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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@lin.usda.gov. ■

Soil Scientists Infiltrate Boise for the NCSS 2017 Conference

By Shawn Nield, NRCS, and Paul McDaniel, University of Idaho. Photos by Tammy Cheever, NRCS.

The NCSS National Conference was held in Boise, Idaho, June 25th to 29th. In true cooperative fashion, the diversity of participants was apparent with attendance by multiple State and Federal agencies, universities, and consultants. The 116 attendees engaged in 3 days of meetings and presentations. For the first time in NCSS history, plenary session meetings and presentations were live streamed to the public. The content was saved and is available on the program page of the NCSS website. In addition to meetings, attendees were treated to field trips on Sunday the 25th and Thursday the 29th. Field stops ranged from the Owyhee Plateau to the Snake River Plain to the Rocky Mountains of the Boise National Forest and covered three land resource regions (LRRs) and four major land resource areas (MLRAs).

Sunday's field trip participants began the day with a ride up to the Bogus Basin ski area for a look at soils and landscapes of the Central Rocky Mountains (MLRA 43B). They examined a forest soil (Vitrandic Haplocryoll) whose upper horizons have been influenced by volcanic ash from the eruption of Mount Mazama (now Crater Lake, Oregon) approximately 7,600 years ago. Mike Regan, NRCS Soil Survey Region 1 Director, and Paul McDaniel, University of Idaho soil scientist, discussed the formation and unique properties of these soils, which, in the lower 48 States, are unique to the western United States.

Stephaney Kerley of the Boise National Forest described the Bogus Basin Forest

Health Project to field trip participants. This project is part of ongoing efforts to improve resilience of these seasonally dry forests to disturbance as well as to ensure the safety of skiers, mountain bikers, hikers, and other forest users. Danny Tappa, NRCS Snow Survey Hydrologist, showed the group the Bogus Basin SNOTEL site and discussed the various uses of the SNOTEL automated data collection network. The SNOTEL network is a critical part of the Snow Survey and Water Supply Forecasting Program, which is used extensively in the western United States. SNOTEL sites provide real-time snowpack and other meteorological data that are needed by researchers, irrigation districts, river and reservoir managers, emergency managers, recreationists, and power generation companies.

Field trip participants examining a forested Vitrandic Haplocryoll at Bogus Basin Ski Area.

Following lunch at the Frontier Nordic Lodge and a bus ride back down the mountain, participants viewed an urban landslide area in the Boise Foothills. Because of the layered Glenns Ferry Formation and the fine particle-size and smectitic families of the soils, this area in the foothills has been identified as unsuitable for urban development since the 1970s. The Terra Nativa development became a center of attention in March 2016 when newly constructed homes began to exhibit signs of movement. The mass movement continued to worsen, and the houses on Alta Via Way are now uninhabitable and condemned.

Field trip participants listening to a discussion on forest health while observing a high-elevation soil. The Bogus Basin SNOTEL site is visible in the background.

An expansive view from Bonneville Point that encompasses MLRAs 10, 11, and 25.

The third stop on Sunday's field trip was Bonneville Point, a historic site located along a branch of the Oregon Trail southeast of Boise. This site provided an excellent view of four MLRAs: the Central Rocky and Blue Mountain Foothills (MLRA 10), the Snake River Plains (MLRA 11), the Owyhee High Plateau (MLRA 25), and the Central Rocky Mountains (MLRA 43B). Dr. Kurt Othberg of the Idaho Geological Soil Survey provided an overview of the regional geology to the participants, who by that time were starting to feel the effects of the 95 °F temperature and the cloudless sky.

From Bonneville Point, the buses proceeded to the final stop of the day at the Percy Ranch, located on the western Snake River Plain near the town of Mountain Home. Owners of the ranch have partnered with neighbors, NRCS, and other State and Federal agencies to improve rangeland quality for their cow/calf operation. By paying attention to the soil limitations and closely managing cattle movement, they have been able to increase the quantity and quality of rangeland production. Participants were able to view the Chilcott soil, which is an Abruptic Xeric Argidurid. The depth to the duripan in Chilcott soils ranges from 20 to 40 inches and greatly influences rangeland plant performance. Examination of a Sebree-like soil (Xeric Natridurid) provided examples of a slickspot soil and the controversial new V master horizon.

Thursday's field trip kicked off with a visit to an organic farming operation, Peaceful Belly, in the Dry Creek Valley just north of Boise. The valley is one of the oldest agricultural areas in this part of Idaho. Shawn Nield, Idaho State Soil Scientist, pointed out features of Cumulic Mollisols in the valley that were impressive for the 10- to 14-inch precipitation zone. Mollic properties may be the result of a wetter, cooler,

Josie Erskine, operator of Peaceful Belly Farm, explaining the challenges and triumphs of organic farming.

Pleistocene climate. Prime farmland and the adjacent suburban sprawl, which quickly removed much of the valley's soil from production, were also key to the discussion. Additionally, farm operator Josie Erskine gave an extensive tour, explaining the organic vegetable and greenhouse operations as well as the pastured poultry operation, cider production, and direct-to-restaurant marketing.

Wayne Gabriel, NRCS soil scientist, examining the Truesdale soil and its duripan while Manuel Matos, NRCS Caribbean Area staff soil scientist, and several others look on.

After leaving Peaceful Belly, participants crossed the Snake River Plain and traveled onto the Owyhee Plateau to look at rangeland study plots treated with weed-suppressive bacteria (WSB). Post-fire invasion of weeds such as cheatgrass and medusahead are widely problematic in arid western environments. Research suggests that the *Pseudomonas fluorescens* bacteria may inhibit root growth of exotic annuals. Various treatments were applied to assess the effectiveness of this WSB. The study is a collaborative effort led by U.S. Geological Survey and funded by U.S. Fish and Wildlife Service, NRCS (Conservation Innovation Grants), Bureau of Land Management, and others. Nearby, participants discussed the local geology and climate in conjunction with McKeeth soils, which are Durinodic Calciargids. Episodes of volcanism along the margins of the Snake River Plain and the influence of calcareous loess from the plain are thought to be key contributors to the soil's formation.

Phil King and a budding young soil scientist looking at the calcareous response of Garbutt silt loam.

Bitner Vineyards near Marsing, Idaho, welcomed attendees for a picnic lunch and talks on sustainable viticulture, bees, and contrasting soil development in the area. Ron Bitner, bee entomologist turned viticulturist, talked about his operation and establishment of the Snaker River Valley Appellation. Soils in the area include Truesdale (Xereptic Haplodurids) and Turbyfill (Xeric Torriorthents). Although in different map units, these soils commonly occur within tens of meters of one another. Episodic filling of ancient Lake Idaho and the Bonneville floods were discussed to explain the formation and positions of the soils.

The week's activities concluded with the final stop and dinner at McIntyre Farms. Brad McIntyre explained the evolving soil health practices and the incorporation of livestock into the diverse operation as well as the

Soil Scientist Achievement Award recipients: Debbie Anderson, Steve Campbell, Suzanne Kienast-Brown, and Darrell Schulze. Soil Science Division Director David Lindbo is in the back.

history of this multi-generation farm. The McIntyres attribute soil health practices with boosting organic matter and productivity. Participants also examined Garbutt silt loam, a Typic Torriorthent. Locally sourced meat and produce from McIntyre Farms and Peaceful Belly Farm rounded out the menu. The dinner finished with awards. ■

2017 NCSS Conference: Interpretations Committee

The Interpretations Committee met Monday, June 26, at the conference in Boise, Idaho. It was co-chaired by Mickey Ransom (Kansas State University), Edgar Mersiovsky (NRCS Arkansas), and Robert Dobos (NRCS National Soil Survey Center). Dobos updated the group on the activities of the Interpretations Branch. Debbie Surabian (NRCS Connecticut) then gave an overview of the Coastal Zone Initiative. Edwin Muniz spoke on the Urban Soils Tech Note and on agriculture on urban soils in general.

The group discussed dispositions of the many charges from previous conferences, some of which are included here. One charge was creation of a manual or published index of soil interpretations for reference (by technical soil services, consultants, etc.). Something like this already exists in the AOI inventory of Web Soil Survey, but an annotated list will be developed and distributed, perhaps from the “Job Aids” webpage. A previous suggestion was to expand the availability of training of “triple crown” interpretations to NCSS cooperators. This will be done to the extent possible, but two of the classes require a NASIS login, which cooperators can have only if they get 2nd level e-authorization. The “Science of Interpretations” class is open to anyone. A request was made to improve the process for addressing requests for assistance, which are not always easily met. Steps have been taken to improve the process, including increasing the number of staff across the country that are able to develop interpretive criteria conceptually and work the mechanics of the fuzzy logic modelling system. In this way, local staffs are able to address local interpretive concerns.

The current committee also provided some charges. One charge was to refine methodology for the interpretation of certain miscellaneous areas in some situations. It is thought that some interpretations for certain types of miscellaneous areas should be allowed to be rated. Another charge was to explore the possibility of displaying, using Web Soil Survey, State or local interpretations that use data from NASIS and outside sources. Currently, only interpretations generated in NASIS can be exported. A final charge was to continue to expedite the development of interpretations for soil-based conservation practice standards. Many standards, despite being soils based, lack an accompanying interpretation. A final, implicit charge was to continue dialogue throughout the year. ■

2017 NCSS Conference: Standards Committee

By Chad Ferguson, soil scientist/GIS specialist, National Soil Survey Center, Lincoln, Nebraska.

This year, for the first time, the Standards Committee session was split into two concurrent sessions—a General Standards Session and a Taxonomy Session. This departure from tradition was deemed necessary to allow each topic sufficient time for discussion.

For the general standards session, a group of 16 participants gathered to discuss "all things Standards." The session opened up with a report on what has been happening in the Standards Branch (not including taxonomy) over the last year at the National Soil Survey Center in Lincoln. Subjects discussed are as follows:

NSSC Training

- Training was delivered to more than 700 employees and partners.
- 17 Webinars were produced (1,800 live attendees and an additional 1,800 views on YouTube).
- 1,040 people subscribed to the soils training channel on YouTube.

Soil Survey Manual

- Published hard copies were delivered in May 2107.
- 4,500 copies were printed.
- This was the first update since 1993.

National Soil Survey Handbook

- Work progressed under a mandate to put the NSSH in eDirectives format.
- Broken hyperlinks were updated.
- Changes resulting from reorganization were handled.
- The revision is happening in 3 phases.
- Completion is planned for January 2018.

Raster Standards

- The need for standards pertaining to digital soil mapping is being addressed.
- Discussions and drafts were started in the spring and summer of 2017.
- The due date for the first cut is the end of the fiscal year.

Editing

- More soil surveys were added to the online archives.
- Development is ongoing for the Enterprise Content Management System.

After the report from the National Soil Survey Center, Deb Surabian, Connecticut State Soil Scientist, presented the proposal from the Subaqueous Focus Team to add a "shelly" modifier for soil texture. The proposal has been accepted and should be seen with the next NASIS release. The other branches at the National Soil Survey

Center will be addressing the effects the new modifier has on their various business elements. Deb also presented, from the Subaqueous Focus Team, the proposal to modify the choices for flooding and ponding frequency and duration. The proposal seeks to add “continuous” and “permanent” to the choice list. The committee agreed that none of the current choices adequately reflect subaqueous conditions, but also recognized there are other considerations for the flooding and ponding attributes that need to be a part of a larger discussion. No formal action was taken on the proposal. ■

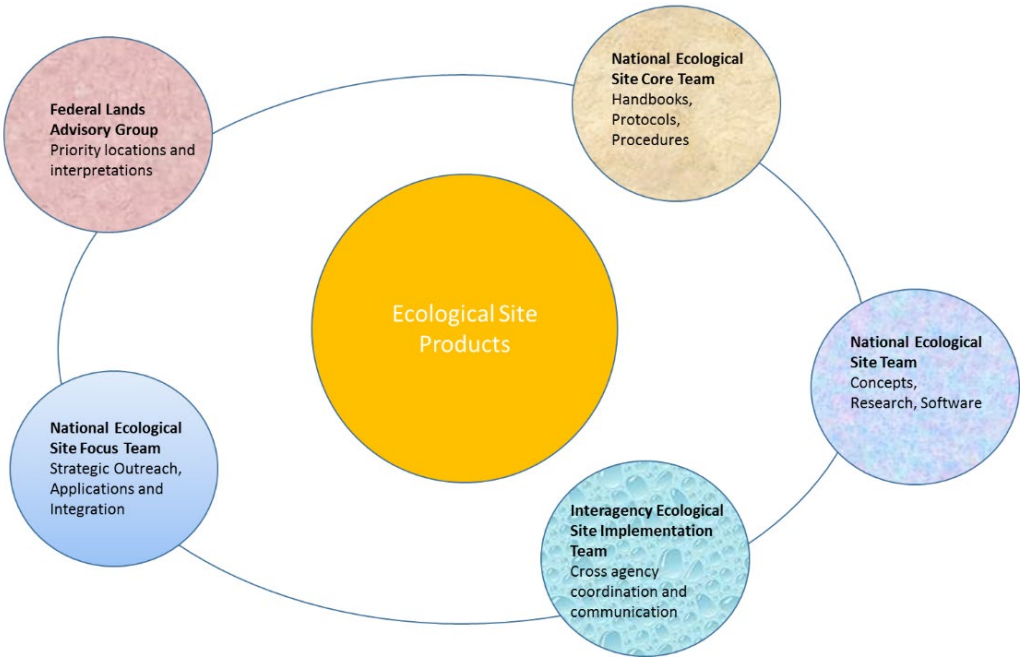
2017 NCSS Conference: Soil and Ecosystem Dynamics Interpretations Committee

By Curtis Talbot, National Ecological Site Team, Jornada Experimental Range, Las Cruces, New Mexico.

The Soil and Ecosystem Dynamics Committee has a three-part charge: ecological sites, dynamic soil properties, and soil quality (health). At the conference in June, however, due to the limited time and the interests of the attendees, the discussion was restricted to the topic of ecological sites. The attendees, representing four Federal agencies and two universities, conveyed the primary message that the ecological site effort should be more collaborative and involve more partners at all levels of the workload process. Key recommendations included:

- *Broaden the Ecological Site Focus Team to include interagency representation.* The current members of this team are all from NRCS.
- *Clarify roles within the “Ecological Site Universe.”* The Ecological Site Universe, as shown below, was developed by Joel Brown, NRCS National Leader for Ecological Sites, in the draft charge of the Ecological Site Focus Team.

The Ecological Site Universe



- *Designate author(s) for forestland guidance in the "National Ecological Site Handbook."* The current handbook is centered on rangeland because a majority of the NRCS personnel who have led the ecological site effort have spent their careers on rangelands.
- *Promote discussion of a single national land hierarchy system.* The planned revision for Agriculture Handbook 296, "Land Resource Regions and Major land Resource Areas of the United States, the Caribbean, and the Pacific Basin," happens to coincide with planned revisions of land hierarchy mapping by the U.S. Forest Service. There may be a window of opportunity to adopt a common system or at least develop a closer coordination of concepts and mapping lines.

A final discussion topic was the need for greater continuity in committee participation between the biannual national NCSS conference and the four regional conferences. Effort will be made to continue committee discussion between conferences and increase continuity in the personnel who attend consecutive meetings. ■

2017 NCSS Conference: Soil Taxonomy Committee

By Ken Scheffe, soil scientist, and Curtis Monger, National Leader for Soil Survey Standards, National Soil Survey Center.

On Monday, June 26, 2017, the Soil Taxonomy Committee meeting was held at the National Cooperative Soil Survey Conference in the Delamar Room of the Riverside Hotel in Boise, Idaho. Thirteen scientists attended: Sid Davis, Jane Karinen, Cathy McGuire, Susan Casby-Horton, Paul McDaniel, Mickey Ransom, Meghan Krueger, Matt Bromley, Mark Stolt, Dave Lindbo, Doug Malo, Ron Collman, and Michael Whited. Future and current taxonomy efforts were discussed.

Future Taxonomy Efforts

3rd Edition of "Soil Taxonomy" in 2022 was proposed. Why?

- It's time. Fifteen years passed between the 7th Approximation (1960) and the 1st edition (1975), and 24 years passed between the 1st and the 2nd edition (1999). If the 3rd edition is published in 2022, a period of 23 years will have elapsed.
- The year 2022 is the year of the next World Congress of Soil Science after the 2018 conference in Rio de Janeiro.
- Enough new material has accumulated to warrant a new edition. Human-altered and human-transported soils and subaqueous taxa, for example, would be added.
- A new edition would provide the opportunity to clarify many sections, add footnotes to reduce complexity, add more rationale and history of concepts, and add more science in the form of graphs and tables to support taxa rationale.

Densic properties are a high priority issue. Progress has been made in understanding densic horizons resulting from glaciers and heavy equipment, but how do these densic horizons differ from those in coastal areas of Texas? Regional and national working groups are needed to resolve this issue.

Yermic and *takyric diagnostic epipedons* need study. Currently, the ochric epipedon is too broad. It includes, for example, the Ap horizon of Ultisols, the A horizon of forest soils, and most of the surface horizons in deserts. The yermic epipedon would be quantitative and associated with the V horizon. The takyric epipedon would be associated with dry, barren surfaces of former lake beds.

A 13th, wet soil order was discussed. *Aquasols,* or similar name, was considered. The University of Rhode Island has received funding from NRCS to host two workshops. The first workshop would determine if a new order is needed and, if so, the second workshop would design a taxonomic architecture.

The *Soil Taxonomy Focus Team* was discusses on Wednesday, June 28. The team will be used to recruit pedologists to work on multiple topics. That is, one focus team will concentrate on the 3rd edition of "Soil Taxonomy," another team will focus on Aquasols, another on densic properties, and other ones on yermic and takyric epipedons and isotic properties.

The *Fundamental Changes to Soil Taxonomy* working group within the Soil Science Society of America had two sessions on Tuesday, June 27. This working group serves the important function of bringing new ideas about and challenges to Soil Taxonomy. This is healthy for the science. The working group is not designed, however, to replace NCSS or NRCS responsibilities for maintaining and updating "Soil Taxonomy." The traditional regional and national taxonomy committees will continue to function as in the past and follow the process for proposals and updates described in the "National Soil Survey Handbook," Part 614.

Current Taxonomy Efforts

The Soil Taxonomy Committee discussed how to find the current status of taxonomy proposals. Finding the status involves going to the National Soil Survey Center website and clicking through Soil Survey > Partnerships > National Cooperative Soil Survey > Regional Conferences > 2016 NCSS Regional Standards and Taxonomy Committee Proposals (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/partnership/ncss/?cid=nrcs142p2_053541). Each proposal is summarized according to (1) What is the issue? (2) What is the fix? and (3) What is the cost? The following proposals were reviewed:

<u>Proposals on Soil Taxonomy from the 2015 Conference</u>

- Aquic Hapludults—Phil King et al.
- Calcareous Fens—Doug Wysocki et al.
- Epi vs. Endo and the Densic Contact—Mark Stolt et al.
- Subaqueous Soil Revisions—Jim Turenne, Mark Stolt, et al.

<u>Proposals on Soil Taxonomy for 2016 Regional Meetings</u>

- Proposed Densic Great Groups of Udepts and Aquepts—Mark Stolt et al.
- Proposed Changes for Spodosols and Spodic Horizon Symbols—Stolt and Rabenhorst
- Proposed Changes in Limnic Horizons and Materials—Ed Tallyn, Thor Thorson, et al.

<u>Other Proposals</u>

- Surface Mantle Clarifications—Craig Ditzler and Ken Scheffe
- Bedrock, Fragments, and Densic Materials Decision Tree—Wayne Gabriel et al.
- Isotic Mineralogy in Sandy Soils—Joe Chiaretti et al., Ken Scheffe, and Mike England
- Initiation of Yermic Diagnostic Feature Investigations Project—Ken Scheffe
- Oxyaquic Subgroup for Fragiudults—Kevin Godsey and Ken Scheffe

<u>Ranking of Proposals from the 2016 North Central NCSS Conference</u>

Approved

- Aquic Hapludults—Variable depth from top of the argillic rather than the soil surface
- Calcareous Fens—Organic soils with carbonates family reaction class of "kalkic"

- Subaqueous Soil Revisions—Changes in terminology or more classes are warranted
- Changes for Spodosols and Spodic Horizon Designations—Provisionally approved the proposal with a more complete review of impacts
- Buried soil concepts not adequately defined—Human-transported materials

Not Approved

- Epi vs. Endo and the Densic Contact—Densic and paralithic need more work
- Densic Great Groups of Udepts and Aquepts—Need to better define densic
- Changes in Limnic Horizons and Materials—The impact needs more investigation
- Bedrock, Fragments, and Densic Materials—Good start in better defining densic materials

No Comment

- Isotic Mineralogy in Sandy Soils
- Initiation of Yermic Diagnostic Horizon

Ranking of Proposals from the 2016 Northeast NCSS Conference

Approved

- Densic Great Groups of Udepts and Aquepts
- Changes for Spodosols and Spodic Horizon Designations
- Changes in Limnic Horizons and Materials
- Buried Soil Concepts Not Adequately Defined

Not Approved

- Bedrock, Fragments, and Densic Materials—Good start in better defining densic materials

Not Discussed

- Isotic Mineralogy in Sandy Soils
- Initiation of Yermic Diagnostic Horizon
- Aquic Hapludults

Discussions of Soil Taxonomy Committee meetings from the 2016 West and South NCSS Conferences are on the NCSS website under “Regional Conferences.” ■

2017 NCSS Conference: Research Needs Committee

The Research Needs Committee was provided an overview of the research investments of USDA–NRCS Soil Science Division (SSD) since 2009. The SSD has continued to support the research needs of the National Cooperative Soil Survey, investing almost $9 million into 138 cooperative research projects. The goals of the SSD are to promote timely and needed research related to soil survey, increase the scope and extent of research beyond activities of the SSD, involve the academic community through funded time for professors and students, involve SSD scientists in collaborative work, and provide research for a diverse and varied public audience. The National Soil Survey Center, led by Director David Hoover, prepared and disseminated a report containing the partnerships.

The Research Needs Committee Chair Candiss O. Williams and SSD Director David Lindbo discussed the changes being made to the allocation of funds to support research. Research funding is based on the SSD budget and availability of funds. Beginning this year, each region will have a chair that will serve for 2 years. The regional chair will also serve as co-chair on the national committee. During even-numbered years (when NCSS regional conferences occur), the committee will prioritize research needs for their region, ranking them from most to least important. The recommendations from the regional meetings will be submitted to the Chair of the

NCSS Research Committee, who will then present them to the SSD for consideration for the subsequent year. During odd-numbered years, the SSD will attempt to fund one research project that addresses a regional concern from each of the four regions. During odd-numbered years (when the NCSS national conference occurs), the committee will take the recommendations from the regional meetings and select research topical areas applicable to all regions. The recommendations will then be presented to the SSD for consideration for funding in even-numbered years. During even-numbered years, the SSD will attempt to fund two research projects that address a national concern. The funding for the national projects will be greater than the funding for odd-numbered years. In summary:

Even-numbered years

- Research priorities determined at regional conferences for regional projects.
- SSD funds 2 national projects as determined the previous year.

Odd-numbered years

- Research priorities determined at national conference for national projects.
- SSD funds 1 project per region as determined the previous year.

The SSD seeks to fund research projects that are collaborative in nature and consist of multiple cooperators that span the region or nation. The cooperators include university partners, Federal and State agencies, and other partners, all of whom must be members of the Cooperative Ecosystem Studies Units (CESU) network. Each project must also include a NRCS soil scientist who participates in all facets of the research. Each project must have achievable deliverables that can be met at the end of 2 years.

The committee was also presented the recommendations from the regional meetings held in 2016. The participants were then grouped by region to further discuss the topical area that would most benefit their region. The NCSS regions submitted the following topical areas for funding in FY 2017:

North Central—Expansion of the Soil Explorer Tool
Northeast—Disturbance of wetlands on carbon pools
South—Soil genesis on benchmark landscapes in the Southeast
West—Identification of indicators of soil change as a result of management and natural disturbance in the West

Recommendations from the committee for FY 2018 research priorities include the following topical areas:

- Precision agriculture—New soil data projects
- Data collection and tool development in support of data delivery and interpretations
- The effect of erosion, transport, and deposition on soil organic carbon sequestration
- Development of protocols for subaqueous soils in the Gulf of Mexico
- Development of materials, tools, and approaches to communicate the importance of soils in the K-12 system
- Documentation of physical and biological properties under different management and land uses
- Support for the evaluation of LiDAR and high-tech tools for the future of disaggregation and interpretations
- Support of background and urban soil data collection and analyses on heavy metals
- Research that would contribute to Ecological Site Inventory and Dynamic Soil Property initiatives

The committee also agreed to accept additional topical areas through October 2017 for consideration for the FY 2018 funding opportunity. ■

Range and Wildlife Management Students Participate in a Summer GIS Internship Program

By Chance Robinson, NRCS soil scientist, Stephenville, Texas.

The week of July 17th, the Stephenville MLRA Soil Survey Office and Dr. Donald McGahan of Tarleton State University, Stephenville, Texas, provided training to Jaclyn Robles and Taylor Shedd as part of a summer GIS (Geographic Information System) internship program at the USDA–NRCS Central National Technology Support Center in Fort Worth, Texas. Jaclyn and Taylor will soon complete their undergraduate program of study in Range and Wildlife Management at Texas A&M University—Kingsville.

During the week of training, classroom and field instruction focused on soil genesis and morphology with a special emphasis on the factors of soil formation. Dr. McGahan offered two training sessions, and Alan Deubler, Sidney Paulson, and Chance Robinson (USDA-NRCS) provided the remainder of the training exercises and lessons. Morning field trips included visits to Tarleton State University's Hunewell Ranch and Agriculture Center as well as to numerous road cuts in rural Erath County, Texas. The field trips provided learning opportunities and lots of "arm-waving" discussions on landforms, stratigraphy, soil genesis, and classification.

Following a week of instruction and exploration of the project area, Jaclyn and Taylor spent a week developing environmental covariates. They built a knowledge-based soil-landscape model for the catena of soils observed in the field (see table below). This model was created using the ArcSIE extension in ArcGIS. Environmental covariates created from airborne-based LiDAR (Light Detection and Ranging) digital elevation data were processed with System for Automated Geoscientific Analyses (SAGA GIS) and ArcSIE software.

Classification of Dominant Soils in Project Area

Soil name	Family or higher taxonomic classification	Epipedon	Endopedon	Depth class
Maloterre	Loamy, carbonatic, thermic Lithic Ustorthents	Ochric	None	Very shallow
Pidcoke	Loamy, carbonatic, thermic Lithic Calciustolls	Mollic	Calcic	Shallow
Norse (tentative)	Fine-loamy, carbonatic, thermic Udic Calciustolls	Mollic	Calcic	Moderately deep

For this project, the study area was limited to soils currently mapped as Maloterre (undifferentiated group) in eastern Erath County. The area was chosen because the soil map unit mostly delineates the Keys Valley Marl member of the lower Cretaceous Walnut Clay formation. The Keys Valley Marl consists of interbedded limestone and calcareous mudstone. This member is easily recognized by the *Gryphaea marconi* oyster shells (formerly *Texigryphaea* spp.), which form the cemented limestone beds (shell aggregate) shown in figure 1. Limiting the project to this area reduced the effect of parent material in the modeling effort and allowed Jaclyn and Taylor to focus on building an understanding of the soil factor of relief.

One special problem encountered during this process was modeling a benched or stair-stepped topography consisting of risers and treads. In this effort, the deeper "soft beds of calcareous mudstone" on risers were included with the very shallow soils forming in the tread. The decision to do this was based in part on the ecological significance of mapping the divergent nose slopes as one class.

Another problem was observations that did not fit into the central concept of a single

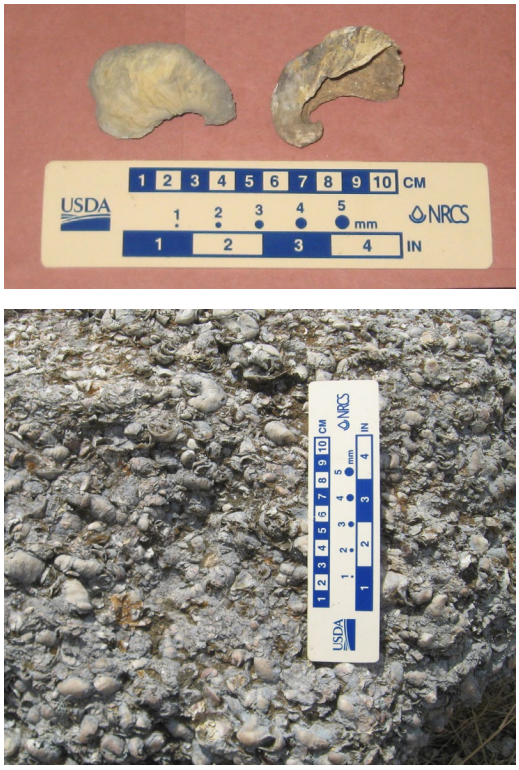


Figure 1.—*Gryphaea marconi* fossils (top) and cemented fossiliferous limestone (shell aggregate) (bottom). Photos courtesy of John Sackett, USDA–NRCS.

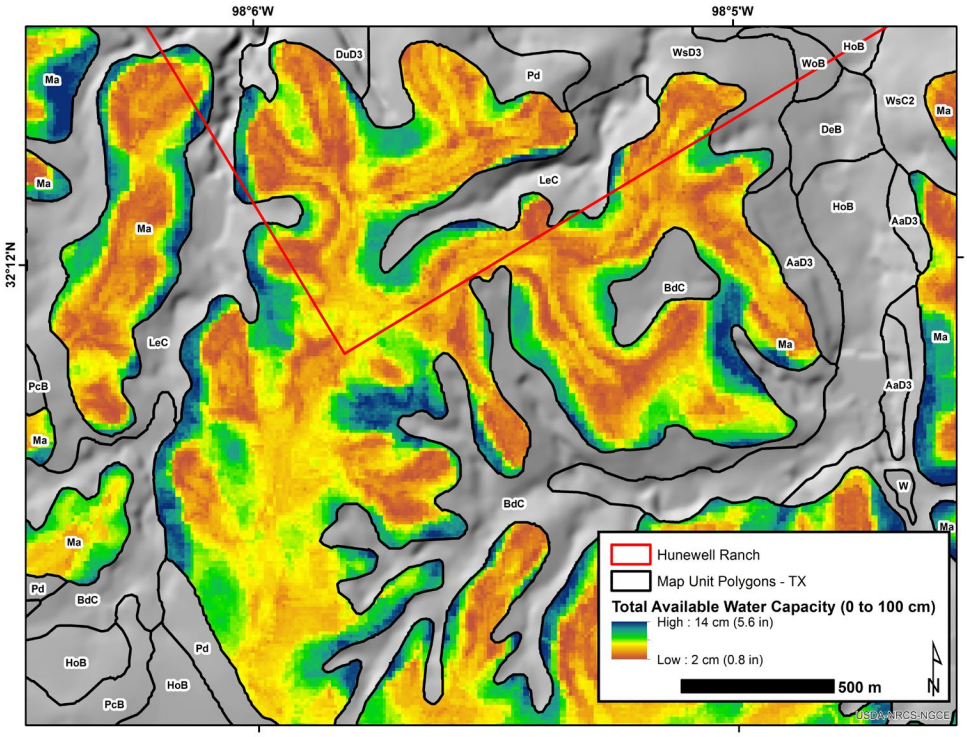


Figure 2.—Estimated available water capacity (0 to 100 cm depth increment) created from machine learning methods. The values represent a weighted average computed from "random forest" component probability and representative values for the three components modeled.

Figure 3.—Taylor Shedd (left) and Jaclyn Robles describing a soil that is an intergrade between the Maloterre and Pidcoke soil series. The family classification of this pedon is loamy-skeletal, carbonatic, thermic Lithic Calciustepts.

class. Such observations are sometimes referred to as "intergrades." The students attempted to address this issue by modeling the central concept of a class, allowing the "fuzzy" areas to contain partial membership in multiple classes. These fuzzy relationships between soil components can be illustrated using raster techniques but cannot be shown in traditional vector soil mapping (figure 2).

Jaclyn and Taylor returned to Stephenville on July 31st to create a machine learning model of the project area using the same training data (soil descriptions) used to create their model in ArcSIE. On August 1st, they returned to the field for field validation of the knowledge-based and machine learning ("random forest") digital soil maps. Soils were described at three previously selected sites (figure 3).

Should Jaclyn and Taylor tire of their future careers in range and wildlife management, they would have bright futures as field soil scientists! ■

Historic Visit to Cuba and July 7th Commemoration of Soil Survey and Soil Conservation

By Linda Scheffe, National Soil Survey Center, Lincoln, Nebraska.

Hugh Hammond Bennett

Reflecting on observations from different travels, an American soil scientist and conservationist noted: "Probably in no other country of the world has soil character had stronger influence upon national welfare than in Cuba. The wealth of the island has been derived directly and almost wholly from its varied soils."

After considering several factors of agricultural

The state-run organopónico (organic raised-bed operation) that the NRCS team visited on December 15. The more than 80 organopónicos located throughout the Havana Province are just a fraction of the elaborate network of organic and urban operations that produce a variety of vegetable crops for the Cuban population. Photo courtesy of Linda Scheffe, USDA–NRCS.

production, such as soil quality, crop selection, and fertilizer use, he concludes, "… the possibility of establishing for Cuba a new economic equilibrium based upon an improved type of agriculture constitutes one of the most attractive and important scientific problems to be found anywhere in the field of agricultural development today."

These were not recent statements—they were made in 1928 by Hugh Hammond Bennett, in his article "Some Geographic Aspects of Cuban Soils." Bennett and fellow researcher Robert Allison performed soil and agricultural surveys in Cuba in 1925 and 1926. Just a few years later, in 1935, Bennett would be named the first chief of the newly established Soil Conservation Service, later renamed the Natural Resources Conservation Service.

Nearly 90 years after Bennett's trip to the island nation, three NRCS scientists participated in the agency's inaugural information exchange with the Cuban Ministry of Agriculture. The NRCS team, consisting of Conservation Agronomist Linda Scheffe, Civil Engineer Chayla Rowley, and Agricultural Engineer John Tiedeman, visited Havana, Cuba, December 11–17, 2016. During the week, they met with government officials and scientists and toured farms to observe agricultural practices. Of particular interest were the Cuban's advancements in urban and organic agriculture.

The NRCS International Programs Division (IPD) interviewed the team upon their return. They asked them how—after having briefly visited the Havana Province of Cuba—their observations compared to those made by Bennett, the "Father of Conservation," more than 90 years ago. Referring to the monoculture of sugarcane

production, Bennett recommended that Cuba place more importance on diversity of cropping systems and also on judicious use of chemical fertilizers. In recent years, Cuba has diversified their cropping systems and gone beyond just the judicious use of chemical fertilizers—they have made great advancements in the use of organic amendments and biofertilizers.

The NRCS team's limited introduction to Cuban soils tends to confirm Mr. Bennett's observations. Prior to the establishment of sugar plantations, much of the island was covered by rain forests and rich soils. Forest clearing and intense cultivation led to soil degradation and loss of natural productivity. Beginning in 1960, and especially since 1990, focus has returned to sustainable soil conservation with particular emphasis on soil biology. It would be fair to say that the country's emphasis on biological soil management was borne out of necessity. The Cubans have risen to the challenge and are now contributing beneficial knowledge to other countries.

The soils are so varied that they provide the Cubans a great many opportunities within agriculture. Bennett's view of soil character having the strongest influence on national welfare in Cuba compared to any other country might be expanded to include societal cooperation and human resiliency. Because there were no computers or Internet for so many years, Cubans had the opportunity to read books, study, and work with each other in the field to feed themselves and develop solutions to sustainability issues. In fact, Bennett's observation could be updated to: "Probably in no other country of the world have societal cooperation and human resiliency as well as soil and environmental resources had a stronger influence upon national welfare and sustainability than in Cuba."

On July 7th of each year, the Cuban Ministry of Agriculture commemorates Hugh Hammond Bennett with National Soil Conservation Day. The USA and Cuba recognize the importance of integrated approaches and tools for inventorying and addressing soil, water, air, plant, animal, energy, and human resource concerns and utilizing local resources and opportunities to build sustainable farming systems. The Cubans were very impressed by the model approach of soil survey and conservation planning that NRCS has provided across the globe. ■

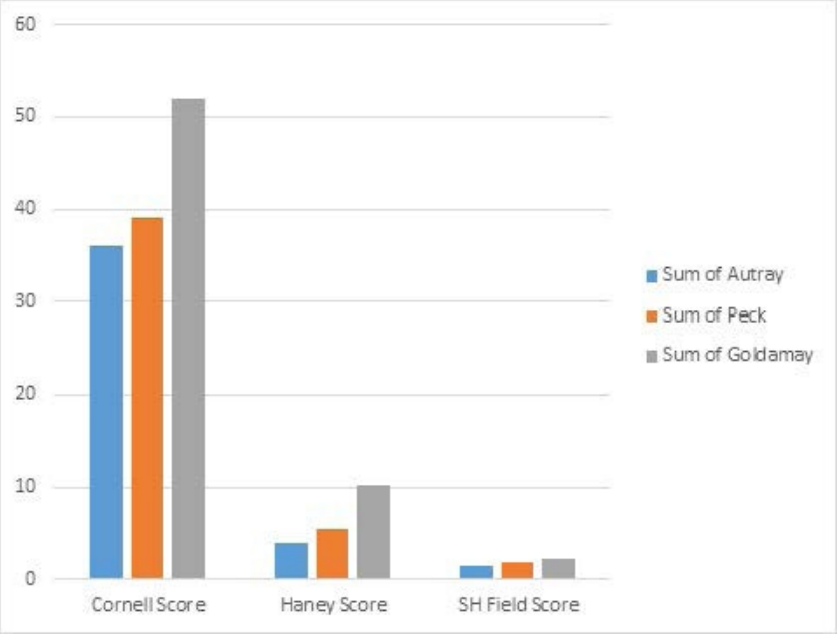
Soil Science Field Techniques Used for Colorado's Soil Health Monitoring Program

By Clark K. Harshbarger, NRCS; Andy Steinert, NRCS; and Vanessa McCracken, BCPOS.

With the adoption of the Boulder County Cropland Policy in 2011, the Boulder County Parks and Open Space (BCPOS) Agricultural Resources Division was prompted to initiate a soil health monitoring program on county-owned and privately operated agricultural lands. In 2014, BCPOS began a partnership with NRCS for this endeavor. NRCS was a logical partner because of the agency's technical expertise in the science of soil health and its history of working with land managers to establish a conservation plan for natural resources. The objective of the soil health monitoring program is to bring a heightened awareness of the benefits of managing agricultural lands within the context of a soil health management system (SHMS) to policy makers, tenants, and concerned citizens in Boulder County. SHMSs are farming systems that use a combination of conservation practices to address resource concerns, including erosion (wind, sheet, and rill), soil quality degradation (such as organic matter depletion and soil compaction), and insufficient water infiltration (such as that due to soil crusting). Conservation practices, such as residue and tillage management, conservation crop rotations, cover crops, and prescribed grazing, are used in combination to address documented resource concerns.

Vanessa McCracken, BCPOS agriculture resource specialist, explains the plot layout to volunteers participating in the soil health assessment.

The soil health monitoring program is being delivered in three phases*:* awareness, assessment, and implementation. The *awareness* phase began with efforts to train local volunteers and BCPOS staff on using soil science observation techniques to complete the Colorado NRCS Soil Health Cropland Resource Concern Assessment card. Training was provided by the NRCS area resource soil scientist (RSS), MLRA project leader, and local field office staff. Ongoing training ensures that methods and

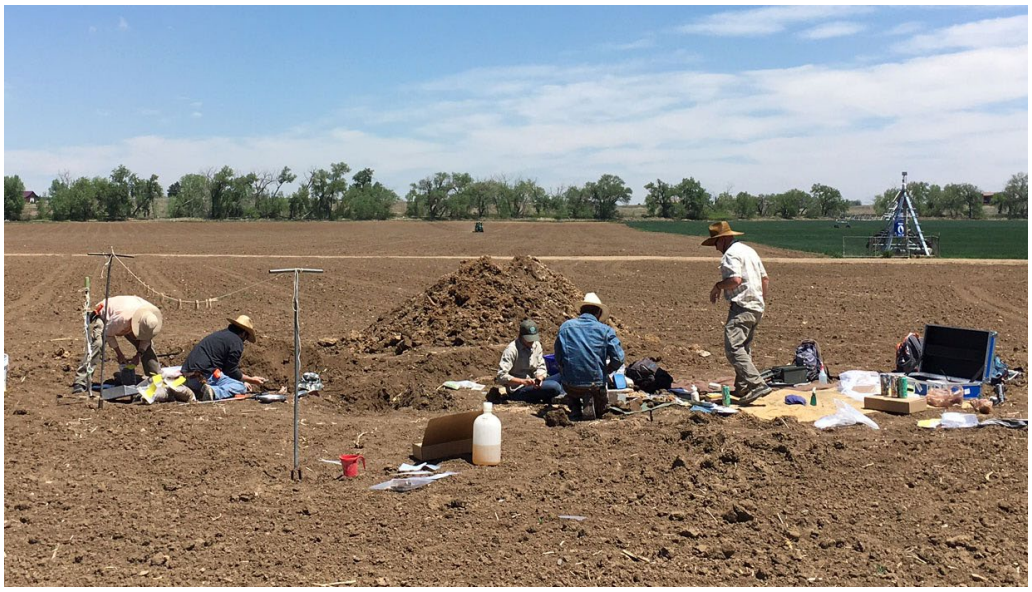


Comparison of soil health assessments showing similar trends.

The NRCS sampling team (left to right): Resource Soil Scientist Clark Harshbarger, Assistant State Soil Scientist Riley Dayberry, MLRA Project Leader Andy Steinert, Soil Data Quality Specialist Paul Rindfleisch, and Soil Scientist Mike Moore.

documentation are performed consistently over the course of the growing seasons. The soil health card is used to document qualitative soil properties relating to soil function. Properties are described according to soil horizon to document changes, by depth, of soil structure, soil color, root and pore size distribution, and compaction. Evidence of the soil food web and percent surface residue cover are observed across the plot area. NRCS and BCPOS are using both qualitative and quantitative methods to assess soil health and to document their findings.

The quantitative *assessment* phase began as a project plan submitted by the resource soil scientist and MLRA project leader to sample representative agriculture systems for dynamic soil properties and full characterization data. The NRCS National



Staff from MLRA, regional, State, and area offices working together to collect DSP and full characterization samples.

Soil Science Center (NSSC) and NRCS Kellogg Soil Survey Laboratory (KSSL) provided sampling guidance and analysis of dynamic soil properties (DSPs), such as soil organic carbon, particulate organic matter, bulk density, aggregate stability, and permanganate extractable carbon. Skye Wills, soil scientist and DSP specialist, and Rudy Garcia, regional soil health specialist, provided technical assistance to the project team via teleconference to ensure proper sampling protocol. Three of the seven sites in the project area were submitted to private laboratories for soil health testing and assessment. Each assessment combines multiple attributes to give a score. The results using the assessment card revealed the same trends as the industry standard soil health test. They showed a similar diagnosis of the systems' soil health. Dig a little, learn a lot!

Residue displacement from sheet erosion.

Weak physical crust with evidence of raindrop impact.

The awareness phase culminated in a collaborative effort between several local agencies to deliver a "Soil Revolution Conference" to the Boulder County area. The conference was the first of its kind. Colorado State University, NRCS, BCPOS, City of Boulder-Open Space and Mountain Parks, and private producers gave presentations on SHMS, farming philosophies, and applicable research from the region to almost 200 attendees. Attendees also had opportunities to visit educational booths and to network. Access to online content and suggested literature were provided. *Awareness* was bridged to *assessment* by presentations from NRCS and BCPOS staff summarizing the findings from the assessments of the soil health monitoring program. The audience included local government officials and agencies, producers, and interested citizens.

The assessment phase was completed by the quantitative data collection of full soil characterization and dynamic soil properties from seven sites sampled across the project area. Site selection placed an emphasis on locally important farmland managed with farming practices common to the region. Representative landform positions and soil-forming factors were also considered in the selection of the sites. The sampling team, consisting of NRCS soil scientists and BCPOS staff, used national protocols. This data set is the first full characterization produced by USDA-NRCS for the Soil Survey of Boulder County Area, Colorado (CO643). The data will be available to the public and to research groups with a vested interest in the study area after analysis by the NRCS Kellogg Soil Survey Laboratory in FY 2018. It will be published at: https://ncsslabdatamart.sc.egov.usda.gov/.

Soil pedons were sampled for full soil characterization by horizon to a depth of 2 meters. The Texas T, trench-style pit was used to allow easy access and safe egress. The team sampled each soil horizon for organic carbon, texture, particle-size distribution, bulk density, pH, CEC, CCE, base cations, elemental content,

water content, nitrogen, phosphorous, and base saturation. The team emphasized separating the epipedon into multiple sampling layers. The plots were set up using a triangular method from a central location: two satellite sites were sampled by small pits to a depth of 40 cm at an offset of 30° and 50 meters distance. Bulk density was sampled using the clod method at the central location and using the core, constant-volume method at all three locations. Dynamic soil properties were collected using a penetrometer and Jornada aggregate stability test and using field observations as referenced in the "Field Guide for Pedoderm and Pattern Classes." Data were collected on pedoderm class and development, subtype of crust, resource retention, and soil redistribution class.

The *implementation* of conservation practices within soil health management systems will begin the last phase of the soil health monitoring program. Commodity market fluctuations, political activities, and changes in input costs are creating new opportunities for farmers; however, the inherent challenge of the semi-arid, brittle climate of the central high plains leaves little margin for error. Producers have been cautious to adopt the practices being promoted, such as the germination and termination of cover cropping, for this reason. On-farm case studies are needed to document the best management practices and success stories of early adopters of SHMS. As with all conservation, it will be important to assess the practices and then adjust them based on the results and what is learned from the initial implementation. ■

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