil mass movement, liquefaction, methylmercury production, and productivity indices for tropical crops, to name a few.

To address this need, the Soil and Plant Science Division (SPSD) has initiated a Soil Survey Interpretations Focus Team. This team is charged with:

1. Forming an interdisciplinary working group to enhance and preserve the body of knowledge and techniques used in the process of creating soil survey interpretations,
2. Developing new interpretations to meet customer needs,
3. Maintaining and improving the existing interpretations, and
4. Enhancing the documentation of current and future interpretations.

This focus team will enhance the ability of the NCSS to meet customer needs for interpretive information. It is coordinated by the National Soil Survey Center and draws talent from across the country. The team is divided into work groups for each of the four charges, as follows:

*Science group.* This group handles the literature review and any other research required to develop the criteria needed to create the model. This work is basically what is done in the class known as the “Science of Interpretations.” While any interested person is welcome to participate, some experienced people will be needed from diverse professional backgrounds to best explore what soil and site properties need to be accounted for in a particular interpretation.

*Model design, development, and maintenance group.* This group works in the NASIS environment to assemble the properties, evaluations, and rules needed to make the models work. It will receive specialized training as needed to attain a high level of proficiency with the Calculations, Validations, Interpretations, and Reports (CVIR) scripting language as well as the rule-based fuzzy logic system. This group also will keep up with NASIS data model changes and scientific advances to ensure that the syntax and logic of the interpretations are up to date.

*Testing group*. This group critically examines the outputs generated from the interpretations that are being developed to assess the accuracy of the results and suggest ways to improve the predictions. Proficiency in Arc-GIS and statistics would be very helpful in examining large quantities of information efficiently. Having a good idea of how soils should be rated for a particular land use or soil function in an area is essential. This group will also be able to detect data voids, peculiarities, and inconsistencies.

*Documentation group.* This group assembles and publishes the metadata for each interpretation. This includes descriptions for the Web Soil Survey Rule and Report Manager as well as more in-depth descriptions with diagrams that could be linked to an as yet undeveloped documentation site associated with Web Soil Survey. The work will include publishing articles on the models in refereed journals as needed.

The functions of the workgroups, of course, have always been done. The team framework will formalize the concept of parsing the stages of work to different groups, including all the cooperators and disciplines, to help keep any one person from being overwhelmed, especially as most are already fully engaged in present workloads. Distributing the various kinds of tasks will also allow the team to take advantage of the talents and strengths of the staff involved and make the process as inclusive as possible. This process will require buy-in and permission from supervisors because the time commitment will be significant. Training will be needed to maintain a continuity of practitioners that have the background to accomplish the tasks that are needed.

Anyone interested in the process of converting soil survey data into information needed for wise land use and management decisions should contact Robert Dobos at bob.dobos@usda.gov. For more information, visit the website: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/focusteams/?cid=nrcseprd1547815. ■

## CocoaSoils Conference Held in Yaoundé, Cameroon

Rising global cocoa consumption rates, due to growing world population pressure and affluence as well as declining yields on mostly old farms, cause sporadic spikes in cacao prices, creating renewed concerns about the long-term sustainability of the cocoa industry. There is a growing need to reassess the ways to improve the quality and quantity of global cocoa supply. Booming cocoa consumption per capita, particularly in Asia, is expected to increase the demand for the main ingredient in the $100 billion chocolate industry by about 1 million tons by the end of 2020.

Although potential yields are projected at about 6,000 kilograms per hectare, actual farm yields range from 400 to 600 kilograms per hectare, about 10 percent of the genetic potential. The much needed increase in cocoa supply can be achieved by (1) improving yields per unit area of production or (2) expanding the acreage under cultivation. Low cocoa yields due to poor soil health, disease, changing weather

**Figure 1.—Dr. Jonas Mva Mva, Cocoa Program Director – IDH, and Dr. Richard Asare, IITA CocoaSoils Coordinator, answering questions from the press.**

patterns, and less than optimal cultural management practices put enormous pressure on farmers in major cacao-producing countries to convert more forestland and, in some cases, protected areas to cocoa farms to maintain or increase production targets. Exploitation of new forests, however, has serious ramifications, including habitat destruction, loss of biodiversity, and climate change. Declining yields also mean decreasing incomes for many cocoa farmers who already live in extreme poverty.

The CocoaSoils program addresses the issues of decline in quality and productivity of aging cocoa farms and ways to improve the livelihoods of smallholder cocoa farmers, while avoiding further deforestation. It aims to increase yields per unit of land area through sustainable intensification. The program is evaluating current production practices in major cocoa-producing countries while conducting rigorous Integrated Soil Fertility Management (ISFM) trials with targeted soil health assessment and monitoring that combine improved planting materials, canopy cover management, and pest and disease management strategies.

The CocoaSoils program is funded and led by the Norwegian Agency for Development Cooperation (NORAD) and has more than 50 partners. Collaborators include the International Institute of Tropical Agriculture (IITA) and Wageningen University and Research (WUR) with engagements from National Cocoa Research Institutes of Cameroon (IRAD), Côte d'Ivoire (CNRA), Ghana (CRIG), and Nigeria (CRIN); international research centers (including the International Centre for Tropical Agriculture (CIAT), the World Agroforestry Centre – (ICRAF), the UN Environment World Conservation Monitoring Centre – UNEP-WCMC); and some cocoa and fertilizer companies convened through the Sustainable Trade Initiative (IDH) as lead partners.

The program has two main arms: Research for Development (R4D) and Partnership for Delivery (P4D). The R4D focuses on developing protocols for establishing trials as well as data collection, management, and interpretation. This data is accessible initially to partners but will be eventually made available to all end users. The P4D focuses on disseminating the recommendations from the results of these trials to empower farmers to improve cacao quality and productivity per unit land area and hence increase profit margins and farmers' livelihoods.

### Second Workshop

The second CocoaSoils workshop was held in Yaoundé, Cameroon, from January 20 to 25, 2020, as a follow up to a strategic meeting on cacao intensification in Accra, Ghana, in July 2019. The workshop addressed challenges facing smallholder cocoa farmers globally as well as child labor and gender issues related to cocoa farm operations.

Following brief introductions on January 20, the organizers delved directly into group discussions on specific issues on the satellite trials, led by IITA scientists and partners. These discussions were followed by 30-minute presentations by four PhD

**Figure 2.—Daniel van Gilst, Senior Adviser for NORAD having a lively exchange with the public administrator and others of a cocoa-producing region of Cameroon.**

students currently conducting research under the program. The presentations were followed by question and answer sessions. The day ended with a presentation on the current protocol for the core studies and satellite studies.

On January 21, opening deliberations focused on updates on the status of the core trials, with emphasis on the challenges and opportunities, and proposed solutions, presented by the Core Trial Managers. They included a discussion of the spatial analysis of the agro-ecological zones under cocoa production. Given the vast amount of data already collected and yet to be collected, the issues of a data portal, databases, and data collection applications for the core and satellite trials were discussed. A prototype of the big data portal hosted and managed by Wageningen University was demonstrated. A presentation on the aims and objectives of the trials, how the plots were laid out, and baseline information, including the setup and execution of the first phase and a discussion of preliminary results, followed. A major challenge was how to deal with the diversity of agroecological zones and underlying soil types involved. A major weakness in the design was the lumping of the different soils into two soil types to reduce the number of samples and the cost of sampling. The morning session ended with a presentation on the impact of deforestation on ecosystem services and the need for reforestation.

The afternoon session began with comparisons of management recommendations across countries and organizations, including the use of blanket fertilizer recommendations without the benefit of soils investigations or soil test recommendations. Other issues addressed included the use of chemicals for pest control without adequate protection and the general lack of access to agricultural inputs.

Parallel or breakout group sessions focused on one of the following topics: pruning recommendations; integrated pest management approaches to disease control, including crop sanitation; integrated pest management to pest control; integrated Soil Fertility Management (ISFM) recommendations, including fertilizer use and recycling of on-farm organic waste; and agroforestry and shade management. Each small group gave a presentation and their recommendation to the larger group. The day

ended with a presentation on the living income of cocoa producers and the potential contributions of yield intensification versus price hikes. The presentation portrayed a bleak scenario for cocoa farmers' incomes under price hikes and recommended that increasing yields through cocoa intensification was the best alternative for the long-term sustainability of the cocoa industry.

**Figure 3.—Meeting members of a local cocoa cooperative clarified objectives, expectations, and roles and responsibilities for all those participating in ongoing and anticipated field trials.**

Program partners made presentations on ongoing work on core trials and satellite R4D trials to help provide site-specific Integrated Soil Fertility management (ISFM) fertilizer recommendations across West Africa, where more than 70 percent of the world's cocoa is produced. The core trials are long-term, researcher-managed, multi-locational trials of at least 2 hectares with a factorial design to evaluate yield response to different nutrient rates over a 10- to 15-year period. In addition to the core trials, smaller trials (satellite trials) will be established in farmers' cocoa plantations. These trials will demonstrate best management practices learned from the core trials, notably different fertilizer combinations, pest management strategies, and shade interactions, to convince farmers to accept recommended practices.

On Wednesday, January 22, attendees visited two farm trials in the outskirts of the city of Yaoundé. Although the farms were less than 10 miles apart, the yields were different due to different management practices. The day ended with a visit to a cocoa farmers' cooperative that works to improve working conditions, transport, and storage facilities and markets the cocoa on behalf of the farmers in the district. Members of the cooperative expressed the hope of finding direct markets for their cocoa in the United States.

Thursday, January 23, marked the formal opening ceremony of the CocoaSoils workshop. Dr. Bernard Vanlauwe, IITA Director for R4D, set the stage by outlining the overall objective of the CocoaSoils Program: A sustainable cocoa supply sector where productivity of cocoa farms will be increased by about 30 percent through the efficient use of agricultural inputs, and the livelihoods of about 90,000 farmers will be improved without further deforestation. He explained that besides smallholder cocoa farmers, other groups would benefit. National research and extension agents would gain necessary skills and state-of-the-art knowledge and tools; policy makers would be empowered to support the smallholder cocoa sector while protecting the environment; and society as a whole would be able to avoid deforestation and secure a predictable supply of cocoa for global markets. Dr. Vanlauwe acknowledged challenges encountered by cocoa farmers and encouraged workshop participants to work together to seek viable solutions to these challenges.

In his opening remarks, Honorable Gabriel Mbairobe, the Cameroon Minister of Agriculture and Rural Development, stated that Cameroon produces about 260,000 tons of cocoa annually but plans to increase production to 600,000 tons per year in 5 years. He applauded the accomplishments of the CocoaSoils program so far and also pledged to collaborate with project partners to support the CocoaSoils program

in Cameroon. Independent model predictions by CIAT and NRCS, which indicated that Cameroon would have a high level of resilience to climate change with respect to cocoa production, were very encouraging. Others who spoke at the opening ceremony included high-level representatives of partner organizations and institutions from various countries.

Friday, January 25, was dedicated to reviewing the various presentations, deliberations, and declarations of the workshop and making plans for the next workshop.

**Challenges and Opportunities**

Cacao trees have specific ranges of soil types as well as temperature and moisture regimes that limit their geographic distribution. Cacao is grown mostly by about 5 million resource-poor farmers in humid tropical conditions, within 20 degrees north and 20 degrees south of the equator, on more than 70 million hectares of land. Farms are typically 2 to 3 hectares in size and are located on a wide variety of soil orders. The FAO (FAOSTAT) Harmonized World Soil map from which these estimates are derived ranges in scale from 1:5,000,000 to 1:1,000,000. While this scale may be appropriate for regional comparisons it is not detailed enough for operational farm management. Individual farmers do not know what soil types are dominant on their farms, let alone how to manage them. NRCS, as the leading U.S. agency for soils and vegetation inventories for productive uses, could help by using its digital soil mapping expertise to define the agro-ecological zones for optimum high-quality cacao production.

USDA has a long history of providing technical assistance on cacao improvement in Ecuador, Peru, Brazil, and Colombia. NRCS has two ongoing cocoa initiatives: (1) the Cacao for Peace Project in collaboration with CIAT, facilitated by FAS and funded by USAID, and (2) the World Cacao Suitability map (a collaboration between ARS and NRCS) based on FAO maps with very coarse resolution. NRCS needs partners in major world cacao-producing regions to contribute toward refining and validating this World Cacoa Soil Suitability map.

NRCS participation at this meeting provided ample opportunities to develop partners for future collaboration on sustainable cacao improvement programs, to learn from the experience of other partners, and to use such information in ongoing NRCS cacao projects. NRCS also benefited by identifying partners in different cocoa-producing regions in the world who could verify and validate the World Cacao Soil Suitability map.

NRCS has a vast amount of knowledge and expertise in developing guidelines for excellent soil health quality assessment and monitoring for various crop management scenarios in diverse ecosystems. The agency's Soil and Plant Science Division has provided technical assistance on soil health assessment and monitoring using soil quality test kits for years. The kits can be readily deployed in developing countries which do not have standard soil laboratory services.

The United States is the largest global consumer and importer of cacao, the key raw material used in chocolate. For example, an estimated 80 percent of Americans consume chocolate on Valentine's Day. Cocoa, however, is not grown commercially in the U.S. The confectionary industry positively impacts the U.S. economy, with estimated sales of more than 34.9 billion dollars in 2015 and projected estimates of roughly 38.1 billion dollars by the end of 2020. The industry directly and indirectly employs hundreds of thousands of workers nationwide. It is of national interest to support increased production of healthy cocoa beans and promote geographic diversification of dependable quality cacao supplies.

It is important that the U.S. chocolate industry safeguards the production potential of West African countries. Declines in cacao productivity in West Africa were largely due to poor soil health, the result of many years of poor soil management (including

no use of fertilizers and manures and no control of soil erosion), and prevailing high temperatures, which led to declines in soil organic matter. Declining yields also mean lower income for local farmers. To compensate for low yields and improve their livelihoods, farmers are converting new forests to cocoa farms. The result is massive deforestation. In addition, the knowledge gap on good crop nutrition and proper management of cocoa trees cannot be over emphasized, particularly knowledge on different key plant nutrients (e.g., nitrogen, phosphorus, potassium, and micronutrients).

The annual forum of the CocoaSoils project was designed to set a road map to evaluate progress, identify challenges and options to overcome, deepen collaborations and partnerships among key stakeholders, and apply the lessons learnt in subsequent project-years, as well as celebrate the program's successes. Program partners were delighted by NRCS presence at the workshop and their willingness to share their activities on cocoa improvement with the group and are hopeful NRCS will become an active partner in this global initiative. ■

## SSSA Field Tour in North Central Texas Focuses on Noncemented Bedrock Layers

By Chance Robinson, Travis Waiser, and Wayne Gabriel, NRCS soil scientists. Photos courtesy of Douglas Freese, consulting soil scientist.

On November 6 to 9, 2019, over 30 soil scientists from 18 States and countries participated in the "Soils and Landscapes of North Central Texas" field tour preceding the 2019 ASA-CSSA-SSSA International Annual Meeting in San Antonio, Texas. The tour was organized and led by NRCS soil scientists from the Stephenville and Kerrville MLRA (Major Land Resource Area) Soil Survey Offices together with Texas NRCS staff, Soil Survey Region 9 staff, and Tarleton State University faculty.

The tour explored 10 unique soil landscapes across the extent of 7 land resource areas in North Central and South Central Texas with a special emphasis on the interpretative significance of noncemented bedrock layers (fig. 1). Soil landscapes forming in mudrocks, sandstones, limestones, and granites of Cretaceous, Pennsylvanian, Ordovician, and Precambrian age were encountered during the trip. In the sub-humid and semi-arid climate of the Southern Great Plains, slightly

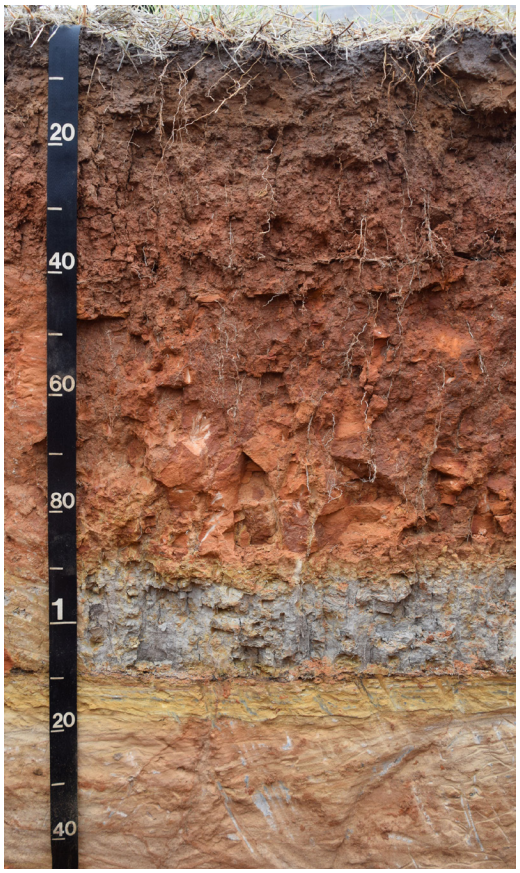



**Figure 1.—Profile of the Birome series (Ultic Paleustalfs) observed in the East Cross Timbers (MLRA 84C) at Stop 2. Note the interbedded gray mudstone and sandstone bedrock below a depth of 91 cm. These interbedded bedrock layers represent the parent material from which the overlying solum formed.**

weathered mudrock layers are often encountered proximal to the surface in a dry moisture state. Excavation difficulty and water relationships of these layers are dependent on the moisture status. Weathering and persistence of these layers within 2 meters is dependent on the environmental factors of landscape position, bedrock depositional environment, and present soil climate. Mudrock layers have been inconsistently described as C, Cr, and Cd layers (paralithic and densic contacts, materials, and bedrock) in published soil surveys of North Central Texas from 1972 to 2009.

One of the overarching goals for the tour was to meet as a national (and international) group of soil scientists in the field to build understanding and consistency in the description of soft and weathered bedrock. It is important that the soil science community meet together in soil pits to see what we see, discuss issues, and work toward consistency in the Southern Great Plains as well as other places nationally and internationally. Soil Survey Region 9 staff have been working toward a consistent description of these materials since 1987. In the mid-1990s with the soil survey of Young County, Texas (in Major Land Resource Area 80B), these efforts toward consistency focused on noncemented soft sedimentary bedrock layers (fig. 2). In the mid-2000s with the soil survey of Mason County, Texas (in Major Land Resource Area 82A), efforts focused on consistency in describing soils forming in weathered igneous and metamorphic rocks. Soils such as the Voca series (fig. 3) that form in weathered granite present a different set of issues compared to the fractured sedimentary rocks that dominate the Southern Great Plains.

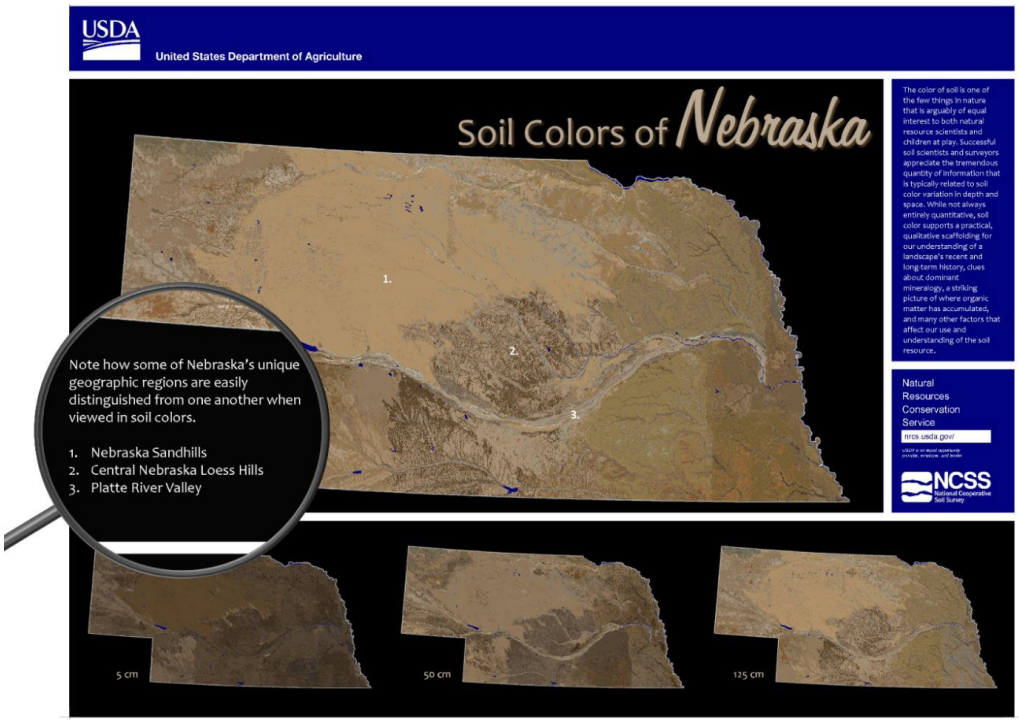
On the final day of the tour, the group visited a meteorite impact crater and explored the hillslope created following the impact. They viewed several examples of

**Figure 2.—At Stop 7, tour participants discuss the significance of engineering interpretations with respect to the clayey densic bedrock underlying the profile of the Owens series (Typic Haplustepts). Several buildings in nearby Graham, Texas, have suffered from structural issues related to altered moisture relationships of similar bedrock layers. NRCS Soil Scientists John Sackett, Sidney Paulson, Wayne Gabriel, and Tom Cyprian (retired) led this discussion.**

**Figure 3.—NRCS Soil Scientist Travis Waiser addresses the tour participants at Stop 9. This soil profile of the Voca series (Typic Paleustalfs) in a decomposed granite quarry was described by NRCS Soil Scientists Amanda Bragg, Ashley Anderson, and Travis Waiser.**

petrocalcic horizons and degraded petrocalcic horizons that formed in association with limestone and marlstone bedrock of the Edwards Plateau).

With the “official” tour completed, the group headed to San Antonio, still discussing, arguing, and defending what they saw. Conversations like these present many viewpoints and expand the understanding of the ever-changing soils. ■




**The “Soil Colors of Nebraska” poster annotated with information about Nebraska’s landscape.**

## Soil Color Posters by State

By Tammy Umholtz, Chad Ferguson, and Dylan Beaudette, NRCS National Soil Survey Center, and Jason Nemecek, NRCS Wisconsin.

The SSURGO-based “Soil Colors of the Continental United States” was announced about a year ago. Since then, the images and datasets have received a lot of attention from within the agency as well as from outside organizations. From the start, the project was always about communicating, specifically about the rich geographic variability found within the soil resource. To help spread the word, the National Soil Survey Center compiled a 19-by-25-inch poster for each State. The posters are now available on CloudVault. Just like the individual images, the posters speak without words. We encourage you, however, to add some simple annotation to the posters. A few simple remarks will help the audience link the colors to pedology and the landscape. To make the process easier, the posters are available as PowerPoint templates. The templates are ready for you to liven up the story behind the colors. We envision each State taking just a few minutes to communicate the story of their colors. These stories should be on the Web and your wall! What are your colors? ■

## Soils Topics in GovDelivery and NASISNEWS

By Tammy Cheever, information technology specialist, National Soil Survey Center, Lincoln, Nebraska.

We encourage everyone to subscribe to Soils topics in GovDelivery. (Click here to subscribe.) You may subscribe to one or more of these topics:

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## Blast from the Past

Each issue of the newsletter now will include information or a document considered historical. Please submit any ideas to the Editor Jenny Sutherland. We kick off this featured section with a poem by W.S. Ligon. A Xerox hard copy of the following poem had the attached note:

*This "Correlator's Lament" was found among W.S. Ligon's effects. It was given to me by Mrs. Ligon – with permission to pass it on to interested people.*
*– A.H. Paschall 12-64*

**Correlator's Lament**

A man there was, Guy Smith by name,
Inventor of a guessing game
To put all other such to shame.

This game, though based upon the soil,
Consisteth chiefly of turmoil
And is a cause of endless toil.

This brainstorm hardly had begun—
Out popped Approximation 1—
And we thought that the job was done!

But ‘ere the ink had time to dry,
Our hero made another try
His second draft bloomed but to die.

Then came Approximation 3;
Our weary eyes began to see
The 4th would not the last one be.

The 5th Approximation found
Us on the ropes and giving ground
From going round and round and round.

The 6th was just a stepping stone,
To make us swear and sweat and groan—
To make us want to be alone.

In padded cells, from which to cry,
At every sane man passing by
And sense his sympathetic sigh.

Herr Smith now thought the time was ripe
For high-brow nomenclature tripe,
While we were all too beat to gripe.

Now we engage in hide-and-seek
With Sanskrit, Latin, Smith and Greek;
The future never looked more bleak.

These hellic orthic Argudolls
And those God-damic Haplaquolls
And ruptic, cruddic Natrabolls

But friends, you haven’t heard the half
Try glossudalfic Fragaqualf
And Albaqualfic Typustalf.

And haplic cryptic Cryudents,
And orthustentic Psammustent
And hyperbolic Haplaquents.

And rhodochruentic Typumbrults
And typumbrultic Rodochrults
And chrodotypic Brultorhults.

We’ve made a lot of Pfalsistarts
And let a lot of Psuephopharts
And spun the wheels upon Ourcarts.

Despite the 7th being bound
We still cannot get off the ground,
The spit and polish keeps us downed.

If one of us is still alive
In 19 hundred 65
There is no doubt that he will strive.

To get past sub-group and to see
What he can do with family
It may be you! It won’t be me! ■

# Rubbleland…Surprising Soil Characteristics

By Mike Jones, resource soil scientist, West Virginia NRCS, and Stephanie Connolly, forest soil scientist, USFS Monongahela National Forest.

Many people have the opinion that the term Rubbleland means a pile of rocks with nothing growing or even able to grow there. After more than 5 years of shovel-breaking, rock-breaking, and back-breaking work, soil scientists in West Virginia know this is just not true. It might appear to be a pile of rocks on the surface, but there is a plethora of soil, plants, and animals found within the nooks and crannies between these rocks! One example is the Cheat Mountain salamander, which is a federally listed threatened species (fig. 1). This salamander's habitat and native range include areas of Rubbleland within the Central Appalachian Highlands of West Virginia.

**Figure 1.—Cheat Mountain salamander climbing a moss-covered rock within a Rubbleland delineation.**

Soil surveys consider Rubbleland areas as miscellaneous areas, and little effort was dedicated to describing these areas when they were first mapped because these landscapes and soils did not support agricultural activities. Rubbleland is defined by the USDA-NRCS Soil and Plant Science Division as areas of cobbles, stones, and boulders commonly at the base of mountains, or left on mountainsides by glaciation or periglacial processes. Developing soil properties and resultant interpretations is of particular interest to the U.S. Forest Service's Monongahela National Forest (MNF) staff since much of the Rubbleland map unit occurs throughout the National Forest System lands.

**Figure 2.—Areas of talus and talus slopes near Smoke Hole, West Virginia. Exposures of Tuscarora Sandstone form a resistant cap on the ridge.**

West Virginia is "blessed" with many areas that meet the definition of Rubbleland, with over 400 delineations. Areas mapped as Rubbleland in West Virginia are found in Hampshire, Mineral, Monroe, Tucker, and Randolph Counties, with much of it occurring within the MNF. Thanks to the hard work of the staff of the MNF Soils Resource Program, the MLRA 127 Soil Survey Office staff (Morgantown, West Virginia), and West Virginia State Office staff, the soil survey

program is gathering valuable information to better understand the importance of these areas.

Rubbleland polygons tend to occur below ridges that are capped by Tuscarora Sandstone (fig. 2). Geologists call these materials scree, or talus, and the landforms on which they occur are called talus slopes. There are also many areas of Rubbleland on the very resistant sandstone formations in the Pottsville Group (fig. 3).

**Figure 3.—Very resistant sandstone conglomerate stones, flagstones, and boulders on a ridge within Dolly Sods Wilderness. These rocks are from the Pottsville Group geology.**

Rubbleland map units have interesting soil characteristics due to large rock fragments at or near the ground surface. The wavy boundaries and discontinuous horizons of the soil profiles beneath the rocks are examples of the distinguishing features that display those interesting soil characteristics (fig. 4).

The associated coarse sandstone parent materials do not always produce the sandy textured soils that one might expect. The finer soil textures commonly found in the subsoil, such as silty clay loam, make these Rubbleland map units interesting from a soil interpretation and soil genesis viewpoint (figs. 5, 6, and 7). High volumes of rock fragments with random orientation facilitate preferential flow, which causes differential soil development. Pockets or bands of organic and iron compounds are commonly irregularly distributed within fine-earth material, creating features of a spodic horizon.

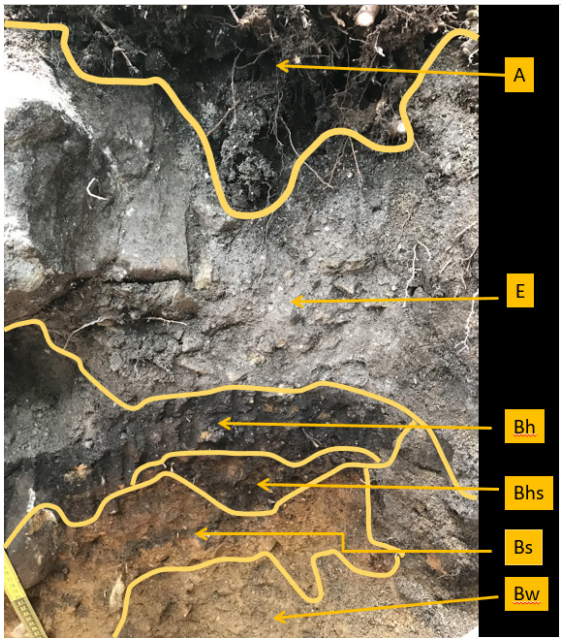


**Figure 4.—Profile of a Spodosol described in a Rubbleland map unit at a high-altitude site in West Virginia.**

Some spodic horizons can have a reddish hue, which denotes the presence of amorphous iron oxide compounds (figs. 5, 6, and 7). These iron compounds, as the commonly associated aluminum compounds (sesquioxides), can create strong cementation (Bs horizon). Other spodic horizons have a very dark to nearly black color below an eluvial (E) horizon, which indicates the presence of mobile amorphous organic compounds (Bh horizon). The mixing of sesquioxides and organic compounds often occurs in a single horizon(Bhs horizon) (fig. 4).

Another property of these soils is very low pH, due to the parent material, vegetation, and high amounts of precipitation, which drive nutrient leaching. The parent material is naturally low in base cations. Plant communities, typically consisting of red spruce, laurel, rhododendron, hemlock, and other less abundant

**Figure 5 (left).—Sandy fine-earth material between rock fragments. Figure 6 (right).—Silt loam fine-earth material between rock fragments.**

**Figure 7.—Organic material and smaller rock fragments between large rock fragments.**

species, produce a litter layer that creates more acidic conditions through decomposition. The pH values measured during the Rubbleland sampling ranged as low as 2.7 where red spruce was dominating the forest around the site.

Conducting investigations in Rubbleland areas is very difficult due to the quantity and size of the rocks and the remoteness of these delineations. For these reasons, along with the historical lack of emphasis placed on nonagricultural lands for soil mapping, little information on infiltration or saturated hydraulic conductivity exists for these soil types and the map units. The information generated from this project will add a great deal to the understanding of soil properties and interpretations of miscellaneous areas. In addition, it will assist land managers of the Monongahela National Forest in determining management prescriptions for active and passive restoration.

What will be done with this new information? Current interpretive reports, in most cases, return no results (i.e., “Not rated”) when run on miscellaneous areas such as Rubbleland. The new data on the physical and chemical properties of the underlying soils will enable soil components to be developed, and creation of new soil series is likely. They will allow interpretations for these areas. Currently, the National Cooperative Soil Survey is participating in a study to produce even more data and provide information for future management interpretations. ■

## Connecticut State Police Train with Soil Scientists

USDA-NRCS soil scientists, Connecticut Office of State Archaeology archaeologists, and the Connecticut Office of the Chief Medical Examiner forensic anthropologist teamed up to offer training to local law enforcement professionals on the preparation, excavation, and recovery of remains and evidence.

Jacob Isleib, resource soil scientist, and Debbie Surabian, state soil scientist of Connecticut and Rhode Island, trained State police on the use of spatial data, soils information, and geophysical tools for criminal investigations. Isleib talked about the soil scientist’s unique ability, by reading the landscape and describing soil details, to recognize natural versus disturbed soils as well as the extent of disturbance in the field. He also reviewed where to get and how to use spatial data like LiDAR to understand a crime scene area over time. Surabian discussed using soil survey information to identify the likelihood of a burial, the decomposition of bones in soil, and soil characteristics that affect the movement of the scent pool when using human remains detection dogs. She also talked about identifying clandestine graves and evidence using geophysical tools.

**Figure 1.—Law enforcement professionals learn how to properly excavate and recover skeletal remains and evidence in soil during the field exercise.**

**Figure 2.—Jacob Isleib (orange hat) and Scott Brady (blue cap) are videotaped during the field exercise of the law enforcement professional training.**

Presentations were also given by Dr. Nick Bellantoni, emeritus Connecticut State archaeologist, on forensic archaeology search and excavation techniques and

by Dr. Kristen Hartnett-McCann, forensic anthropologist, on the bare bones of forensic anthropology.

In the afternoon the law enforcement professionals searched for two clandestine graves created using plastic skeletons buried months ago. After locating the graves, they were instructed by Scott Brady, president of the Friends of the Office of the State Archaeologist, on how to properly dig and recover remains and evidence in the field. They also got a chance to lay out a grid and run ground penetrating radar over staged evidence. ■

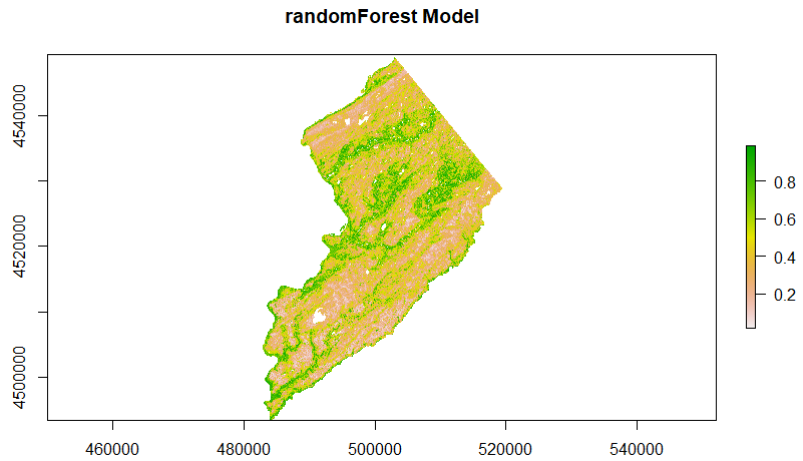


**Figure 1.—Prediction map generated with Random Forest model in a scale of 0 to 1, where 1 is high probability and 0 is low probability.**

## Digital Mapping Using Machine Learning Models for Potential Native American Campground

By Edwin Muñiz, New Jersey Assistant State Soil Scientist.

Cultural resources are evidence of past human activity. They may include pioneer homes, buildings, or old roads; structures with unique architecture; prehistoric village sites; historic or prehistoric artifacts or objects; rock inscription; human burial sites; and earthworks, such as battlefield entrenchments, prehistoric canals, or mounds. These nonrenewable resources often yield unique information about past societies and environments and provide answers for modern-day social and conservation problems. Although many have been discovered and protected, there are numerous forgotten, undiscovered, or unprotected cultural resources in rural America (USDA-NRCS, 2003).

Landscape, landform, and soils data, which take into consideration inherent soil properties, are good sources of information for modeling the probability for the occurrence of past human activity. NRCS is working to combine the soils database (NASIS) with geospatial data into a machine learning model. The objective of this project is to create a layer that provides a more scientifically sound dataset for areas of archeological sensitivity and that can be used in the Environmental Evaluation Worksheet (NRCS CPA-52). The dataset would also offer additional information helpful

in the conservation planning process and increase awareness of the preservation of potential Native American archeological sites while planning and implementing conservation practices.

To predict the location of Native American campgrounds in Warren County, New Jersey, analysis was conducted by comparing three machine learning models. The models were CART (Classification and Regression Trees), Random Forest (RF), and Cubist (C). The input data for the analysis and prediction were aspect, digital elevation model, soil drainage class, presence of rock fragments in the soil surface, slope, distance to stream, soil texture, and wetness index. The digital models used are considered non-linear machine learning models for classification, regression, and prediction.

In "A Preliminary Report of the Archeology Survey of the State of New Jersey" (GSNJ, 1913), campsites are described as sites near fresh water, on sandy, well drained bluffs or knolls, and on the northern side of streams or lakes. Warren County consists of a diverse topography, ranging from steep slopes and narrow valleys to rolling and nearly level areas and is within three physiographic provinces, the Ridge and Valley, the Highlands, and the Piedmont.

The data consisted of 287 known campground locations and 287 randomly selected locations without campgrounds for a total of 574 points. The point data was used to extract soil aspect, elevation, soil drainage class, presence of rock fragments in the soil surface, soil slope, distance to stream, soil texture, and wetness index. The wetness index is the function of the flow accumulation upstream and the topography measured as slope, and in addition incorporates a soil transmissivity factor. Soil transmissivity indicates the volume of water that infiltrates as a hydrology factor. In this case, the volume of water is restricted to the depth of a restrictive layer or the seasonal high water table.

This is an ongoing project that needs to include additional computing indicators to measure the model accuracy. Nevertheless, the model's performance was measured by comparing the root mean square error (RMSE) and the coefficient of determination ($R^2$). RMSE indicates the absolute fit of the model and how close the predictions are to the values. $R^2$ indicates how the model explains the variability around the mean value. In this study, Random Forest provided the best prediction (fig. 1) by providing the best fit (RMSE = 0.22) and explanation of the variability ($R^2$ = 0.90) compared with CART and Cubist with a RMSE of 1.15 and 0.43, respectively, and a $R^2$ of 0.27 and 0.26, respectively (table 1).

Table 1.—Model performance

| Model | RMSE | $R^2$ |
|---|---|---|
| CART | 1.15 | 0.27 |
| Random Forest | 0.22 | 0.90 |
| Cubist | 0.43 | 0.26 |

**References**

Geological Survey of New Jersey. 1913. Bulletin 9. A Preliminary Report of the Archeology Survey of the State of New Jersey. Trenton, New Jersey.

USDA Natural Resources Conservation Service. 2003. National Cultural Resources Procedures Handbook. https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=42752 ■

**Figure 1.—A plaque at Liberty State Park shows the approximate dates of the filling of the land. The dashed line indicates the original coastline prior to 1860 and the different colors represent the approximate dates of filling. The colors and dates filled by are as follows; pink, by 1860s; yellow, by 1872; dark brown, by 1905; purple, by 1916; and light brown, by 1928.**

## Communipaw Cove to Liberty State Park—An Urban Soil Story

By Debbie Surabian, Connecticut and Rhode Island State Soil Scientist.

Over 9,000 years ago, present-day Liberty State Park in Hudson County, New Jersey, was known to the native Lenape as Communipaw Cove. The shallow body of water was known for its good fishing and vast oyster beds (NJDEP, 2010) as the sandy alluvial soils in this area created a peninsula that extended into the Hudson River (Karnoutsos, 2010). Originally, the water of the Upper New York Bay (situated near the site of today's Liberty Science Center) hosted one of these vast oyster beds and was harvested well into the 19th century (Kurlansky, 2006).

Throughout the Colonial Period and into the 19th century little changed in the Communipaw Cove area (NJDEP, 2010) until the Industrial Revolution. Transportation was key during this period. Raw materials had to get to the factories, and finished products had to get to the markets. The once quiet Communipaw Cove soon evolved into a major transportation hub to fulfill this need. The soils of this area would change forever, as the thriving shallow waters received massive amounts of fill to create land that would boast railroad tracks, boat docks, and finally a beautiful grassy park known as Liberty State Park (fig. 1).

### Morris Canal and Railroads

First to arrive in this area was the Morris Canal in 1836. The canal connected the Delaware River at Phillipsburg, New Jersey, to the New York Harbor. Soon the Central Railroad of New Jersey (CRRNJ) purchased and began filling Communipaw Cove. Between 1860 and 1928, as the need to expand their facility grew, CRRNJ continued filling the cove. The terminal was constructed primarily on garbage from New York City, dredge spoil, and ship ballast (sand, earth, and other low-value but weighty materials carried by sailing vessels to ensure stability at sea). At its peak, the northern area of the park was crisscrossed by nearly 100 miles of railroad tracks and surrounded by a web of docks and piers. The site was a virtual beehive of activity with hundreds

of trains, ferries, barges and tugboats, and a variety of other water and land crafts arriving and departing daily (NJDEP, 2010).

The CRRNJ was not the only railroad to operate out of the area. The Lehigh Valley Railroad (LVRR) began running in 1855, and by 1880 it was one of the four great railroad lines in New Jersey. The railroad took its name from the beds of anthracite coal on Pennsylvania's Lehigh River. LVRR trains transported most of this cleaner, "smoke-free" hard coal to the New York harbor markets (NJDEP, 2010).

Heavier transportation demands soon rendered the original terminal inadequate. By 1889, a new terminal had been designed and constructed. The three-story head house joined 12 tracks with 6 platforms to the ferry slips at the water's edge. Service and repair facilities, float bridges, barges, and thawing sheds combined to make this complex the largest in the New York Harbor at the turn of the century. With the opening of the Immigration Station on Ellis Island in 1892, traffic increased dramatically. Of the 12 to17 million immigrants that passed through Ellis Island's Great Hall between 1892 and 1954, approximately two-thirds of these courageous newcomers would take their first step on American mainland soil at the CRRNJ Terminal. By the turn of the century, the CRRNJ Terminal accommodated between 30,000 and 50,000 people per day on 128 ferry runs and 300 trains. By 1914, the train and ferry sheds were enlarged to accommodate the growing numbers of commuters. The Bush train shed, still standing today, housing 20 tracks, was the largest one ever built (NJDEP, 2010).

**Black Tom**

A small island, called Black Tom, was once located in New York Harbor not far from Liberty Island. The name "Black Tom" is said to have come from an African-American fisherman who lived on the island for many years (NJCU, 2010). Between 1860 and 1880, Black Tom was connected to the mainland by a causeway and rail lines terminating at a freight facility with docks. The area between the island and the mainland was filled in sometime between 1905 and 1916 by the Lehigh Valley Railroad as part of its Jersey City facility. By the beginning of the 20th century, Black Tom was serving as a major munition depot (NJDEP, 2010).

Before the United States entered the First World War, American businessmen would sell their supplies to any buyer. However, by 1915, the British Navy had established a blockade effectively keeping the Germans from being able to buy from the American merchants. On July 30, 1916, the German government orchestrated the sabotage of freight cars at Black Tom, which were loaded with munitions for the Allies in Europe. The resulting explosion was the equivalent of an earthquake measuring between 5.0 and 5.5 on the Richter Scale. Windows within a 25-mile radius were broken, the Brooklyn Bridge was shaken, the outside wall of Jersey City's City Hall was cracked, and pieces of metal from the explosion damaged the skirt of the Statue of Liberty (NJDEP, 2010). It was one of the worst acts of terrorism on American soil in American history.

**Liberty State Park**

In 1964, President Lyndon Johnson declared Ellis Island a National Monument and promised to beautify the area. The following year, Jersey City gave the State of New Jersey 156 acres, including Black Tom, which became the nucleus of Liberty State Park. By 1967, all train traffic was rerouted to Pennsylvania Station in Newark and CRRNJ declared bankruptcy and ceased operation (NJDEP, 2010). At this time, residents convinced the State and Federal governments to preserve the terminal with the development of Liberty State Park (NJCU, 2010). Through local, State, and Federal funds, the CRRNJ Terminal and adjacent acreage were added to Liberty State Park. A massive clean-up campaign began, and by 1975 the terminal building

**Figure 2.—The docks at Liberty State Park are home to the ferries that take visitors to Ellis Island and Liberty Island, where the Statue of Liberty stands.**

was added to both the State and National Registers of Historic Places. One of the first projects undertaken by the State was a systematic clearing of railroad tracks, dumps, and abandoned industrial buildings (NJDEP, 2010).

Through the efforts of local advocates, the deserted rail yard was transformed into New Jersey's first and largest urban park, opening to the public in 1976 (fig. 2). Today the Park encompasses 1,212 acres. The 88-acre Green Park has wildflower meadows, lawns, a playground, plazas, and a network of paved pathways. It has become an oasis in the heart of one of the most densely populated areas of the country. It is a haven for local residents and weary travelers, people as well as a wide variety of birds, fish, and other small animals (NJDEP, 2010).

### Soils of Liberty State Park

In 2009, a memorandum of understanding was signed to complete the soil survey of Hudson County, New Jersey, in accordance with National Cooperative Soil Survey standards at a scale of 1:12,000. This mission would be achieved by providing scientific expertise to identify, classify, characterize, correlate, and interpret soils through field investigations, remote sensing, and laboratory information.

As soil mapping progressed through this mostly industrial, commercial, and residential county, the parks became valuable assets to consistently track where the glacial till, outwash, and eolian material existed. The parks were also used to compare different types of fill materials used to expand or shape the areas. As the largest park in the county and mostly made of fill, Liberty State Park was the ideal location for investigating anthropogenic soils. It would also be one of the toughest since most of the park was capped with clean fill and digging holes in this area was not an option.

However, with the use of historical records, ground penetrating radar (GPR), electromagnetic induction (EMI), and several backhoe pits for soil sampling and investigations, the soil survey crew was able to piece together the formation of the anthropogenic soils at Liberty State Park. Historical records indicate that the terminal was constructed primarily from New York City landfill material, dredge spoil, and ship ballast. From soil descriptions done at the park, most of the area consists of moderately well drained Ladyliberty (sandy-skeletal, mixed, mesic Oxyaquic Udorthents) and Secaucus (loamy-skeletal, mixed, superactive, nonacid, mesic Oxyaquic Udorthents) soils.

The Ladyliberty series consists of very deep soils that formed in a thick mantle of human-transported material consisting of coal slag, dredged materials, and/or any geologic deposits (ranging from till, outwash, alluvium, or coastal plain sediments

**Figure 3.—Profile of the Ladyliberty series, which consists of very deep soils that formed in a thick mantle of human-transported materials.**

usually from a local source) (fig. 3). Rock fragments within the particle-size control section range from 35 to 75 percent and are mostly artifactual. Some areas mapped as Ladyliberty have a thin loamy capping of relatively clean refuse, which contains less than 20 percent rock fragments. These areas were reclaimed and are currently open to the public as part of the Green Park.

The Secaucus series consists of very deep soils that formed in a thick mantle of human-transported material consisting of construction debris intermingled and mixed with natural soil materials that was used to fill wet areas (fig. 4). The construction debris material commonly originates from the demolition of buildings and roads. The dominant rock fragments in the construction debris are concrete, asphalt, bricks, coal ash, coal slag, and steel with some natural rocks sparsely intermingled. The human-transported natural soil material is dominantly from locally excavated upland materials, such as alluvium, till, outwash, or coastal plain sediments.

Within the restoration area, there were several backhoe pits dug for soil sampling. At the bottom of one of the pits, large wooden timbers covered the entire floor bottom. The wooden timbers, at a depth of 150 centimeters from the soil surface, were thought to have been part of a web of docks and piers built in this area to accommodate docking ships. After locating a space in between the foot-wide boards, a bucket auger pulled up the sandy natural soils of what once was Communipaw Cove. The soil was grayish in color and contained an occasional large oyster shell.

In the southern section of Liberty State Park that includes Black Tom, the soils are sandier with large amounts and sizes of artifacts. This area is mapped as the well drained Laguardia soil. The Laguardia series consists of very deep soils that formed in a thick mantle of construction debris intermingled and mixed with natural soil materials (fig. 5). The transported construction debris may include pieces of plastic, glass, rubber, bricks, lumber, asphalt, coal ash, unburned coal, gypsum board, concrete, and steel. The transported natural soil material may originate from any geologic deposit, including till, outwash, alluvium, coastal plain sediments, or residuum, usually from a local source.

**Figure 4.—Profile of the Secaucus series, which consists of very deep soils that formed in a thick mantle of human-transported materials.**

**Figure 5.—Profile of the Laguardia series, which consists of very deep soils that formed in a thick mantle of construction debris intermingled and mixed with natural soil materials.**

Between Black Tom and the Green Park is one of the State's largest remaining salt marshes. It is included in New Jersey's Natural Areas system, which identifies certain ecologically significant areas that may not be altered in any way and must have a comprehensive management plan to ensure the protection of the ecosystems and species within that area. The wetland area is mapped as the very poorly drained Westbrook soil (loamy, mixed, euic, mesic Terric Sulfihemists). The Westbrook series consists of organic deposits over loamy mineral material. The organic deposits range from 40 to 130 centimeters in thickness and consist of partially decomposed organic materials from salt-tolerant herbaceous plants.

Two types of geophysical nonintrusive techniques, EMI and GPR, were used in areas of the park that were off limits to digging since being reclaimed. EMI was used to help characterize the fill materials and delineate zones with different types and amounts of artifacts (fig. 6). It identified several major contrasting zones that appear to correspond with historical records of land use and may be differences in the composition of the fill. GPR was used to estimate the thickness of clean fill material overlying the coal or ash slag or dredged materials. Radar records showed that there is a relatively thin cap (less than 30 centimeters thick) of clean fill materials that cover the reclaimed areas of the park.

The soil survey of Hudson County, New Jersey, was completed in April 2012 and is currently available on Web Soil Survey. The new generation of soil surveys include more detailed information on urban or anthropogenic soils, soils having properties and pedogenesis dominated by profound human influences. USDA-NRCS soil scientists acknowledge that anthropogenic soils play an important role in our global soil system as much as soils under any other land use.

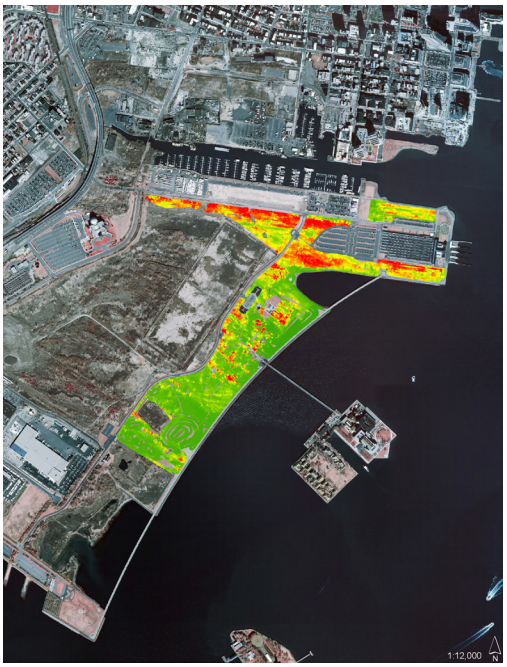


**Figure 6.—A map of the EMI data shows areas of high conductive soil materials or buried metallic objects in shades of yellow, green, and red. The red areas are associated with buried rails and other debris related to this former land use.**

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## Training on EDIT, the Ecosystem Dynamics Interpretive Tool, in Raleigh, North Carolina

By Matt Duvall, NRCS forester and ecological data quality specialist, Raleigh, North Carolina.

I have worked for the SPSD (Soil and Plant Science Division) regional office in Raleigh, North Carolina, on ecological site descriptions for 3 years. I am relatively new to the division and the effort—this is my sixth or seventh "career." This is the best job I have ever had. I work with such amazing, smart, passionate, and interesting professionals, and we do work of such potential importance, that I cannot believe how fortunate I am.

I did not attend the national NCSS conference in Rhode Island, but out of that meeting, three great colleagues of mine (Charles Stemmans, Belinda Esham-Ferro, and Jamin Johanson) started buzzing about a grassroots Eastern NRCS ecological sites workshop that they planned to convene in eastern Tennesee. Unfortunately, that workshop hit a snag, but it was (and is) a fantastic idea that, at the very least, inspired all of us to begin considering the possibility of convening our own meetings, trainings, and workshops as we need them.

Charles Stemmans rode a wave of momentum from this and started the regular monthly teleconferences for ES-ers (ecological site specialists) in the Southeast Region. Out of one of those teleconferences, George Otto went sleuthing about how we might be able to wrangle Curtis Talbot to provide some much-needed EDIT database training out East, and Otto hit pay-dirt. The Southeast Region ES Team would host the training January 28 to 30, 2020, at the regional office in Raleigh.

Those first contacted about participating were all NRCS ES specialists in the East, because this is core mission duty for us. Once we decided on a meeting, we sent out a general invitation to as many potential partners (tech team members) in the East as we could think of. The size of the training audience was limited only by the number of computers in the training lab. We wanted any remaining seats to be filled by people who self-nominated because they wanted to be there. Goodness gracious were we ever pleasantly surprised. Two state soil scientists (North Carolina and Pennsylvania), an assistant state soil scientist (Georgia), the national grazing lands team leader

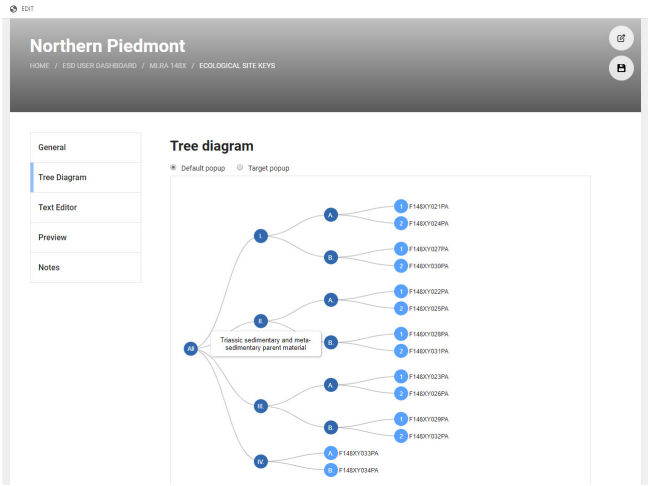


**Figure 1.—Screen shot of a tree diagram, the Ecological Site Key. This is the actual Site Key for the Northern Piedmont.**

(Fort Worth, Texas), a state rangeland specialist (Florida), the East National Technical Support Center forester, two regional soil data quality specialists (Auburn, Alabama, and Morganton, West Virginia), a soil survey office leader (Clinton, Tennessee), an MLRA soil scientist (Richmond, Virginia), an SPSD editor, an ES Pathways intern (Raleigh, North Carolina), and eight eastern ES specialists convened to soak up as much wisdom as the venerable Curtis Talbot could deliver in 3 full days of hands-on EDIT training.

EDIT is the new internal and public-facing web-based database for managing ecological data and for producing ecological site description (ESD) reports. It includes plenty of text blocks to allow complete descriptions of an ecological site concept, physiography, hydrology, soils, climate, vegetation communities, and ecological dynamics. But the real strength of EDIT is not its ability to manage text descriptions. Its real strength lies in its database functionality. Like its predecessor ESIS (Ecological Site Information System), EDIT has a built-in tool for selecting weather stations so that it can create custom climate data summaries and graphics. Unlike its predecessor, EDIT goes much further and includes dynamic tools for creating multiple ecological site keys and interactive state-and-transition models (STM). The ecological site-key tool enables an ESD developer to intuitively design a graphic representation of a complex conceptual ecological site classification of an MLRA. From that intuitive graphic representation, EDIT will automatically generate a full-text dichotomous key that a field end user can use to easily identify the ecological site at any location within an MLRA.

Possibly even more powerful than the site-key tool is the interactive STM interface. ESD developers can (and probably should) still develop and deliver a traditional two-dimensional STM to post within an ESD. However, the EDIT database also enables the development of a multidimensional interactive STM, which is particularly innovative. In relatively simple ecosystems, a traditional two-dimensional STM is easy to use because it provides all of the relevant information on one page. However, as we strive to provide more complete and detailed information in an STM, traditional two-dimensional STMs can get very busy at the very least. They can even become difficult to understand, especially in complex ecological settings. As the number of land uses, states, and phases increase, providing all the relevant information on one page becomes nearly impossible. The multidimensional STM builder enables an ESD developer to break a full STM down into more easily digestible components. However,

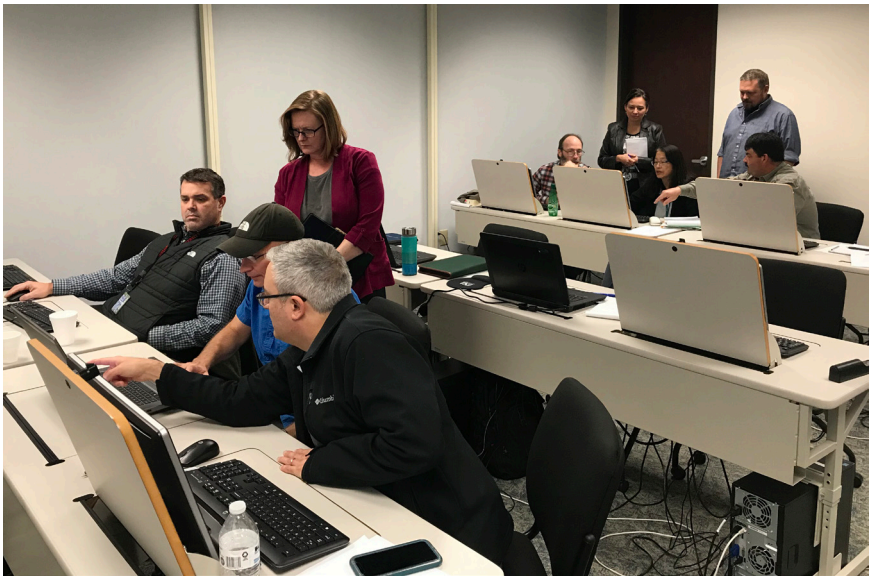

**Figure 2.—Participants working through a hands-on exercise in the review functions of EDIT. The team was divided into small groups and were assigned various review role permissions as they tried to simulate the review workflow process.**

graphic depiction of a complex multidimensional STM is challenging on flat pages; so, this user recommends that folks develop both a traditional two-dimensional STM as well as a multidimensional interactive STM. End users can use the traditional two-dimensional STM for a traditional overview, but they can also leverage the ability of the multidimensional STM to deliver much more complete and detailed information that is highly relevant to conservation management. For example, in many areas in the East, end users will want relevant STM information regarding native vegetation communities (e.g., natural forests), pastures, cropland, and urban land. Within the pastureland use, some end users will be interested in the warm-season pasture state. Others will want the same for the cool-season pasture state. Both of those states have at least a well managed phase and a degraded phase. In a traditional two-dimensional STM, developers would draw those phases as boxes nested within the boxes of the warm-season and cool-season states, respectively. In the interactive multidimensional STM tool within EDIT, the end user need only drill down into the warm-season state to discover the ecological dynamics between the well managed and degraded phases. Or, alternatively, they can back out to learn about the transition potential to change that pasture area to forest, for example.

Interestingly enough, there is some serious and interesting debate within the ecologist community in NRCS regarding the multidimensional STM tool in EDIT. The traditional two-dimensional STM is so well established and validated by academic and management communities alike that some are concerned that implementation of the multidimensional STM tool may have important unintended consequences. I find this debate quite interesting because, on one hand, it is obviously quite critical that our products, which proudly carry Uncle Sam's initials, be set on a solid foundation. Why else do we consider quality assurance, quality control, and scientific review such critical processes? On the other hand, is there not significant importance and value in innovation from within the agency? What other resource agency or academic curriculum considers such a diversity of ecosystems under such a wide range of management objectives as NRCS does?

I, for one, think that the EDIT database is great and has a lot of highly sophisticated functionality and potential. At our workshop in Raleigh, Curtis Talbot very skillfully

enabled all of us to unlock much more of that potential than when we started. Everyone was given hands-on exercises and provided space in the database to directly interact within all portions of it. Several ES specialists solved existing real problems on their current ESD projects in EDIT during hands-on exercises, problems that had previously confounded them. What we learned will significantly improve progress towards production output goals. Much of the database is highly intuitive, but some processes can be challenging at first, at least until taught by an experienced user such as Curtis Talbot.

The agency is currently using a second version of EDIT. The database has been significantly improved even in the short time since the first official deployment. Developing the site key tree is my personal favorite new skill that I learned from Curtis. The tree view is so visually helpful that I am surprised that it is not part of the publicly viewable display and report. I hope that the agency fully institutionalizes the database and continues development.

I am excited to have EDIT as a tool that I use in my daily work, and I am eternally grateful to have attended the training. It will definitely help me to develop ecological site descriptions more quickly and efficiently. Nonetheless, the best part of the week for me was the team. The professionals who participated were all engaged, collegial, participatory, and fun. Cheers to the great work that we are all doing for the Nation's natural resources! ■

**Santa Lucia Conservancy staff and NRCS and ARS scientists by an excavated Reliz soil (Lithic Xerorthents). The Pacific Ocean is in the background. Pictured left to right: Christy Wyckoff, Madison Ono, Genevieve Landucci, David Toledo, Robert Pennington, and Shawn Salley.**

## Digital Soil Mapping to Support California Ecological Site Development

By Shawn Salley, ARS Soil Scientist, Las Cruces, New Mexico.

In late January 2020, soil and rangeland scientists from the Agricultural Research Service (ARS) joined conservation staff from the Santa Lucia Conservancy in Carmel, California, to describe and sample grassland soils of the Central California Coastal Range. Recently, ARS scientists entered into a partnership with the Santa

Lucia Conservancy, which stewards an 18,000-acre preserve of protected natural lands, to provide expertise and advice on rangeland ecology, develop state-and-transition models, and analyze grazing and landscape data to evaluate grassland and rangeland response to the conservancy's targeted grazing program.

ARS cooperators used digital soil mapping techniques to sample and map soils classes across the preserve's grasslands. Prior to sampling, we applied the conditioned Latin Hypercube Sampling (cLHS) method, a random stratified procedure that chooses sampling locations based on a suite of soil-forming environmental variables. Using cLHS with a sampling number optimization algorithm and a cost-constrained implementation, we identified 41 soil and vegetation sampling sites across the preserve's coastal prairie and oak savanna landscapes.

Many stakeholders and cooperators joined the soil and vegetation field sampling, including scientists from NRCS (Genevieve Landucci, Templeton, California), Point Blue Conservation Science (Chelsea Carey, Petaluma, California), the California Conservation Corps, Americorps Watershed Stewards Program, and the Santa Lucia Conservancy. The next step is to analyze chemical and physical properties of the soil samples and conduct analysis of the conservancy's vegetation and grazing data.

Our collaboration helps support the Santa Lucia Conservancy's science-based mission to enable data-driven assessments of grassland and rangeland conditions, including the development of best management practices that promote native herbaceous plants, reduce noxious weeds, control non-native vegetation, and prevent brush encroachment. ■

## History and Evolution of the Soil Geomorphology Institute (SGI)

By Curtis Monger, Doug Wysocki, and Phil Schoeneberger.

In 1952, the USDA Soil Conservation Service acquired responsibility for all USA Soil Survey activities, and Dr. Charles Kellogg assumed the leadership role (Soil Science Institute). Kellogg recognized the value and need of both applying fundamental scientific principles to the Soil Survey and accruing scientific knowledge for it. To that end, during the late 1950s, Kellogg asked Dr. Marlin Cline of Cornell University, who was on a split appointment with USDA and Cornell University, to develop a university-level training directed toward USDA field soil scientists. The design goal of the training was to enhance expertise in soil classification, geomorphology, soil mineralogy, soil chemistry, soil physics, soil fertility, and plant physiology. The first such training began at Cornell through 2-week-long sessions in 1957 and 1958 with participants from New York State (Dick Arnold, personal communication). In 1960, the Soil Science Institute (SSI) per se commenced at Cornell as a rigorous 6-week-long session open to soil scientists throughout the USA. As paraphrased from Marlin Cline:

> "The pressure on the students was enormous. Few anticipated the intensity of the course. The fact that they were examined and graded, in contrast to the usual in-service training courses to which they had been accustomed, hung heavily over their heads. They were in class for five 50-minute periods 5 days each week for 6 weeks with problems and library assignments for evenings and weekends.There were, in fact, a few who became physically ill under the stress during the life of the project. Nevertheless, once the individuals returned to their jobs, most looked back on the Soil Science Institute as one of the most rewarding experiences of their professional careers." (Soil Science Institute)

Later, probably in the 1970s, the SSI was shortened to 4 weeks and alternated between Cornell and Iowa State University. Beginning in 1984, other universities hosted SSI, including Texas A&M, University of Florida, North Carolina State University, University of California, Davis, Alabama A&M, Washington State University, and Kansas State University (table 1).

Geomorphology always served as a key element of the SSI, as it was for other formal and informal Soil Survey trainings (e.g., Basic Soil Survey, Soil Correlation, and direct field assistance). Contributors who presented geomorphology aspects included Erling Gamble, Ray Daniels, and Carolyn Olson. Geomorphology training expanded as Phil Schoeneberger and Doug Wysocki developed the "Geomorphic Description System." This system built on Hawley and Parson's 1980 "Glossary of Selected Geomorphic and Geologic Terms" and Fred Peterson's effort to expand on his publication "Landforms of the Basin and Range Province" and create a national-level landform system.

An initial proposal for a separate, more comprehensive geomorphology training was encouraged by then Soil Survey Division Director Dick Arnold. As a result, in 1994, the 5-year plan for the Field Investigations staff included a proposed training course that would provide hands-on exercises to compensate for diminished field experience and geomorphology expertise. Projected training goals were to (1) communicate fundamental geologic and geomorphic principles, (2) examine soils and landscape as "synthographs" to obtain insight about their evolution, (3) understand the concept of geomorphic surfaces, both constructional and erosional, as a means for grouping soils of similar age, (4) provide "how-to" training on geomorphic techniques of ground-truthing, (5) show the utility and limitations of maps as a way to understand soil patterns at multiple scales, and (6) apply stratigraphy to the development of OSEDs (official series descriptions), map unit design, delineations, legend composition, and soil interpretations.

When Horace Smith became the Soil Survey Division Director in the late 1990s, he emphasized that a new generation of field soil scientists should know and apply the knowledge and principles developed by the landmark SCS Soil Geomorphology Projects conducted during the 1950s, '60s, and '70s. To that end, Smith advocated for a distinct Soil Geomorphology Institute (SGI).

The first geomorphology-centered SGI was held in 2002 at the Desert Project study area and hosted by New Mexico State University (Curtis Monger) with NRCS Training Coordinator Earl Lockridge. The lead instructors were Doug Wysocki, Phil Schoeneberger, and John Hawley. The second SGI was held in 2004 at Iowa State University, and hosted by Tom Fenton and Lee Buras.

In about 2004, a review group composed of Soil Survey cooperators and NRCS personnel was formed under the leadership of Carolyn Olson to make recommendations on the foremost topics to be covered in a soil geomorphology training. The key aspects of the review included (1) a set of fundamental geomorphic and geologic principles, (2) a process-based approach, and (3) a strong field component that included numerous field trips and field projects. In 2007, a subsequent NRCS operational survey by Marc Crouch (training coordinator) was sent to regional directors requesting input on SGI training. This yielded recommendations that (1) the course should be shortened from 4 weeks, (2) the SGI should rotate through the different regions in the U.S., and (3) the training should be held at a time outside the active field season.

As a result of these recommendations, the SGI became a 3-week session conducted at various locations. In addition, to address the increasing role of GIS (geographic information systems) in Soil Survey, the SGI incorporated a digital modeling component. Fred Young, a GIS expert, joined Phil Schoeneberger, Doug Wysocki, and Jimmy Richardson as a core SGI instructor. The first 3-week SGI was held in March 2007 in Lincoln, Nebraska, with help from the University of Nebraska

(Mark Kuzila, Matt Joeckel, and Paul Hanson). A second SGI session followed later that year at the University of Idaho, with Paul McDaniel as host.

The GIS component in the SGI originally included considerable hands-on computer time. This approach, however, received less-than-stellar reviews. Participants felt that hands-on GIS training should be its own course and that SGI should focus distinctly on geomorphology. A separate GIS modeling course based on the Soil Inference Engine was subsequently created to cover the targeted GIS material. Fred Young revamped the GIS modules, adapting the SGI context of process-focused soil geomorphic and hydropedologic settings and principles. This new approach proved effective and was well received.

By 2008, when SGI was held again at the New Mexico Desert Project (Curtis Monger, host), four geomorphic principles had fully developed to organize the training—pedology, stratigraphy, geomorphology, and hydrology. The training also was augmented with new GIS applications. The four core principles guided SGI courses when they were held at Penn State University in 2008 (Henry Lin, host), Alabama A&M in 2009 (Monday Mbilia, host), and University of California—Davis in 2010 (Toby O'Geen, host). The four SGI principles proved to be robust and continued to be the core framework used for subsequent SGIs. In 2012 and 2013, the SGI spent 1 week at the National Soil Survey Center in Lincoln, Nebraska (Shawn McVey, training coordinator), then traveled west over 2 weeks. The group covered a traverse from the Missouri River to the Continental Divide, across the progressively drier regions of Nebraska to Colorado State University (Eugene Kelly, host), where soils and geomorphology of the Rocky Mountains were discussed. Curtis Talbot and Zamir Libohova joined the instructor cadre during this period to share their ecological and digital soil mapping expertise. The SGI returned to University of California—Davis in 2015 (Toby O'Geen, host).

The last SGI training comprised of the core cadre (Richardson, Young, Schoeneberger, and Wysocki) was in 2017 at the Desert Project in New Mexico (Manoj Shukla, host) (fig. 1). Following this, SGI Jimmy Richardson and Fred Young retired and a new cadre of instructors were recruited as detailees (Paul Rindfleisch, Sarah Quistberg, Jamin Johanson, and Aaron Miller) for training at the 2018 SGI at the Desert Project (Colby Brungard, host).

**Figure 1.—Participants of the 2017 SGI held in the Desert Project study area and hosted by New Mexico State University.**

**Figure 2.—SGI instructors Doug Wysocki (right) and Phil Schoeneberger (middle) and participant (Ted Huscher) in the Sandhills of Nebraska, September 2019.**

Management decided that the SGI would change from a 3-week face-to-face training to a course consisting of 1 week online and 2 weeks face-to-face course and that the course would be held in the East. As a transition before moving the SGI east, the 2019 SGI in its new format started with 1 week online, followed by the face-to-face segment, which began in Lincoln and traversed Nebraska to the University of Wyoming (Karen Vaughn, host). Afterwards, Schoeneberger and Wysocki (fig. 2) retired as core instructors. The SGI 2021 is scheduled to be taught by the new cadre and hosted by the University of Georgia (Matt Levi, host).

The SGI consistently received positive training evaluations, and most participants expressed that it was very important for their understanding and ability to evaluate soils, landscapes, and ecosystems. The soil landscape tenets and training condensed in the SGI become more pertinent as Soil Survey relies more and more on digital technology, including artificial intelligence and machine learning. The authors affirm that it is essential to pass on a time-tested, human understanding of soils as dynamic, integrated components of the geomorphic landscape. New technology must build on the crucial basis of soil-geomorphic relationships to avert a hiatus between the two approaches and to minimize disconnects between the existing soil database information and new information and models. Successful digital models are critically dependent upon a robust understanding of a given terrain that integrates geomorphology, stratigraphy, pedology, ecology, and climate. Soil-geomorphic concepts provide the underpinning for existing National Cooperative Soil Survey maps and databases. By merging digital technology with traditional knowledge, the accuracy of soil maps—the main product of NRCS's Soil and Plant Science Division—will improve to a greater extent than if either method were singly employed.

Table 1.—Locations of the Soil Science Institute (SSI) and the Soil Geomorphology Institute (SGI) from 1960 to 2021 by calendar year

| Year | SSI/SGI | Host |
|---|---|---|
| 2021 | SGI | University of Georgia (planned) |
| 2020 | SSI | North Carolina State University |
| 2019 | SGI | University of Wyoming / National Soil Survey Center |
| 2018 | SGI | New Mexico State University |
| 2017 | SSI | North Carolina State University (cancelled, low enrollment) |
| 2017 | SGI | New Mexico State University |
| 2016 | SGI | New Mexico State University (cancelled due to travel cap) |
| 2015 | SGI | University of California—Davis |
| 2014 | SSI | Kansas State University |
| 2013 | SGI | Colorado State University / National Soil Survey Center |
| 2012 | SGI | Colorado State University / National Soil Survey Center |
| 2011 | SSI | Kansas State University |
| 2010 | SGI | University of California—Davis |
| 2009 | SGI | Alabama A&M |
| 2008b | SGI | Penn State University |
| 2008a | SGI | New Mexico State University |
| 2007b | SGI | University of Idaho |
| 2007a | SGI | National Soil Survey Center / University of Nebraska |
| 2006 | SSI | North Carolina State University |
| 2005 | None | |
| 2004 | SGI | Iowa State University |
| 2003 | SSI | Washington State University |
| 2002 | SGI | New Mexico University (*1st geomorphology-centered SSI*) |
| 2001 | SSI | North Carolina State University |
| 2000 | SSI | Alabama A&M |
| 1999 | SSI | North Carolina State University |
| 1998 | SSI | Texas A&M University |
| 1997 | SSI | University of California—Davis |
| 1996 | SSI | North Carolina State University |
| 1995 | SSI | Cornell University |
| 1994 | SSI | Iowa State University |
| 1993 | SSI | Texas A&M University |
| 1992 | SSI | Texas A&M University |
| 1991 | SSI | Cornell University |
| 1990 | SSI | University of Florida |
| 1989 | SSI | Iowa State University |
| 1987 | SSI | University of Florida |
| 1986 | SSI | Texas A&M University |
| 1985 | SSI | Iowa State University |
| 1984 | SSI | Texas A&M University |
| 1983 | SSI | Cornell University |

| Year | SSI/SGI | Host |
|---|---|---|
| 1982 | SSI | Cornell University * |
| 1981 | SSI | Iowa State University |
| 1980 | SSI | Cornell University |
| 1979 | SSI | Iowa State University |
| 1978 | SSI | Cornell University * |
| 1977 | SSI | Iowa State University |
| 1976 | SSI | Cornell University |
| 1975 | SSI | Cornell University * |
| 1974 | SSI | Iowa State University |
| 1973 | SSI | Iowa State University |
| 1972 | SSI | Iowa State University |
| 1971 | SSI | Cornell University |
| 1970 | SSI | Iowa State University |
| 1969 | SSI | Cornell University * |
| 1968 | SSI | Iowa State University |
| 1967 | SSI | Cornell University or Oregon State * |
| 1966 | SSI | Cornell University or Oregon State * |
| 1965 | SSI | Cornell University |
| 1964 | SSI | Cornell University |
| 1963 | SSI | Cornell University * |
| 1962 | SSI | Cornell University |
| 1961 | SSI | Cornell University |
| 1960 | SSI | Cornell University |

* Presumed location. ■

## Submitting Soil Taxonomy Proposals

Many classification systems have a single author, such as those for limestones and sandstones. Soil Taxonomy has more than 100 authors, each contributing an understanding about specific soil types across the global landscape.

The procedure for submitting Taxonomy proposals has long been contained in the "National Soil Survey Handbook." It is now also on the NSSC website in four locations: (1) Regional NCSS conference page, (2) Soil Taxonomy Focus Team page, (3) Topics/Technical References/Classification, and (4) Soil Survey/Soil Classification. In addition, the status of existing proposals and the list of current proposals to be reviewed this spring are available (see links below). The next printed version of the "Keys to Soil Taxonomy" is planned for early 2021.

2020 NCSS Regional Standards and Taxonomy Committee Proposals

How to Submit a Taxonomy Proposal

Status of Existing Proposals ■

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